Shackles of Kinship Bonds: Land Tenure Institutions and Smallholders' Farm Investments in Ghana

by Yuichi Kimura

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Yuichi Kimura†

Oita University

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†Oita University, 700 Dannoharu, Oita, Oita, Japan. Email: ykimura@oita-u.ac.jp. Phone: +81 97 554 7689.

Abstract

Concerns that ambiguous and overlapping land rights held under customary land tenure institutions undermine potentially productive investments in agriculture have prompted an ongoing process of land tenure formalization in many African countries. Using data from smallholder rubber growers in Ghana, this study shows that while land titling is weakly related to investments in tree planting, it does not impact the subsequent productivity of farms. Conversely, interventions by the the rubber company to reconcile contract growers' potential land tenure conflicts with their lineage groups significantly enhanced yields. Land acquired via inheritance or through allocation by lineage groups was found to impede potential increases in income by constraining contract growers' decisions to invest in tree planting, discouraging them from taking up the rubber company's intervention to reconcile tenure. The most compelling reason that relates unclearly defined land tenure with low levels of investment and productivity of rubber plot is that it constrains access to the credit at the onset of rubber cultivation.

1 Introduction

The question of whether land tenure formalization improves incentives for investment in land and enhances long-term investments in cash crops has been of central focus in land policy debates in Africa. Majority of subsistence farming villages operates under customary land tenure system. Under the customary system, individuals most often acquire access to land through negotiations held by lineage members or inheritance within a matrilineal inheritance system. While norms pertaining to access to land and farming resources not necessarily egalitarian (Berry 1993; Austin 2005), with its limited land transferability and customary norms, the customary land tenure system sustains stable small holding structure and provide minimum livelihood for subsistence farm village population.

However, under the customary land tenure system, long-term access to land may be threatened because land that is inherited or allocated by a matrilineal clan is always sub-

ject to potential renegotiation by members of the lineage group. Perennial cash crops, such as cocoa, oil palm, or rubber, could contribute to improvements in income (Byerlee et al. 2007). These crops require substantial initial investments and years of maintenance before they begin to provide yields, and long-term security of land access is a prerequisite for decisions on investing in tree planting. Given that returns on investments in land are always acquired in the future, an individual's ability to collect the profits accruing from investments in land can be undermined when land ownership is ambiguous. Therefore, it has been acknowledged that unclear and mutually overlapping land rights that are determined according to customary land tenure systems may hamper investment incentives and limit opportunities to achieve poverty reduction (Bruce and Migot-Adholla 1994, Platteau 1995). This recognition is in line with the property-right institution argument that have received significant attention within the literature of institutional and economic development, as reflected in the seminal works of Coase (1937, 1960) and North (1981). Based on on such a rationale, land tenure privatization is underway in various parts of sub-Saharan Africa.

Rubber contracting is a relatively new opportunity available to farmers in the western coastal region of Ghana, which is the area examined in this study. It gained prominence after the rubber plantation company established branches as it expanded its catchment areas by setting up village extension offices and calling for the participation of smallholder contractors. Access to new farming technologies, loans for purchasing agricultural inputs, and market channels were provided through the company's extension offices and processing facilities. These local settings provides ideal circumstances for testing the potential impacts of land tenure security, since the effect of land security depends on other conditions listed above (Asaaga et al. 2020). This study particularly focus on how loosely defined land rights of land acquired through kinship ties affect investments in farming, and how external interventions impact these decisions. Two types of interventions were examined in this study. The first is the introduction of a formal land registration project implemented in the area. Pilot formal land tenure reforms were initiated across broad stretches of the

country, including the villages examined in this study. The second type of intervention is an informal intervention by the rubber company aimed at reconciling land tenure between its contractors with their lineage members in cases where there is a risk of conflict erupting over multiple claims to rights over the land.

The findings of different studies on the impacts of land rights or land tenure formalization on investments in fam land are acknowledged to be inconsistent. Many studies have found that perceived land rights have insignificant impacts on farm investments. These findings suggest that customary land tenure systems provide sufficient protection and cast doubt on the necessity of land right formalization (Place and Hazel 1993; Migot-Adholla et al. 1994a, 1994b; Pinckney and Kimuyu 1994; Platteau 1995; Brasselle et al. 2002; Place 2009). Other studies have found that perceived land rights or the formalization of land rights significantly impacts certain types of land investments in different parts of sub-Saharan Africa (Besley 1995; Deininger and Jin 2006; Abdulai et al. 2011; Ali et al. 2014). Lambrecht and Asare (2015) surveys different studies conducted in Ghana to find that results vary even within the same country. Therefore, there is no firm consensus on the importance of land rights or the effectiveness of land titling projects.

Why exactly are vaguely defined land rights potentially related to lower investments? One pertains to the sharing pressure of returns to investment. Platteau (1991, 1996, 2000), among others, observes that in a context of shared norms within a traditional community, guaranteed access to, or monopolizability of returns to investment is impeded by redistributive norms. Put differently, it is an issue of mismatch between the beneficiary and cost bearing. That is, the costs of investing in cash crops are borne by the cultivator, but the consequent enhanced outputs may be subject to free riding by multiple stakeholders in the lineage group. Although majority of studies on land security and farm investments have implicitly assumed the relevance of this channel, several other channels may account for the link between vague land rights and disincentives against investment.

According to the moral hazard argument, family members within collectively managed farms reduce labor efforts, which are reserved for their own individual plots (Guirkinger

et al. 2015). From the perspective of credit access, in a context where an accessible credit market exists, land for which rights are clearly defined acquires collateral value (Feder et al. 1988; Feder and Feeny 1991). Loosely defined land rights and potential overlapping claims, which pose risk of credit loss on the loan providers, can lead to a low provision of input loans. In addition to the above points, Besley (1995) considers trade gains in village land markets. Specifically, access to the land market (sales and rentals) motivates investments because higher land values translate into higher sale or rental prices. This view is not considered here because land sales are low in the study area. While land rentals are common, rental rates are mostly fixed at one-third of the crop yield (*abusa*).

Gender gaps relating to land security and investments in farms have been reported as a concern within the land tenure literature. The transformation of customary land tenure system following earlier reforms to Ghana's formal inheritance law have evidently led to a shift toward individualized land tenure. These changes are generally viewed in terms of reduced customary restrictions against women. However, biases remain in areas such as land inheritance and security of use rights, leading to lower investments in land by women (Quisumbing et al. 2001b; Goldstein and Udry 2008), significantly lower rates of cash crop adoption, limited use of farming inputs, and lower productivity (Udry 1996). This study explores how the rubber company's promotion of women's participation as smallholder contractors fared in removing gaps between male and female cultivators in investments in and yields obtained from rubber cultivation.

The rest of this paper is organized as follows. Section 2 presents the data along with a description of the land tenure system in the study area, the spread of rubber cultivation, the formal land titling process, and the rubber company's intervention to reconcile overlapping land rights. A brief review of the literature on land tenure systems and incentives for investing in agriculture is provided in section 3. Section 4 discusses empirical strategy for identifying the impacts of these interventions on long-term investments and the subsequent productivity of rubber plots.

Section 5 presents the empirical results. The first subsection show that formal land

titling is positively related to investments in tree planting. Land titling involves self-selection where individuals with relatively secure land rights are more likely to formally register land title. However, the investment-enhancing effect was found to be robust to controlling for such selectivity. The second subsection reports on a sample calibration conducted to confirm the robustness of the tree planting equation and to assess changes over time in the impacts of land titling, of non-individual land rights of family-provided land, and of gender bias in farm investment. The third subsection presents the results of an analysis on the impacts of policy interventions on the productivity of rubber plots. It shows that whereas the rubber company's interventions to reconcile land tenure led to higher yields, formal title registration did not have this effect.

The fourth subsection discusses and interprets empirical results on the adverse impacts of overlapping rights over allocated or inherited land. The analysis reveals that land rights originating from matrilineal land tenure are associated with less enthusiastic responses to lucrative opportunities of rubber cultivation. The yield of rubber, when investment is made, is lower for less intensive input use in such lineage-related land. Further exploration of the reasons why land acquired within matrilineal systems leads to lower investment and yields does not provide sufficient evidence to draw any definitive conclusions in favor of any one of the competing hypotheses. However, the results suggest that while redistributive norms evidently create disincentives, credit access is the likely reason for lower investment and yields in land acquired through family ties. The final section offers the study's conclusions.

2 Data and Background

2.1 Data and Historical Contexts of Land Right institution

Data were collected from four districts in the western region of Ghana. Eight villages were sampled from the four districts: two villages from Ahanta West district, where Ghana

Rubber Estates Limited (GREL) started a rubber company in 1962, three villages from Mpohor/Wassa East district, one from Wassa West district, and three from Nzema East. These four districts are the major catchment area where the company has been expanding its number of household contract growers. The company started smallholder contracting in 1995, and by the year 2000 it had around 449 households registered as contract growers. This number increased to 1160 by 2005, 2832 by 2010, 5500 by 2013, and 7815 by 2015. The data for this study were sampled from these smallholder growers. The villages studied here roughly fall into two categories. One group consists of two villages located in inland of Western Region of Ghana, where spread of rubber is relatively new. The other group is six villages located in the coastal areas of the same region where the rubber plantation company's headquarter is located and the spread of rubber occurred among the earliest in the country.

The company originally started by the form of plantations in 1957 and expanded its plantation to 39 thousand hectares by 1962. Despite that the plantation scheme is a cost effective form of investment, the company switched to a smallholder contracting scheme (commonly known as the outgrower scheme) after 1995 for pursuing further expansion. Smallholder scheme allows farmers to enter in the production as they maintain their original land holdings, which does not involve any land transaction between the farmers and the company. Behind such change of schemes, there is recognition built among cash crop businesses that large scale land acquisition associated with the establishment of plantations often lead to displacement and dispossession of land. Such conflicts emanated resentment of the local population and caused failure of plantations in many cases (see, e.g., Fold and Whitfield 2012; Hall et al. 2017; Berry 2018). As the GREL undergo its smallholder scheme, it launched in 2007 a company responsibility policy that includes goals such as peaceful coexistence with the local community, sustainable environment, safe and decent livelihood of plantation employees.

Summary statistics are shown in Table 1. The data include 228 households with a total of 541 farm plots collected from interviews with one respondent from each of the sampled

households. The sample excludes recent migrants in 1995 and later which are likely to be migration for the purpose of rubber cultivation. The sampled households had on average 2.4 farm plots with an average size of 2.9 hectares. Majority of the households are Akans for which matrilineal inheritance has been traditional practices. In the matrilineal inheritance system, the cultivator's nephew (sister's son) is eligible to inherit land. Hypothetically, this system evolved for the advantages of allotting land rights to a large number of individuals and attracting labor for future reclamation of lands (Austin 2005). Other non-Akan households are moslems for which ordinary patrilineal inheritance is common. Majority of the cultivators are males. Females account for 16 % including female headed households. Slightly more than half of the sample plots were planted with rubber at the time of the survey. Figure 1 shows number of adoption of rubber and other crops against the years when the cultivators started that crop. Three cash crops increases starting from the second half of 1990s. Rubber cultivation particularly spread rapidly during the same period. Comparing yield value per hectare across crops, rubber is much more lucrative than other cash crops and food crops such as cassava and plantain. Roughly one-fourth of the sample plots received the company's intervention in tenure reconciliation, half of the plots were title registered.

[Table 1 Summary Statistics]

[Figure 1 Adoption of Rubber and Other Cash Crops]

Figure 2 shows when and how each plot was acquired by the respondent's family prior to the respondent accessing it. Previous land acquisition by the respondents' family was almost solely through appropriation from the village (55 % of plots under current cultivation by the sample households), which was observed dating from as early as the colonial rule during the nineteenth century. Customary practices provide incentives to clear the forest and prepare land for cultivation, as land rights are conferred to those who exert these efforts. Appropriated lands are held collectively by lineage groups, which in customary land tenure practice, are allocated for use by lineage members, or are transferred to the

next generation by matrilineal inheritance. Matrilineal inheritance system emerged and persisted under conditions of abundant land and scarce labor, which are advantageous in attracting family labor to cleared land (Austin 2005).

Migrants from various surrounding regions have settled in the study area: the northern part of Ghana, Burkina Faso further to the north, Togo in the east and Côte d'Ivoire in the west. The settlement of migrants became frequent during the expansion of cocoa cultivation particularly in 1920s and 1950s and culminated in late 1960s when cocoa cultivation expanded most rapidly. Increasing population pressure has altered the conditions of local resource endowments towards being labor-rich and land-scarce. These changes in resource endowments induced institutional change toward individualized land ownership, and a land market is gradually being formed (Austin 2005). Other types of acquisition besides appropriation from the village have begun to be observed. These changes coincide with the period when virgin forest had almost disappeared in Ashanti and other regions south to it (Quisumbing et al. 2001a).

[Figure 2 Year of family's plot acquisition by acquisition mode]

Figure 3 shows the transition over time of land acquisition modes for the current cultivators. It highlights that allocation from the village is no longer an important means of obtaining land. Instead, among the current generation of cultivators, allocation from lineage group, inheritance, renting, and purchasing from the village have become prevalent. These means of accessing land were rarely observed among the previous generation. Lands previously allocated from the village were held collectively by the lineage group, then for subsequent transfers gradually changed hands by other means. Among respondents, around half of the plots they cultivate were obtained through transfers from a lineage group, while renting gradually became more prevalent and currently accounts for one-third of all land acquisition.

The composition of land transfer modes changed further in the periods before and after 1995, when rubber cultivation began to spread in these regions. Land acquisition by renting

surged from 31 cases (or 23 % of all land acquisitions in 1995 and earlier) to 160 cases in the period after 1995 (to make up 36 % of all acquisitions). The land rental market is unarguably a powerful institutional apparatus that improves access to land by landless and land poor. Rental contracts are often passed on from the previous cultivator to their siblings or family. As rental contracts persist across generations, land rights are virtually passed on to the cultivator (Deininger and Mpuga 2009).

[Figure 3 Year of cultivator's plot acquisition by acquisition mode]

There are also changes occurring in the customary land inheritance system. One example is the emergence of gift transfer that appeared in the 1980s, where land use rights are passed directly from father to wife, son, or daughter rather than to other lineage members through the matrilineal bond (Quisumbing et al. 2001a). This type of transfer, which is essentially an ordinary patrilineal inheritance, has gradually emmerged since the issuance of the Intestate Succession Law in 1985, which was devised to remedy wives and siblings having insecure land rights. Gift transfer is observed in our sample and accounts for five to 6 % of plot transfers. Allocation from lineage groups and inheritance are acquisition modes particularly related to customary tenure system where cultivators' land tenure is most likely to subject to overlapping claims. These two acquisition modes, although declined in share as acquisition by renting in surged, still comprise half of all plots under control of the cultivators interviewed.

2.2 Land Titling and the Rubber Company's Intervention

Population pressure, and new lucrative cash crop investment opportunities necessitated institutional reforms to formalize and individualize land tenure systems. However, registration only occurred sporadically after a deed registration system was initiated under the Land Title Registration Law of 1986. Titling was practically initiated after a second wave of land reform under the Land Administration Project (LAP) that followed the implementation of the 1999 National Land Policy. Implementation of phase 1 of this policy

occurred from 2004 to 2010 and was intended to ensure enhanced personnel and logistical capacity (Kasanga and Kotey 2001; Cotula et al. 2004). Under the new land registration system, farmers voluntarily register land at local offices of the Lands Commission (the land administration authority). Titling and the issue of title deeds ensure the provision of exclusive land use rights to the right holder, guaranteeing the holder's rights when conflicts over contested land use rights are brought to court.

There has been concern that the commercialization of rural land institutions causes distress sales that lead to the concentration of landholdings within a small elite group and an increase in the landless poor. In the study site, customary law prohibits outright land sales to outsiders even after formal titling. Attempts to sell land, whether to outsiders or other villagers, must be preceded by consultations held with village chief and elders. Such inquiries are rejected in most cases, because of the strictures of customary norms. Despite widespread concern, land sales are rarely occur, as confirmed in other studies such as those of Yamano et al. (2009) in Kenya and Ali et al. (2014) in Rwanda.

Apart from the formal land reform, Ghana Rubber Estates Limited (GREL) intervenes to assist prospective smallholder contractors through a land rights reconciliation process when their land ownership is complicated and prone to the risk of land-related disputes or litigation. The company provides a mediating service for stakeholders within the lineage group or with the landlord, intervene in the negotiations and process to confirm the cultivator's long-term access to the plot. Interventions to reconcile land tenure occurred for 25% of the sample plots. However, it should be noted that this intervention is provided on the prospect that the cultivator potentially a rubber contractor. Almost all of the company's interventions (over 95%) resulted in rubber contracting.

The existence of financial constraints at the time of making the initial investment is a widely recognized barrier to cash crop adoption. Cash expenditure is required for preparing the land, purchasing seedlings, periodic applications of fertilizer, and acquiring labor for weeding. The financial and technical assistance that the company provides for these tasks helps farmers to overcome their financial constraints related to the initial investment. The

company's operations or the marketing opportunities that it provides are preconditions for smallholder farmers to have choices of participation in rubber cultivation.

Table 2 shows the types of crops adopted by gender of the main cultivators and frequency of interventions applied. There are 454 plots managed by men as the main cultivators and 87 plots managed by women as the main cultivators. The numbers in parentheses in the table indicate percentage shares within men's plots and within women's plots. Women are more often in charge of food crop production than men, with plots planted with food crops accounting for over 32% of women's plots, compared with 12% of such plots cultivated by men. Women were much less frequently the main cultivators of cocoa (10%) and oil palm (3%), which are relatively traditional types of cash crops, than men (17% and 13%, respectively).

The rubber company is directly promoting women's participation as a part of their corporate social responsibility efforts. By encouraging women to register with them as contractors, the company aims to increase the share of female contractors to meet a target of 30% compared with the current 18%. The rate of adoption of rubber cultivation among women (54%) is comparable with that of men (58%). Overall, the company's promotion of female contractors seems to have contributed to women's participation in rubber cultivation. The table shows that interventions to reconcile land tenure are exclusively provided for prospective rubber grower contractors. Titling is also applied almost exclusively to rubber plots. The proportions of reconciliation interventions involving men's and women's plots are balanced: 26% for both. The gender balance also holds roughly for title registration: 42% and 46% for men and women, respectively.

[Table 2 Interventions in land tenure by crop and gender]

Table 3 depicts how titling and tenure reconciliation actually influenced perceived land rights (or possibly how land rights influenced decisions to receive these interventions). It reveals seven types of land rights as perceived by men and women (including single female household heads). The rights of both the husband and the wife are recorded for given

plots cultivated by the household. The numbers in parentheses indicate differences in perceived rights between the treated and untreated plots. The statistical significance of the differences in the perceived rights between treated and untreated groups is indicated by symbols attached to the parentheses. Tenure reconciliation is associated with significant differences in mortgage rights for both husbands and wives, and in other transfer rights for wives, while land titling is associated with the right to give as gifts for both husbands and wives.

[Table 3 Perceived rights and interventions in land tenure]

Table 4 shows the company's interventions in tenure reconciliation and land titling by plot origin. The first column in the table shows the number of plots according to the acquisition mode. The first two family-related modes account for half of all of the acquired land. The second and fourth columns show the percentages of the plots treated with each of the two interventions. The third and fifth columns show how likely plots obtained via a given mode were to be treated. The numbers in parenthesis indicate the differences between the percentages of treated plots within a particular mode of acquisition and percentage of treated plots obtained via all of the other acquisition modes. T-tests were performed to determine statistical significance of the differences, results of which is indicated with a symbols attached to the parentheses. Tenure reconciliation was less likely to be provided to owners of plots acquired via the first two modes of acquisition: allocation within the lineage group and matrilineal inheritance, which are family-related modes. Tenure reconciliation would be most desired for plots obtained via those family-related modes, but such plots tend to have a deterring effect on these treatments. Land titles are similarly less likely to be applied to the lands allocated via lineage groups.

[Table 4 Plot origins and interventions in land tenure]

3 A Brief Survey of the Literature

There is an unresolved debate about whether customary land tenure is an impediment to long-term investment in land or input use for intensifying land use. The findings of earlier studies, in particular, indicated that on the whole, perceived land rights does not significantly enhance investments or the use of farming inputs.[1] These results have been interpreted as indicating that customary land rights are sufficient for securing incentives for investment and the use of inputs.

According to historical accounts from West Africa, weak tenure security is a product of legal pluralism, where the overlapping of the statutory land tenure system imposed by the colonial regime with the existing customary land tenure system, causing confusion (Amanor 2001; Crook 2008). The deterioration of customary rights has been apparent in some instances involving customary chiefs taking advantage of the confusion to sell community land for their own benefit (Lavigne Delville 2000). Holden and Otsuka (2014) observed that the capture of land resources by the elite occurs where statutory law (or titling projects) fail to recognize or build on customary land tenure systems, while Quan et al. (2008) points to critiques about supporting by formal institution of customary land relations which involve power relations that is inherently unequal.

There are sharp trade-offs between individualization of land tenure and communal ownership. The relative desirability of risk mitigation through mutual insurance for sustaining subsistence livelihoods and individual incentives for intensification of farm land use is a critical issue which potentially conflict with each other. Given the possibility of better income opportunities that became available by the entry of rubber companies into the region, investment incentives were accorded high priority. Land reform programs in sub-Saharan Africa, were introduced under these circumstances, which essentially are individualization and formalization of land rights broadly in line with neoliberal ideology (Amanor 2001; Pickery and Kimuyu 1994; Chimhowu 2019).

Customary land tenure has been evolving towards more individualized land tenure sys-

tems over the course of economic development, in response to returns on investments in commercial crops and rising population pressure (Bruce and Migot-Adholla 1994; Amanor 2001; Otsuka et al. 2001, 2003; Quisumbing et al. 2001b; Place 2009; Holden and Otsuka 2014). In light of the widespread finding of only a weak or absence of linkages between land rights and investment, it is often recommended that titling projects should be directed toward assisting the process of transition of customary systems rather than replacing them outright with a formal system (Place and Hazel 1993; Platteau 1996; Brasselle et al. 2002; Deininger 2003).

The shift in norms from communal management and redistribution of outputs to more individualized norms may be attributed to changes in factor endowment, associated with a shift from a land-abundant and labor-scarce economy to one that is land-scarce and labor-abundant. Customary tenure and matrilineal inheritance have the advantages of allotting land rights to a large number of individuals and attracting labor for future reclamation of lands (Austin 2005). Relative factor endowment has been altered by population pressure and increasing land scarcity has been one of the main rationales behind the reforms to formalize land tenure in Africa (Atwood 1990).

The question of whether more secure land tenure incentivizes investments entails theoretical ambiguity. Customary land institutions provide that once effort and inputs have been invested in the land by the current cultivator, usufruct rights are vested in that person and are maintained as long as the crop is growing over the land. That is, while secure land rights can lead to investment, investment can enhance tenure security. Under this condition, weakness of current land rights, rather than secure rights may potentially lead to long-term investment in expectation of enhanced future land security. Stronger land security can also result from making a long-term investment when the cultivator demonstrate to other lineage members his or her usage rights on a plot by planting perennial crops (Austin 2005).

The issue is particularly prominent for perennial cash crops that entail many harvesting years after the initial investment. Once the cultivator has successfully made their long-

term investment, co-owners within his or her lineage group conventionally acknowledge the cultivator's usage rights as long as the crop is growing on the plot. If such an impact is foreseen, it is unclear whether stronger security of land rights will lead to investment, or cultivators with weaker tenure security will have greater motivation to making long-term investment in order to cement future land use rights.

When farmers' land tenure is insecure, they may invest in land as a strategy for strengthening their future land rights. Therefore currently insecure land rights would lead to greater investments. At the same time, insecure land tenure reduces the likelihood of farmers reaping the returns on their investments, thus reducing the incentive to invest. Therefore, the overall impact of existing land tenure security is indeterminate (Besley 1995; Otsuka et al. 2003; Deininger and Jin 2006; Ali et al. 2014). The same ambiguity is present in the relationship between farmers' current tenure security and their decisions to register land or apply to the rubber company to implement a tenure reconciliation intervention. Strong tenure security can both reduce or increase the likelihood of a cultivator registering land or applying for tenure reconciliation. This makes the direction of the impacts of the policy interventions to enhance private land rights on investment unpredictable.

Apart from the impacts of perceived rights or titling, extended family and collective management are considered to deter investments for several reasons. Redistributive obligations among lineage members, or even among friends, are still firmly entrenched in sub-Saharan Africa. The primary motive behind redistributive obligations is to maintain mutual insurance as a safeguard against unexpected shocks resulting from crop failure or illness, and to keep oneself being entitled for mutual insurance (Platteau 1991; Fafchamps 1992). The accumulation of wealth motivates an individual/household to withdraw from community-level mutual insurance, which adversely impacts other community members. Norms to avoid defection from risk sharing are directly linked to norms to avoid individual wealth accumulation. There are trade-offs where redistributive obligations have a risk-mitigating function under survival level of food production but become impediments to responses to investment opportunities, particularly when the returns on investments are

privatized.

The emergence of such restrictive norms can be attributed to the fear that successful individuals will deviate from the risk sharing networks, thereby leaving others with weaker ability to mitigate income-related shocks. Platteau (2000) offers a comprehensive interpretation that encompasses anthropological arguments, thus departing from the usual presumption of economically rational choices made by agents with an individualistic mindset. In what was formerly the prevalent worldview of tribal societies in sub-Saharan Africa, the behavioral principle of individuals was not necessarily to maximize utility from consumption; rather, each individual evaluated their own achievement of welfare through mutual comparison within social relationships. According to this view, in conjunction with the worldview in which food produce is considered to be gifted by a supernatural being, inter-personal or household differences in wealth are not justifiable. These factors account for the existence of egalitarian norms that are aimed at avoiding envy, and excess profit generation is perceived as a violation of this norm. Such egalitarian norms give rise to redistributive pressure and disincentives against productive investments (Di Falco and Bulte 2011). Therefore, individuals who experienced unexpected income gains are motivated to deviate from their social networks in an attempt to evade redistributive pressure (Di Falco et al. 2018).

Guirkinger et al. (2015) observe that the low management intensity of collectively owned lands is an outcome of limited labor inputs. Collectively managed land, usually devoted to food crops that are managed by the entire household, are subject to moral hazard or free-riding problems where household members conserve their efforts for managing their individually managed lands. This explanation can also account for a possible relationship between clearly defined property rights and investment incentives. Redistributive pressure as well as moral hazard relating to the management of collective farms, both have implications for the productivity gaps that exist between men's and women's plots because commonly held plots are often devoted to the production of food crops and are more often managed by female rather than male cultivators.

Yet another explanation for low investments in collectively managed land is that the unclear ownership rights over the land undermine its collateral value. If this is the relevant factor that constrain the financing of long-term investments or input use, then the formalization of rights may enhance the land's collateral value, removing credit constraints relating to investments and the use of farming inputs, provided that a functioning credit market exists within the villages (see Feder et al. 1988; Feder and Feeny 1991).

4 Empirical Strategy

For tenure reconciliation provided by the rubber company as well as for land registration at the land authority, all decisions to accept interventions were made on a voluntary basis by households. Therefore, empirical identification requires to take care of selectivity in assessing the impacts of the interventions. The problem is exaggerated by the fact that these interventions were introduced around the same time as rubber farming was being spread among smallholders in the region.

The rubber company intervenes in negotiations and helps arrange agreements among lineage members. This service is provided in response to an application, and on the basis that the farmers are potential contractors; before the choices related to the intervention, farmers much commit to tree planting. This causes reverse causality where the investment decision explains the intervention rather than vice versa. The rubber company also examines the cases of potential smallholder contractors and may decide to intervene when the land rights are complex and when it sees a potential threat of litigation. On the other hand, the company may also seek to avoid plots where land use rights are overly intertwined and potentially subject to litigation. For cultivators, secure land tenure can make receiving the intervention and the contract itself easier. With the selection bias in two channels in opposite direction with each other, the combined direction of the bias in identifying the relationship between the interventions and investment can not be predicted in advance. It is likely that there is a correlation between the interventions and household/plot attributes,

both observed and unobserved.

The same selectivity issue arises for the choice to register land at the land authority. For similar reasons, the direction of possible bias is indeterminate for the choice to register land. In addition, decisions to register land may not be predetermined independently from decisions to plant rubber trees. In some cases, land registration is carried out with assistance from the rubber company and in around one third of the registered plots registration is completed after a tenure reconciliation intervention. This figure goes up to nearly 50 % among plots eventually planted with rubber. The introduction of a formal land registration system itself was partly motivated by the spread of contract farming with the rubber company. Consequently, among the plots with a registered title deed, 70 % are planted with rubber. This indicates that decisions to register land involve endogeneity that arises from correlation with other decisions, such as whether to apply for the company's interventions or whether to plant rubber trees, and thus with unobservable cultivator/household characteristics.

As was discussed in the previous section, the direction of the impacts of policy interventions on subsequent land security and investment is theoretically indeterminate. Overlapping and unclearly defined land rights may motivate investment, as well as better defined rights may do the same. Therefore, one cannot predict a priori that more stable land security leads to larger investment in land. Same line of consideration applies to the expected impacts of company's reconciliation and titling. Even if we can be surely believe that treatment of these interventions augments tenure security, the securer rights can potentially lead to lower level of tree planting or management intensity, as well as they may motivate these investment. Reverse causality must be resolved before we can examine the impacts of those interventions on investment and use of inputs.

These issues call for elaboration in identifying the causality between current land tenure security and longterm investment. Following Goldstein and Udry (2008), I use proxy variables for current cultivator's political status in the village and in the household to capture pre-determined land security. In the regression analysis of tree planting decisions, I

use these proxy variables to identify the impacts of two types of interventions on investment in land: tenure reconciliation and title registration.[2]

Instruments that represent cultivator status can potentially be problematic particularly in tree planting equation. Cultivator status variables represent, after all, tenure security of the cultivator. While we expect that the instruments be effectively correlated with the intervention variables, they are suspected to be correlated also with investment. Village office holding status as used by Goldstein and Udry (2008) were found susceptible to such concern: exogeneity of office holding variables were rejected in the second stage equation of both tree planting and yield value equations.[3] These were excluded from the set of instruments. Alternatively, subtler indicators of cultivators' status are used. Exogeneity of these variables are tested and ensured, results of which I report in the results section.

The variables are listed in Table 1. The set of instruments comprises of four categories of variables: (1) indicators of whether the cultivator's father is a landed farmer, and their occupation categories, (2) the length of time the cultivator's family has been living in the village, (3) indicators of cultivator's status within the family in relation to the custom of polygamy, and (4) the distance from the cultivator's residence to the plots. For the first category of variables, having a father who was a landed farmer, and having a father with particular occupation types, namely trader or artisan, suggests relatively high social status in the village or in the matrilineal clan (or directly implies stable access to land), compared to occupation types that are excluded, such as agricultural laborer, food processing, nonagricultural laborer, fishery, and various non-farm jobs.

The second variable category is duration of residence of the family in the village. Migrants have shorter land use history and in general have weaker land tenure security. Regarding the implications of customary land tenure systems, migrant households are clearly less susceptible to contested land rights within lineage groups as only 20 % of migrant household plots were allocated from family or inherited, compared to 55 % of non-migrant households. The third category of variables pertains to the cultivator's status within the family and includes three variables: the wife order of the cultivator's mother, which takes

value of one if the mother is the first wife of the cultivator's father, the total number of wives of the cultivator's father, and the number of siblings of the father. Polygamy used to be common and is often found among elders in the region. Among the 244 interviewed cultivators, 10 % or 26 cultivator's mothers were the second or lower order wife. When the father had more than one wife and the cultivator was a sibling of the second or lower order wife, his or her bargaining power in the family was generally reduced.The number of siblings of the cultivator's father may similarly affect his or her bargaining power in the family. The fourth category of variable is the distance from the cultivator's residence to their plot. This is an additional proxy variable for the restraint in investment caused by lineage ownership. Plots closer to the residential areas tend to have been cultivated for longer periods of time and are more likely to be subject to overlapping use claims from multiple lineage members.

5 Empirical Results

5.1 Investments in Tree Planting

Table 5 shows the estimation results of investments in tree planting. To avoid upward bias from in-migrants who moved into the study area for the purpose of starting rubber cultivation, 21 migrant households operating 44 plots that acquired their first plots in the village in and after 1995 were excluded from the sample. The first column of Table 5 shows the results of uninstrumented regression. Inclusive of all biases and ambiguities, both land rights reconciliation and land titling are positively related to tree planting investments. Following observables are not shown but controlled for: dummy variables for Moslem households which practice ordinary patrilineal inheritance practices, dummy variables for female respondents and female-headed households, the ages and years of schooling of household heads, the year of plot acquisition by the cultivator, and the proportion of migrants in the village. Village and household fixed effects are controlled for in this and

all subsequent regressions.

The second column in Table 5 shows the results of the instrumented regression where the two types of interventions are instrumented for. Land tenure reconciliation turns insignificant when instrumented, that is, after controlling for the selectivity resulting from the targeting of prospective smallholder contractors for the intervention. Land titling maintained a significant relationship with investment after being instrumented. Test results for confirming the validity of the set of instruments are reported at the bottom of the table. Overidentifying restrictions are not rejected, and the joint significance of instruments is at sufficient levels for land titling and reconciliation (columns 3 and 4). Therefore, the validity of the set of instruments is guaranteed using standard criteria.[4]

The family origin of land (land that were obtained by inheritance or allocation from the lineage groups), with the selection in the interventions are adjusted, is found to negatively and significantly affect investment in trees.[5] The negative association of family origin with investment contrast with those of other studies from Ghana. Quisumbing et al. (2001b) and Otsuka et al. (2003) found that land acquired through family ties was positively related to cocoa tree planting. A possible reason for this difference is the relative importance of the two driving forces: the incentive to make visible investments in land for the purpose of asserting exclusive rights to the land, which overwhelmed the cultivators' aversion to making large investments under the present conditions of tenure insecurity. The effects of family origins were simulated for the 271 plots acquired through family ties within the sample, and shown at the bottom of Table 5. The baseline probability of tree planting is 49%. Assuming that the negative effect of family origin was absent, that is, assuming that these plots were obtained through other means, the counterfactual probability of tree planting is 65%. The negative impact of family origin was 16%.

The third column of Table 5 shows the determinants of the probability of being the recipient of a tenure reconciliation intervention. This serves as the first stage regression of the instrumental variable estimation shown in the second column. Cultivators whose plots were acquired through family ties, who belong to large extended families, and whose plots

are located in areas close to residential areas where overlapping claims to use rights are likely to be more prevalent are less frequently the beneficiaries of land tenure reconciliation. Recipients of tenure reconciliation interventions tend to be cultivators with weaker land tenure claims, which is reflected in the negative association between being a beneficiary of such interventions and having a father who is a landed farmer.

Cultivators with the reverse characteristics to those described above were the recipients of land titles. The cultivators' stronger political power is associated with a higher probability of titling, as shown in the fourth column of Table 5. Land titles are more likely to be received by cultivators whose fathers are traders and whose mothers are their fathers' first wives. Titling appeared to be availed of by cultivators with relatively stable political power within their lineage groups to cement their exclusive rights.

5.2 Sample Calibration by Year of Land Acquisition

This section looks at the relationship between titling and investment in trees by calibrating the sample by year of land acquisition. This analysis was conducted for two reasons. The first is to examine more closely whether land acquisition is endogenous and is affected by the prospect of commencing rubber cultivation. In the same way as migrant households that moved to the area in 1995 or later can cause reverse causality and upward biases, new land acquisitions by native villagers are subject to the same problem. Calibration by acquisition year enables comparison of the effects of titling between the land acquired before 1995, when rubber contracting was first introduced to the area and those acquired after that time.

The sample calibration enables time variations in other factors of interest, notably land acquired through family ties and investments in trees by female cultivators to be observed over time. Changes over time in the impacts of these factors on investments, in particular, differences between lands acquired long before the arrival of rubber contracting and land acquired in recent years, reflect changes in local social norms around

collectivism/egalitarianism as well as those relating to gender roles.

Table 6 shows the results of the same tree planting equation as the previous section, but with the range of samples calibrated by the year of land acquisition by cultivators. In each column, the sample is restricted to plots acquired before the indicated year. The sample is further restricted through the exclusion of titling that was conducted after tree planting. This reduces the total number of observation from 541 plots to 424 plots. Coefficients of land titling, family origin of land, and female cultivator status are shown in the table, of which land titling is treated as endogenous.[6]

The first column of the table shows the results using a sub-sample of plots acquired before 1986, which is well before land titling was initiated under the LAP. If titling of these lands acquired during an earlier time are linked to tree planting, the problem of reverse causality could be safely discarded. However, the results indicates that there were no significant impacts for the subsample of plots acquired during years up to 1997. The relation between land titling and tree planting for plots becomes larger when the sample includes plots acquired during years up to 1998. Incremental expansion of observations to include the cultivators' land acquisition in subsequent years, a significant relation emerges when sample includes plots acquired by 2001. Expanding observations further to include those acquired in later years, statistically significant relation continues to be observed until the plots acquired before 2009 are incorporated.

Limiting the sample by year of land acquisition does come at a cost because the choice of when to acquire land plots itself is a choice of the cultivators. As Table 6 shows, the number of land acquisitions accelerated as rubber cultivation becomes more accessible and its adoption becomes more widespread. It can possibly lead to endogeneity, particularly regarding land titling in the tree planting equation, as the cultivators who obtained land for the purpose of rubber cultivation would plant trees immediately after acquiring the land, and if they at the same time tend to initiate titling to secure their rights. Endogeneity was tested for titling and the family origin of land, and the results are reported in Table 6a. The table shows the test statistics to confirm the validity of the set of instruments

used in the instrumental variable estimations of Table 6. The first and third rows of the table show p-values of the tests for the joint significance of instruments, overidentifying restrictions, and endogeneity of land titling. Weak instrument problem is evident for some of the subsamples as the set of instruments are not jointly significant. For subsamples of plots acquired by 2005 to that obtained by 2009, endogeneity of the titling variable is properly corrected for. The positive effects of titling on tree planting as shown in Table 6 are established for these periods.

The second and fourth columns of Table 6a show the test results of the joint significance of instruments, overidentifying restrictions, and endogeneity, for family origin of land. The instruments are significant and exogenous, and the exogeneity of family origin is reasonably concluded. Therefore, family origin is treated as exogenous in Table 6. Family origin was found to be negatively related with tree planting throughout different ranges of subsamples according to years of acquisition. As expected, the impediments are greater for plots obtained during earlier years. As shown in Table 6, during the first half of the 1990s, lands acquired through family ties were around 30% less likely to receive investment of tree planting, compared with lands that were acquired through other means. Inclusion of plots obtained in the second half of the 1990s, when rubber cultivation started to spread in the area, slightly weakens the negative impacts. This diminishing of negative impacts suggests that the impediments against investment in cash crops associated with family-related modes are more pronounced for plots obtained earlier, but such constraints attenuated for plots acquired in later years.

Female cultivator status in the refined sample used here is negatively associated with tree planting in most of the subsamples. The estimated negative association is the largest for plots obtained by the 1980s: plots managed by women are around 50% less likely to receive investment in tree planting than those managed by men. The negative association diminishes when the subsamples includes plots obtained during the 1990s and up to 2010s, ranging between 20% and 25%. As was the case for plots originating from families, constraints associated with women's plots declined for more recently acquired land.

Table 7 shows the results of a similar sample calibration that excluded subsamples of plots acquired before 1990. This range omits the plots acquired through family ties and plots managed by women obtained during the early period that was associated with greater impediments against investment in cash crops. The subsample starts with plots acquired in 1990 or later and prior to 1996 (the first column). The validity of the set of instruments for titling and family origin was examined, and the results are shown in Table 7a. As shown in the second and the fourth columns, instruments for family origin fulfills the joint significance and overidentifying restriction for most of the subsamples. The exogeneity of plots acquired through family ties was checked and confirmed. For titling, as shown in the first and the third columns, jointly significance of the instruments are fulfilled for some of the subsamples. It could be concluded that titling enhanced tree planting from the subsamples that include plots obtained by up to 1996 to that include those obtained by 2007.

For land originating from families, there were even greater constraints for land acquired by the end of the 1990s, than those found in Table 6. The negative association becomes weaker for subsamples obtained by the late 2000s, so that statistically significant negative impacts are no longer seen for the wider subsample that include plots acquired in or after 2008. Clearer changes from table 6 are seen for female-managed plots, where statistically significant disadvantages against tree planting are no longer seen.

Overall insights gained from the calibration by year of land acquisition are as follows. The impacts of land titling are observed only for plots obtained after rubber contracts became available in the area. This leaves suspicion that land acquisition after 1995 was intended for rubber cultivation and endogenous, even though such possibility was fairly safely excluded at least on the basis of Wu-Hausman test. Titling becomes irrelevant with tree planting as the subsamples are expanded to include plots obtained after the late 2000s or 2010s, and impediments associated with land acquired through family ties and women's plots declined for recently acquired lands. The weakening of the negative association of family origin and female cultivator status may be attributed to changes in the norms as

rubber cultivation becomes widespread, leading to attenuating constraints against rubber contracts on these categories of lands.

5.3 Productivity of Rubber Plots

Table 8 shows the estimation results of yield values per parcel for 296 plots planted with rubber. The first column shows the regression results without the use of instruments. As in the previous analysis, migrant households that settled in the area in 1995 or later were excluded. Land tenure reconciliation was found to have a positive and significant impact of increasing the yield value per parcel by 1,524 Ghana Cedi. Formal titling, which was found to enhance tree planting, did not increase yield values. In the second column, where the two intervention variables are instrumented, the estimated impact of titling is negative. This finding is in line with those of previous studies by Place and Migot-Adholla (1998), Quisumbing et al. (2001b), and Fenske 2011. Following visible investments in land and securing of exclusive use rights, input use tended to be low.

The coefficient of tenure reconciliation is much larger when instrumented, with the selectivity is controlled for. The results of the first stage regression, shown in the third column of Table 8, reveal characteristics of cultivators and plots that received tenure reconciliation. Similarly with the results of the tree planting equation described in the previous subsection, the company intervention was less likely to be received when the land was acquired through family ties, for larger size of extended family, for farm plots located in proximity to residential areas, and for cultivators whose father was landed farmer, which implies the cultivator's better access to land. That is, while the intervention was less likely to be carried out for plots that are subject to stronger overlapping claims, cultivators with weaker bargaining power were the targeted beneficiaries.

Simulated losses that overlapping land rights incur on rubber yield are shown at the bottom of Table 8, for the 134 rubber plots acquired through family ties. Family origin did not affect the yield values directly, but it had an indirect effect given the lower probability

of receiving tenure reconciliation. Family-provided land are less likely to receive tenure reconciliation by 32% compared with the counterfactual 65% where it is assumed those plots were obtained via other modes. Based on this counterfactual probability of tenure reconciliation, the yield value would be 2,099 Ghana Cedis per hectare, compared with the real baseline value of 1,367 Ghana Cedis. Losses incurred through family origin status of land are around 50% of the baseline value.

The fourth column of Table 8 shows the results of household fixed effects estimation. Looking at the within-household variation reveals that the family origin of land directly affects yield per hectare. Family-provided lands are chosen not to receive for reconciliation interventions among other land plots of the household. The estimated impact of tenure reconciliation is greater in magnitude than what was observed in cross-section estimation (the second column). These family-provided lands are used less intensively than the household's other land plots acquired via non-family modes. For these 134 plots acquired through family ties, counterfactual yield was calculated assuming they were obtained via a non-family mode. Family origin of lands lowers the yield via direct effect of overlapping rights, as well as via an indirect effect by lowering the likelihood of benefiting from tenure reconciliation assistance. The direct effect, assuming these land plots were obtained via a non-family mode, the counterfactual yield increases to 3,437 Ghana Cedes from the baseline value of 1,367 Ghana Cedis. The direct loss that the overlapping rights incur is 2,070 Ghana Cedis. The indirect effect works through higher probability of receiving the tenure reconciliation assistance (.59 instead of the baseline of .44). The value per hectare increases to 2,545 Ghana Cedis from the baseline value of 1,367 Ghana Cedis. Therefore, the loss from the foregone effect of tenure reconciliation is 1,178 Ghana Cedis. With the direct and indirect effects combined, the loss that weak land rights incur on the yield of rubber is 3,248 Ghana Cedis, which amounts to more than two-fold of the baseline value.

5.4 Family Origin of Land and Gender

The results indicated that the family origin status of land negatively and statistically significantly affected investments in tree planting (Table 5). The family origin status of land was also found to reduce yield from rubber plots indirectly (Table 6). Thus, a further exploration was conducted to determine which of the different hypothesized channels is relevant for lowering investment and input use for family-provided land. From the perspective of redistributive pressure, the number of potential stakeholders who could demand dividends from the investment would be expected to affect investments negatively. Assuming that the cultivators would prioritize feeding their own family members, a large extended family could be considered as a burden, and the number of extended family members would then be expected to be negatively related to investment. Evidently, such a view would not hold if the farmers equally care about all of the extended family members, as noted by Besley (1995). The size of the extended family is measured by the number of children who are offspring of the cultivator's mother, and thus the brothers and sisters of the cultivator. The variable measures the number of potential dependents in the cultivator's lineage group. All the variables are measured in household level. Summary statistics of these variables are shown in the bottom of Table 1.

Table 9 shows the results of regressions at household level, of input use relating to family variables. The table shows only the relevant family variables and sizes of rubber plots, but all other control variables used in the yield value equation are included in the regression. In the left half of the table, dependent variables are measured in expenses per hectare of the four types of inputs per hectare of rubber plots.[7] The number of lineage members who are eligible for redistribution, which is measured by the number of children of the same mother, is not found to lower the expenses for seedlings and other types of inputs. Moreover, oppositely to what moral hazard hazard view predicts, labor input per parcel of rubber plots is rather positively related with larger size of lineage groups (number of children of mother), and larger proportion of rubber plots that lineage member

can claim shares (proportion of inherited or allocated land). The size of lineage group simply augments labor input by lineage members, or wages payed for non-family labor. Oppositely, the number of household members living apart is positively related to the level of seedling inputs, presumably because financial means are enhanced through remittance, but it is negatively related to labor input. These suggest that a moral hazard view of family labor does not account for low rubber productivity.

The proportion of rubber plots that were inherited or allocated from the lineage group is negatively related to the expenses for seedlings per hectare of rubber plots. Rubber seedlings are intensively used at the start of cultivation, for which the smallholders heavily depend on loans in kind disbursed by the rubber company. In receiving those loans, the land and standing immature trees serve as collateral. A comparison of rubber plots acquired through family ties and those acquired through other means revealed that the value per hectare of inputs for seedlings for the former (182.6 Ghana Cedis) was much lower that of the latter (252.9 Ghana Cedis). These are consistent with the regression results indicating that the family origin of land lowers tree planting and the likelihood of receiving tenure reconciliation assistance (Table 5), but does not directly affect the yield of rubber (Table 8). This view also accords with the observation that the right to mortgage land for acquiring loans is most prominently enhanced by tenure reconciliation among other types of land rights.

In order to examine this collateral-based hypothesis more directly, a binary indicators for an acquisition of company loans with respect to the four types of inputs are regressed on the same measures of lineage groups. The results are shown in the right half of Table 9. The number of eligible lineage members are not found to reduce the likelihood of receiving loans for any type of inputs. It is rather slightly positively related to loans for pesticide. The proportion of rubber plots that were acquired through family ties is significantly associated with lower likelihood of receiving company loans for seedlings.

These findings indicate that plots acquired via family ties, which are prone to potential overlapping claims, receive lower levels of initial inputs. That is, the credit access perspec-

tive is the most likely explanations for the link between weak land rights and lower yields of rubber plots. Same interpretation applies to the low investment of tree planting. Some level of investment in rubber was nevertheless evident for these plots, as they were identified as rubber plots. But the company's supply of seedlings were clearly lower, delayed, or in some cases completely stalled unless they had undergone the tenure reconciliation, since otherwise there remains a risk of conflict or litigation that may undermine the contractor's ability to repay.

With respect to the gender dimension, the results indicated that investments relating to tree planting were not lower for plots managed by women, and these plots did not exhibit lower productivity after rubber trees had been planted. A possible explanation is that the exclusive promotion of women as contractors were effective in removing gender bias relating to investments in trees, which, however, is not verifiable with the data. Land tenure reconciliation did not disproportionately targeted female contractors were not within interventions,[8] or its impacts were not significantly greater on female cultivators.[9] Given that the farm inputs and credit were supplied by the rubber company, credit constraints against the use of inputs were not gender biased, which may not have been the case if input use was entirely decided by households (see Udry (1996); Quisumbing et al. (2001b); Goldstein and Udry (2008). In other words, the company's intervention was successful in removing gender bias both in terms of tree-planting investments and productivity. The fact that women are slightly less likely to be cultivators of plots acquired through family ties than men may partly explain the absence of a gender bias.

6 Conclusion

Insecurity of land tenure and disincentives against potentially beneficial investments have long been concerns in sub-Saharan Africa, particularly in areas where matrilineal inheritance has prevailed. The trend of land rights formalization implemented over several decades in the region is based on the recognition that overlapping and loosely defined land

rights constrain potentially profitable investments. This study was based on data collected in areas of western Ghana where rubber cultivation has been spreading in recent years following the establishment of extension offices and processing facilities by a plantation company. The input loans, technical support, and market channels provided by the company fulfilled the preconditions for smallholder farmers to make long-term investments in rubber.

A formal land titling project was simultaneously implemented in the study area. The analyses utilize the response to the profit opportunities that relatively newly available to see the impacts of overlapping land rights of lineage-related lands and policy interventions. The paper studied the impacts of land title formalization, the rubber company's intervention of reconciling land tenure with its contractors' lineage groups, and the losses that unclearly defined land rights derived from lineage ties incur on investments in tree planting and on yield of rubber.

The empirical results indicated a linkage between land titling and investments in tree planting. Whereas land titling had investment-enhancing impacts, it had no effect on yields per parcel, that is, on intensive use of inputs. Titling tended to be availed of by cultivators with already secure land rights that were assured by their relatively established political status measured by their fathers' land holdings and their mothers' marital positions. Titling and tree planting were mostly aimed at cementing cultivators' use rights. Titling projects were found to be effective for enhancing long-term investments, if it did not enhance equality. Interventions by the rubber company to reconcile the land tenure of contract cultivators with their lineage groups had no direct impact on tree planting. However, these interventions were found to be effective in enhancing the yield values of farms planted with rubber. Unlike land titling, tenure reconciliation functioned in an egalitarian manner, as it tended to serve cultivators with weaker political status measured by their fathers' occupations and mothers' marital positions.

The impacts of land titling enormously vary across the years plots were acquired. Titling is positively related to tree planting for land acquired after 1995 when rubber contract-

ing became accessible, and up to the time when rubber planting became prevalent in the late 2000s. Impediments against rubber planting on women's plots are observed for plots obtained during the 1980s. Such impediments are not, however, binding for lands obtained more recently. Similarly, the impediments against planting rubber on land acquired through matrilineal inheritance or through allocation by lineage groups are found to be significant for land obtained during the 1980s and 1990s, but such impediments attenuated for more recently acquired land. These changes may reflect changes in norms resulting from information dissemination relating to the newly introduced crop.

The results of the study confirmed that overlapping rights constrains tree planting and yield of rubber. Unclearly defined and potentially overlapping land rights, measured by plot acquisition through matrilineal inheritance or allocation by the lineage group, were found to be associated with losses in the form of foregone income gains via two linkages: a lower likelihood that investment in tree is made in these plots and lower values of yields obtained from the plots that did receive the investment. Family origin does not directly have an adverse impact on the value of yields from rubber plots, but it does lower the likelihood of plots being subject to the company's tenure reconciliation initiative, which significantly enhances the yield per hectare.

Initial inputs, especially seedlings, were lower for land acquired through family ties. In the study area, the low input for family-related land can mostly be attributed to weak collateral function of the land that constrains access to input loans provided by the company, as opposed to other explanatory hypotheses, such as redistributive obligations relating to outputs or moral hazard relating to labor inputs. Overlapping land rights associated with family origin constrain access to loans for seedlings because they deter an intervention designed to strengthen tenure. Yields per parcel were consequently reduced through less intensive inputs of seedlings. The same constraint is also likely to account for the low initial investments in tree planting posed by the family origin status of land. Unclearly defined land rights of land acquired through family ties make the company reluctant to provide loans in kind for seedlings, which the smallholders are in crucial need at the time

of investing in tree planting.

Notes

[1]Perceived rights may be simultaneously claimed subjectively by other right holders within the lineage group, which create difficulties in measurement of perceived rights. Information on perceived rights was collected for the present paper, but these results are not presented because none of the rights categories were found to be related to investments or yield values.

[2]Angrist and Pischeke's (2009) prescription is that multiple endogenous variable in an instrumental variable regression should usually be avoided particularly because it "does not make sense to think of one endogenous variable as a "control" when looking at the effects of another". Nevertheless, such a complication is not avoidable under circumstances in the study villages, where multiple changes are occurring at the same time.

[3]Positions of traditional village office include *abusua panyin* (village chief), *okyame* (lineage head's spokesman), *tufohene* (main advisor to the chief), *mbrantehene* (chief of development issues), *asofohene* (chief of youth issues), and *obaapanin* (queen mother in Akan matrilineal clan)

[4]Further consideration leads to a cautious inference that the instruments used here reflect the cultivators' bargaining power, that is, their land security. Such reasoning counters full endorsement of the view that the instruments are uncorrelated with the dependent variable, tree planting. That is, more powerful cultivators with more secure land tenure may have been more likely to invest in tree planting, giving rise to a positive bias in the coefficient of land title. Standard test measures of overidentifying restrictions may not fully ensure the exogeneity of the instruments even if those tests do not reject it. The method of plausibly exogenous instruments proposed by Conley et al. (2012) was performed for the purpose of further ensuring this issue, but the results revealed that the confidence intervals for coefficients of the two interventions did not converge to form a meaningful boundary when the exclusion restrictions were relaxed. This implies that the instruments cannot be considered "plausibly exogenous".

[5]The family origin itself is treated as exogenous in all of the regressions after confirming its exogeneity using the Wu-Hausman test. The p-statistics obtained from these tests are shown at the bottom of the table. The alternative treatment of family origin as endogenous does not affect the coefficients of other endogenous variables.

[6]The rubber company's tenure reconciliation variable is excluded, as collinearity between the two interventions is strong in this refined sample. As in the previous analysis, all other controls are included

in the estimation apart from household dummies. Omitting household dummies does not qualitatively change the results.

[7]Labor input is measured in expenses for wage payments, which may fail to capture some of labor inputs by family members.

[8]The intervention was received by 28% of female contractors and 26% of male contractors.

[9]A simple check was performed to assess the impact of tenure reconciliation on the productivity of female cultivators' rubber plots by including an interaction term between female cultivator status and an indicator for receipt of the intervention. The results did not indicate any greater effect for women compared with the effect on men.

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Table 1: Summary Statistics

	Number of observations	Mean (percentage)
Household-level variables		
Akan households	192	(84.2)
Moslem (non Akan) households	36	(15.8)
Female headed household	26	(11.4)
Age of household head	228	46.6
Years of schooling of HH head	228	8.9
Household size	228	6.0
Plot-level variables		
Male cultivator	454	(83.9)
Female cultivator	87	(16.1)
Land size (hectare)	541	2.9
Year of acquisition, family	541	1918.1
Year of acquisition, cultivator	541	2001.0
Value per parcel (Ghana Cedi/hectare)		
Food crop	85	1777.0
Cocoa	84	582.3
Oil palm	61	650.3
Rubber	296	3458.4
Interventions in land tenure		
Company's land tenure reconciliation	143	(26.4)
Title registration	231	(42.7)
Instrumental variables for interventions:		
Distance to plots from residence (kilometers)	541	4.0
Family's status in village / mother's status in marriage		
Father was a trader	73	(12.5)
Father was a landed farmer	108	(18.5)
Farther was an artisan	41	(7.0)
Family's length of residence in village	541	102.8
Mother is the first wife of father	322	(59.5)
Number of wives of father	541	2.1
Number of children of father	541	9.6
Measures of input use and extended family		
Farm expenses per hectare of rubber plots (Ghana Cedi)		
For seedlings	136	165.8
For fertilizer	136	130.9
For pesticides	136	125.0
For wages	136	390.4
Acquisition of loans (percent)		
For seedlings	136	(29.4)
For fertilizer	136	(36.7)
For pesticides	136	(8.8)
For wages	136	(1.5)
Extended family		
Number of children of mother	136	5.97
Number of adult members of the household	136	4.09
Number of household members living apart	136	1.38
Proportion of inherited or allocated land	136	.50
Total land size of rubber plots	136	5.89

Note. Percentages are shown in parenthesis for binary indicator variables.

Table 2: Interventions in Land Tenure by Crop and Gender

	All crops		Food crop		Cocoa		Oilpalm		Rubber	
Males' plots										
Tenure reconciled	120	(26.4)	1	(0.2)	5	(1.1)	1	(0.2)	133	(29.3)
Title registered	191	(42.1)	21	(4.6)	20	(4.4)	10	(2.2)	140	(30.8)
All males	454	(100.0)	56	(12.3)	76	(16.7)	58	(12.8)	264	(58.1)
Females' plots										
Tenure reconciled	23	(26.4)	0		0		0		23	(26.4)
Title registered	40	(46.0)	1	(1.1)	1	(1.1)	3	(3.4)	35	(40.2)
All females	87	(100.0)	28	(32.2)	9	(10.3)	3	(3.4)	47	(54.0)
All cultivators	541		84	(15,5)	85	(15.7)	61	(11.2)	311	(57.4)

Note. Percentage shares within all males' plots or within all females' plots are shown in parenthesis.

Table 3: Perceived Rights and Interventions in Land Tenure (in Percentages)

	All	Tenure reconciled		Title registered	
Male cultivator					
To plant trees	88.1	88.1	(–0.1)	85.8	(–4.1)
To cultivate after fallow	77.9	78.4	(0.7)	75.4	(–4.4)
To bequeth/ nominate heir	55.7	55.2	(–0.7)	54.5	(–2.1)
To rent out	46.5	47.8	(1.8)	44.1	(–4.2)
To sell outright	19.7	18.7	(–1.5)	19.4	(–0.5)
To give as gift	22.5	26.1	(4.9)	28.0	(9.4)**
To mortgage	33.2	42.5	(12.8)***	32.7	(–0.9)
Observations	497	134		211	
Female cultivator					
To plant trees	70.2	71.2	(1.3)	69.8	(–0.7)
To cultivate after fallow	49.8	54.2	(6.1)	48.0	(–2.9)
To bequeth/ nominate heir	31.1	37.3	(8.4)*	33.0	(3.1)
To rent out	25.9	34.7	(12.1)***	27.4	(2.4)
To sell outright	9.8	12.7	(4.0)	10.6	(1.4)
To give as gift	11.4	13.6	(3.0)	14.5	(5.3)*
To mortgage	17.7	28.8	(15.1)***	17.9	(0.3)
Observations	75	22		179	

Note. Perceived rights are recorded separately for the husband and wife for each of the sample plots. Percentage point differences between treated and untreated groups are shown in parentheses.

* p < .1.

** p < .05.

*** p < .01..

Table 4: Plot Origin and Interventions in Land Tenure

Mode of land acquisition		Tenure reconciled (Percentage)		Title registered (Percentage)	
Allocated from lineage group	134	16.4	(–13.3)***	35.8	(–9.1)**
Inherited (matrilineal)	137	20.4	(–8.0)*	47.4	(6.4)
Transfer from father	31	48.4	(23.3)***	32.3	(–11.1)
Appropriated from village	24	50.0	(24.7)***	58.3	(16.4)
Rented in	168	31.5	(7.4)*	42.3	(–0.6)
Purchased	39	28.2	(1.9)	56.4	(14.8)*
Other	8	25.0	(–1.5)	12.5	(–30.7)*
All	541	26.4		42.7	

Note. Number in parentheses shows the differences between the percentages treated within the given mode of land acquisition and the percentages treated in all other modes of land acquisition.
$*$ p $<$ .1.
$**$ p $<$ .05.
$***$ p $<$ .01.

Table 5: Investment in Tree Planting

	Tree planting		Land tenure reconciliation	Land titling
	Uninstrumented	Instrumented		
	(1)	(2)	(3)	(4)
Land tenure reconciled	.426***	.060		
	(.039)	(.228)		
Land titled	.227***	.366**		
	(.043)	(.181)		
Inherited or allocated family land	–.084	–.179***	–.147***	.077
	(.043)	(.066)	(.046)	(.057)
Female cultivator	–.103	–.131	–.016	.030
	(.071)	(.086)	(.057)	(.081)
Size of extended family	.012	.007	–.026**	–.0006
	(.009)	(.010)	(.010)	(.012)
Distance from residence			–.020***	.011
			(.007)	(.010)
Father was a trader			–.082	.247***
			(.071)	(.084)
Father was a landed farmer			–.173***	.054
			(.066)	(.070)
Father was an artisan			–.021	.146
			(.070)	(.098)
Year of family's first land acquisition			.0001	–.0002
			(.0005)	(.0005)
Mother is the first wife of father			–.070	.154**
			(.051)	(.059)
Number of wives of father			–.021	–.021
			(.022)	(.028)
Number of children of father			.003	.007
			(.004)	(.005)
Village dummies	Yes	Yes	Yes	Yes
Household dummies	Yes	Yes	Yes	Yes
Observations	541	541	541	541
R^2	.44	.37	.28	.23
Joint significance of IVs			p=.0001	p=.014
Test of overidentifying restrictions		p=.60		
Exogeneity of acquisition mode		p=.27		
Baseline probabilityes (271 family-provided plots)		.49		
Counterfactuals (if obtained via other modes)		.65		

Note. Heteroscedasticity-robust standard errors are shown in parenthesis. Tenure reconciliation and land titling are instrumented in the second column. P-statistics for joint significance of IVs, for Wooldridge's robust score test of exclusion restrictions of IVs, and for Wooldridge's robust score test of exogeneity of land acquisition modes are shown at the bottom of the table. The baseline predicted values and counterfactual are shown for the subsample that were acquired through family ties.

* p < .1.

** p < .5.

*** p < .01.

Table 6: Calibration by Year of Land Acquisition, DV: Tree Planting

Year of acquisition by cultivator	<1986	<1987	<1988	<1989	<1990	<1991	<1992	<1993	<1994	<1995	<1996	<1997	<1998	<1999	<2000
Land titling	.229	−.026	−.302	−.147	.013	.059	.270	.158	.101	.074	.059	.116	.349	.415	.397
	(0.98)	(0.10)	(0.94)	(0.48)	(.05)	(.22)	(.92)	(.55)	(.38)	(.29)	(.23)	(.41)	(1.35)	(1.59)	(1.59)
Family origin	−.238	−.261	−.363***	−.330**	−.329*	−.314***	−.319***	−.327***	−.314***	−.321***	−.316***	−.230*	−.251*	−.260*	−.255***
	(1.60)	(1.56)	(2.62)	(2.43)	(2.56)	(2.69)	(2.71)	(2.85)	(2.71)	(2.83)	(2.87)	(1.93)	(2.28)	(2.53)	(2.77)
Female cultivator	−.462***	−.513***	−.505***	−.108	−.202	−.230*	−.190	−.203*	−.214*	−.122	−.149	−.281***	−.269***	−.260**	−.237**
	(3.04)	(2.97)	(2.66)	(0.38)	(1.55)	(1.84)	(1.45)	(1.65)	(1.73)	(.93)	(1.15)	(2.62)	(2.59)	(2.48)	(2.34)
Observations	74	79	84	87	102	111	117	122	123	135	145	160	178	183	199

Year of acquisition by cultivator	<2001	<2002	<2003	<2004	<2005	<2006	<2007	<2008	<2009	<2010	<2011	<2012	<2013	<2014	<2015
Land titling	.468*	.558*	.572*	.568*	.471*	.478*	.520*	.387	.363*	.236	.019	.048	.052	.157	.161
	(1.92)	(2.21)	(2.27)	(2.18)	(2.03)	(2.03)	(2.41)	(1.57)	(1.68)	(1.07)	(.09)	(.23)	(.24)	(.67)	(.67)
Family origin	−.268***	−.263***	−.251***	−.245***	−.225***	−.211***	−.200***	−.178***	−.164***	−.169***	−.160***	−.151***	−.131***	−.165***	−.170***
	(3.40)	(3.47)	(3.46)	(3.37)	(3.25)	(3.16)	(3.04)	(2.85)	(2.69)	(2.84)	(2.66)	(2.59)	(2.29)	(2.95)	(2.99)
Female cultivator	−.217**	−.253***	−.213**	−.203**	−.165**	−.179**	−.160*	−.136*	−.131*	−.194**	−.193*	−.212**	−.178**	−.135*	−.135*
	(2.28)	(2.59)	(2.29)	(2.25)	(1.94)	(2.14)	(1.93)	(1.70)	(1.70)	(2.55)	(2.47)	(2.80)	(2.38)	(1.83)	(1.83)
Observations	217	231	238	240	254	268	280	296	310	326	352	369	402	420	424

Notes. Absolute values of t-statistics are shown in parentheses.
* p < .1.
** p < .05.
*** p < .01.

Table 6A: Validity Check of the Instruments

Land titling														
Joint significance of instruments	.282	.188	.177	.145	.061*	.095*	.077*	.126	.080*	.059*	.119	.275	.128	.113	.111
Overidentifying restriction	.582	.484	.385	.724	.908	.845	.916	.669	.724	.584	.634	.390	.138	.300	.341
Exgogeneity of land titling	.137	.021**	.008***	.023**	.116	.055*	.021**	.049**	.048**	.097*	.354	.395	.974	.843	.950
Family origin															
Joint significance of IVs	.320	.240	.066*	.068*	.164	.019*	.010***	.009***	.011**	.000***	.000***	.000***	.000***	.000***	.000***
Overidentifying restriction	.445	.549	.474	.851	.949	.860	.883	.721	.744	.661	.778	.645	.237	.263	.338
Exgogeneity of family origin	.855	.694	.401	.332	.667	.824	.713	.614	.940	.817	.479	.301	.252	.368	.211
Land titling															
Joint significance of instruments	.138	.147	.140	.191	.051*	.055*	.034*	.090*	.028*	.038*	.012*	.013*	.022*	.041*	.048*
Overidentifying restrictions test	.579	.643	.765	.725	.535	.607	.737	.899	.945	.686	.474	.390	.723	.581	.530
Exgogeneity of land titling	.789	.416	.341	.373	.522	.523	.362	.839	.844	.867	.191	.331	.357	.790	.817
Family origin															
Joint significance of IVs	.000***	.000***	.000***	.000***	.000***	.000***	.000***	.000***	.000***	.000***	.000***	.000***	.000***	.000***	.000**
Overidentifying restriction	.538	.487	.490	.505	.434	.630	.563	.729	.793	.719	.554	.497	.729	.546	.504
Exgogeneity of family origin	.211	.190	.217	.197	.166	.072	.118	.562	.432	.373	.393	.309	.675	.762	.680

Notes. P-values for the test of joint significance of the set of instruments, test of overidentifying restrictions, and Wooldridge's (1995) robust score test for exogeneity of the explanatory variables are shown. In the test of exogeneity, significant test results represent rejection of exogeneity.

* p < .1.

** p < .05.

*** p < .01.

Table 7: Calibration by year of land acquisition, plots acquired after 1990, DV: tree planting

Year of acquisition by cultivator	<1996	<1997	<1998	<1999	<2000	<2001	<2002	<2003	<2004	<2005
Land titling	.492***	.690***	.459**	.639***	.571***	.871***	.985**	.937***	.870***	.796***
	(5.51)	(4.01)	(2.45)	(3.70)	(3.06)	(3.30)	(2.39)	(2.99)	(3.00)	(2.99)
Family origin	−.883***	−.636***	−.364*	−.445**	−.308*	−.393***	−.373***	−.323***	−.302***	−.278**
	(3.83)	(3.78)	(1.88)	(2.26)	(1.87)	(2.74)	(2.61)	(2.68)	(2.65)	(2.55)
Female cultivator	.750	.335	.163	.159	.111	.144	.047	−.026	−.068	.034
	(3.46)	(1.53)	(0.67)	(0.66)	(0.45)	(0.70)	(0.22)	(0.15)	(0.45)	(0.24)
Observations	34	49	67	72	88	106	120	127	129	143
Year of acquisition by cultivator	<2006	<2007	<2008	<2009	<2010	<2011	<2012	<2013	<2014	<2015
Land titling	.640*	585**	.383	.297	.158	−.050	.049	−.048	.107	.103
	(2.34)	(2.48)	(1.59)	(1.56)	(0.82)	(0.25)	(0.23)	(0.22)	(0.42)	(0.39)
Family origin	−.215**	−.168*	−.113	−.084	−.076	−.055	−.065	−.031	−.078	−.085
	(2.18)	(1.73)	(1.34)	(1.08)	(1.07)	(0.74)	(0.90)	(0.45)	(1.17)	(1.26)
Female cultivator	−.004	.005	−.006	−.018	−.136	−.131	−.159	−.142	−.075	−.079
	(0.04)	(0.05)	(0.06)	(0.16)	(1.26)	(1.21)	(1.54)	(1.43)	(0.76)	(0.80)
Observations	157	169	185	199	215	241	258	291	309	313

Notes. Absolute values of t-statistics are shown in parentheses.
∗ p < .1.
∗∗ p < .05.
∗ ∗ ∗ p < .01.***

Table 7A: Validity Check of the Instruments, Plots Acquired after 1990

Year of acquisition by cultivator	<1996	<1997	<1998	<1999	<2000	<2001	<2002	<2003	<2004	<2005
Land titling										
Joint significance of instruments	.	.000***	.000***	.000***	.008***	.458	.824	.598	.598	.297
Overidentifying restriction	.552	.095	.153	.133	.239	.445	.964	.988	.983	.960
Exgogeneity of land titling	.011	.004	.804	.371	.545	.143	.074	.031	.052*	.066*
Family origin										
Joint significance of IVs	.	.000***	.000***	.000***	.0003***	.000***	.000***	.000***	.000***	.000***
Overidentifying restriction	.034**	.009**	.060*	.042*	.018**	.200	.242	.221	.275	.272
Exgogeneity of family origin	.033	.502	.362	.362	.975	.242	.308	.366	.366	.277

Year of acquisition by cultivator	<2006	<2007	<2008	<2009	<2010	<2011	<2012	<2013	<2014	<2015
Land titling										
Joint significance of instruments	.353	.196	.285	.002***	.004***	.003***	.012**	.030**	.150	.222
Overidentifying restrictions test	.907	.972	.931	.832	.623	.546	.448	.851	.631	.620
Exgogeneity of land titling	.243	.219	.850	.837	.557	.085	.393	.194	.701	.717
Family origin										
Joint significance of IVs	.000**	.000***	.000***	.000***	.000***	.001***	.004***	.007***	.004***	.005***
Overidentifying restriction	.494	.400	.772	.682	.657	.516	.514	.840	.649	.639
Exgogeneity of family origin	.147	.516	.655	.930	.988	.797	.586	.887	.921	.985

Notes. P-values for the test of joint significance of the set of instruments, test of overidentifying restrictions, and Wooldridge's (1995) robust score test for exogeneity of the explanatory variables are shown. In the test of exogeneity, significant test results represent rejection of exogeneity.
$*$ p $<$ .1.
$**$ p $<$ .05.
$***$ p $<$ .01.

Table 8: Yield Value Per Hectare

	Yield per hectare		Land tenure	Yield per hectare
	Uninstrumented	Instrumented	reconciliation	Household fixed effect
	(1)	(2)	(3)	(4)
Land tenure reconciled	1524.2*	5031.3*		8094***
	(786.6)	(2942.9)		(2915.9)
Land titled	435.0	–1554.4		–394.8
	(550.7)	(1306.5)		(1566.4)
Inherited or allocated family land	–608.5	99.1	–.321***	–4572.9***
	(530.8)	(664.2)	(.085)	(1383.1)
Female cultivator	340.6	155.4	–.083	
	(416.4)	(531.2)	(.130)	
Size of extended family	253.7	290.9	–.028***	
	(126.5)	(157.8)	(.017)	
Distance from residence			–.032***	
			(.015)	
Father was a trader			–.179	
			(.177)	
Father was a landed farmer			–.367*	
			(.107)	
Father was an artisan			–.097	
			(.122)	
Year of family's first land acquisition			–.0001	
			(.0009)	
Mother is the first wife of father			.070	
			(.102)	
Number of wives of father			.034	
			(.039)	
Number of children of father			.008	
			(.008)	
Inverse Mills' ratio	4273.1*	28320.7		
	(2858.5)	(13191.6)		
Village dummies	Yes	Yes	Yes	
Household dummies	Yes	Yes	Yes	
Observations	296	296	296	296
R^2	.53	.38	.53	.47
Joint significance of IVs			p=.043	
Test of overidentifying restrictions		p=.72		
Exogeneity of acquisition mode		p=.40		
Baseline predicted values (134 family-provided plots)		1367.0	.44	1367.0
Counterfactuals (indirect effect through tenure reconciliation)		2099.8		2545.9
Counterfactuals (direct effect if obtained via non-family mode)			.59	3437.2

Note. Heteroscedasticity-robust standard errors are shown in parenthesis. Tenure reconciliation and land titling are instrumented in the second column. P-statistics for joint significance of IVs, for Wooldridge's robust score test of exclusion restrictions of IVs, and for Wooldridge's robust score test of exogeneity of land acquisition modes are shown at the bottom of the table. The baseline predicted values and counterfactuals are shown for the subsample that were acquired through family ties.

$*$ p $<$ .1.

$**$ p $<$ .05.

$***$ p $<$ .01.

Table 9: Expenses for Farm Inputs and Size of Extended Family: Rubber Cultivator Households

	Farm expenses per hectare of rubber plots				Acquisition of loans			
	Seedlings	Fertilizer	Pesticide	Labor	Seedlings	Fertilizer	Pesticide	Labor
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Number of children of mother	–1.87	1.83	6.36	27.6	–.009	–.015	.015	–.0003
	(.21)	(.49)	(.79)	(1.54)	(.65)	(.99)	(1.66)	(.12)
Number of adult household members	–7.45	–4.71	–3.40	14.2	–.016	–.011	–.025**	–.005
	(.87)	(1.01)	(.38)	(.74)	(.84)	(.54)	(2.17)	(1.41)
Number of household members living apart	–8.69	5.97	30.4	–28.1	–.004	–.004	.019	.002
	(.55)	(.42)	(1.37)	(1.07)	(.12)	(.15)	(1.08)	(.32)
Proportion of inherited or allocated land	–108.9**	14.4	–30.5	484.6	–.173*	–.069	–.062	–.005
	(2.10)	(.46)	(.94)	(1.07)	(1.72)	(.65)	(1.48)	(.34)
Total land size of rubber plots	3.05	–1.71	–7.61	–20.7	.011	–.017**	.031	.016*
	(.62)	(.58)	(1.13)	(.49)	(1.08)	(1.78)	(4.50)	(2.22)
Observations (household)	136	136	136	136	136	136	136	136
R^2	.28	.28	.14	.14	.19	.19	.32	.40

Note. Absolute values of heteroschedasticity-robust t-statistics are shown in parenthesis.
* p < .1.
** p < .05.

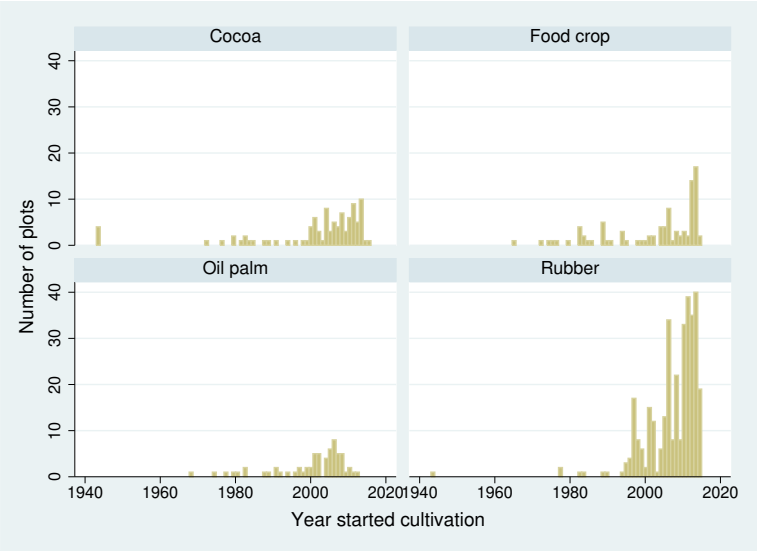

Figure 1: Adoption of rubber and other cash crop cultivation

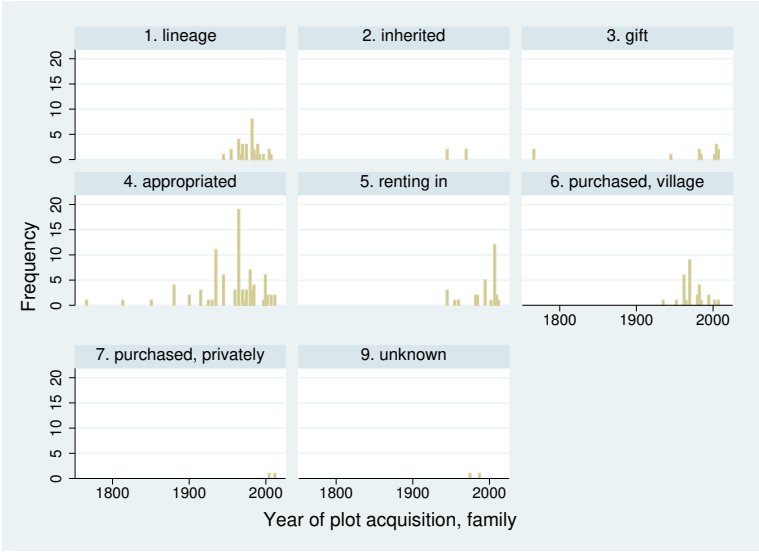

Figure 2: Year of plot acquisition by acquisition mode, family

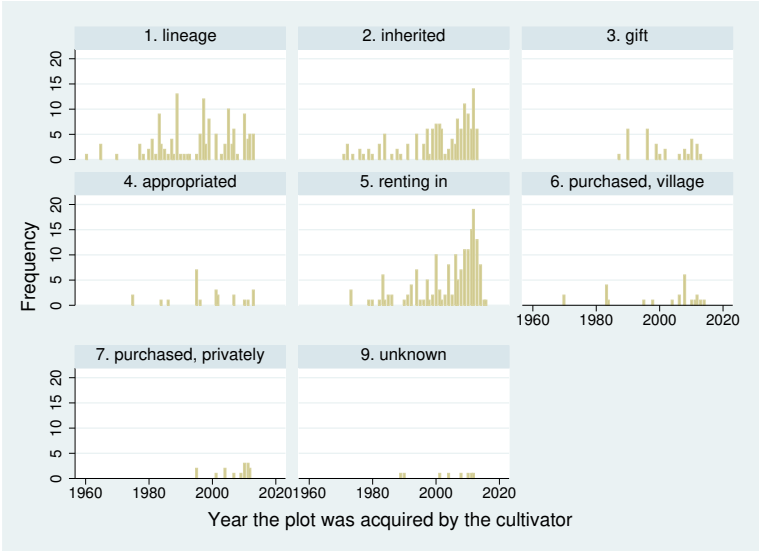

Figure 3: Year of plot acquisition by acquisition mode, cultivator