THE ROLE OF LAND CERTIFICATION FOR THE EXPANSION OF OTHER CASH CROPS IN RUBBER-PRODUCING AREAS IN SOUTHWEST CHINA

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Abstract
This paper analyses the role of land certification among smallholder rubber farmers in the expansion of cash crops other than rubber in the rubber dominated area of Xishuangbanna, Southwest China. A distinction is made between two types of land certificates, namely forest- and farmland tenure certificates. A multinomial endogenous switching model with counterfactual analysis is applied to analyze the effect of certification effects. The empirical basis is a panel dataset of 612 smallholder rubber farmers to investigate the ratio of other cash crops relative to rubber. Results show that households with farmland tenure certificates are more likely to plant other cash crops.

Key Words: forestland and farmland certificate, other cash crop cultivation, Southwest China, multinomial endogenous switching model

1. INTRODUCTION

Land tenure reform is considered to be a vital institutional innovation with the attempt to enhance land use rights of owners (Adams et al., 1999). Secure land use rights are key elements to increase production efficiency, facilitate access to credit and stimulate higher levels of investment (Feder, 1998) and thus contributing to the diversification of agriculture and economic growth.

In recent decades, China has launched a series of land policy reforms including the issuance of land certificates to famers that provides them with more tenure security in farmland and forestland. The aim of land reforms is to establish a functioning land market and hereby increase land productivity and improve land conservation with the ultimate goal to reduce the widely existing urban-rural gap in socio economic conditions (Ding, 2003). There are two types of land certificates in China. One is for land that is covered with forest and the other one is for land that is used for agricultural crops. A certificate for forestland has a duration of 70 years but it does not allow the recipient of the certificate to change its use from forest to crop farming. A farm land certificate on the other hand has a duration of 30 years. It includes all kinds of agricultural crops including annual and perennial crops such as rubber, for example.

It is important to distinguish between certification of farmland and forestland. The main differences between these two systems of land certification are that the durations of land use rights for farmland is 30 and forestland is 70 years (Yin et al., 2013). However, constraints in the process of certification occur. The complexity of geographic conditions and the lack of capacity of local authorities often cause uncertainty in the identification of land use, i.e. whether it is farmland or forestland (Jones, 2010). Tenure insecurity due to historical reasons prior to certification is also cause for potential conflicts (Min et al., 2017).

In this study, we analyze the impacts of forest and farmland certification on cash crop cultivation in, Xishuangbanna (XSBN) in Southwest China. In this area, rapid land use transformations from forestland and subsistence crops like rice to rubber plantations, driven by the long-term increase in rubber prices over the last three decades have taken place. Since 2010 rubber prices started to decline, making other cash crop like tea, coffee, and banana competitive. However, a change in land use is subject to land tenure security. Hence in this paper we (i) analyze the determinants of the existence of land use certificates to smallholder farmers in XSBN and (ii) assess the role of land tenure certification on the shift from rubber to other cash crops. Our analysis is based on the panel data from two socioeconomic surveys of 612 smallholder rubber farmers in XSBN covering the period of 2012 and 2014 respectively. Detailed data on land use history, land tenure status and duration of land use rights, inputs and outputs of rubber and other crops were collected.

In this study we apply a multinomial endogenous switching model. The model separately estimates the impacts of forestland and farmland tenure certification on cash crop expansion. We divide households into 4 groups, namely, (1) households with only farmland tenure certificate, (2) households with only forestland tenure certificate, (3) households with both farmland and forestland tenure certificates and (4) households without any land certificates (as the base group). To capture the shifts in land use from rubber to other cash crops, we employ the “ratio of land allocated to other cash crops relative to rubber” as the dependent variable. In the first step, the selection equation identifies the determinants of the existence of different land certificates on household level. In the second step, an outcome equation is estimated with selection bias correction terms calculated from the multinomial logit model. Then a treatment model is implemented to

estimate the counterfactual effects. For our impact analysis we compute the ATT and ATU effects. ATT effects compare the actual rate of the households with both certificates to the counterfactual rate if the households would have gotten only one certificate or no certificate. Furthermore, we compare land allocation ratio of households with only one certificate to the counterfactual. Correspondingly, the ATU effects are computed by comparing the rate of households without certificate or with only one certificate to the counterfactual.

Our descriptive analysis shows that the issuance of land tenure certificates in XSBN generally follows the progress of land certification in other regions in China. By 2012, about 30% of rubber farmers had farmland use certificate and 31% of rubber farmers had forestland tenure certificates; 34% of farmers obtained both farmland and forestland certificates. Our data of smallholder rubber farmers also show that the proportion of land used for rubber was 77% in 2012 while 6% were planted to other cash crops; 12 % of land was allocated to food crops and about 5% of lands were rent out. In 2014, rubber plantations had decreased by about 4% while other cash crops increased by slightly over 5%.

Results from our model show that several factors are vital for the existence of farmland and forestland certificates by households. Membership in social groups and tree age of perennial crops is positively correlated with availability of farmland certificates, while age of household head is negatively correlated. Results also indicate that households with a higher share of rubber land are unwilling to plant other cash crop even though the rubber price is low. Furthermore, households who frequently experience shocks are less likely to shift to other cash crop. ATT results show that the ratio of other cash crop relative to rubber will respectively rise by 2 % and 28% if households with both certificates would have been certified as sole forestland or farmland certificate. If the only forestland- or farmland-certified households could have been issued both certificates, the ratio will decrease by 5% and 30% respectively. If the households with forest land use certificate were assigned to only have farmland certificate, the ratio will increase by 11%.

To sum up, ATT ad ATU results show that expansion of other cash crop takes place in households with either (a) only farmland certificate or (b) only forestland certificate. Households with both types of land use certificates and those without certificate are less likely to expand cash crops. This suggests that the transition from rubber to other cash crops is not only subject to the availability of land use certificates but is also influenced by the prior share of rubber land.

2. PRINCIPLES OF LAND TENURE CERTIFICATION AND CASH CROP IN XSBN

In recent decades, China has launched a series of land policy reforms involving the issuance of farmland and forestland tenure certificates to guarantee farmers' land use right. The farmland certification and forestland certification respectively date back to 2002 and 2008, built on relevant land laws and official documents. Given similar rights for farmers in contract and management, the main differences of these two systems of land certification are (i) the durations of land use rights of farmland and forestland are up to 30 and 70 years, respectively; (ii) the farmland and forestland certificates are issued by different government departments, namely local Bureau of Agriculture and Bureau of Forestry, according to various land characteristics; (iii) Farmland tenure certificate is more flexible compared with forestland tenure certificate. Specifically, once a land is certified as forestland, it will be always forestland and couldn't certified as farmland forever.

However, if a land has farmland tenure certificate, it still has the chances to change to forestland and then get forestland tenure certificate.

However, constraints in the process of certification derive from the unclear identification in land use between the two certification channels because of the complexity of geographic characterizes, lack of capacity of local authorities, potential conflicts and ambiguous land use due to historical reasons before certification (Min et al., 2017; Jones, 2010).

Linking to this study, Xishuangbanna(XSBN), Dai Autonomous Prefecture in Southwest China has experienced rapid land use transformations from traditionally managed field crops and tropical forests to rubber plantation driven by the increase in rubber prices over the last three decades. Since 2010s, due to the declining rubber prices, local farmers began to seek other sources of income in coping with the price shock, such as other cash crop like tea, coffee, banana. Shifts in rural cropping systems from rubber plantation to other cash crop plantations have been come into being.

One interesting question might be to what extent land certifications, i.e. farmland tenure certification and forestland tenure certification, influence the expansion of rubber and the conversion of land use from rubber to other cash crops in XSBN. It is sensible to hypothesize that smallholders' conversion of land use from rubber to other cash crops is facilitated by owning land tenure certificates as land use rights are guaranteed and land tenure security is increased.

By 2012, about 30% of rubber farmers only had farmland use certificate while 31% of rubber farmers only had forestland tenure certificates. And 34% of farmers obtained both farmland certificate and forestland certificate. Furthermore, crop patterns have been notably changed in XSBN since 2003.

3. METHODOLOGY

In this section, we introduce the methodology we have used to measure the impacts of different land tenure certificates on the ratio of land use size between other cash crops and rubber. A multinomial endogenous switching model is employed to estimate the impacts of forestland and farmland tenure certification on cash crop expansion separately and control for selection bias and unobserved heterogeneity. To capture the shifts in land use from rubber to other cash crops, we employ the "ratio of land allocated to other cash crops relative to rubber" as the dependent variable. In the first step, the selection equation identifies the determinants of the existence of different land tenure certificates on household level. In the second step, an outcome equation is estimated with selection bias correction terms calculated from the multinomial logit model. Then a treatment model is implemented to estimate the counterfactual effects. For our impact analysis we compute the ATT and ATU effects. ATT effects compare the actual rate of the households with both certificates to the counterfactual rate if the households would have gotten only one certificate or no certificate. Furthermore, we compare land allocation ratio of households with only one certificate to the counterfactual. Correspondingly, the ATU effects are computed by comparing the rate of households without certificate or with only one certificate to the counterfactual.

(a) Multinomial logit selection equation

In our analysis, we divide households into 4 groups, namely, (1) households with only farmland tenure certificate, (2) households with only forestland tenure certificate, (3) households with both farmland and forestland tenure certificates and (4) households without any land certificates. The land tenure certificate can be any of above it. Consider the latent model (I^*_{is}) which describes different household *i* under different land tenure certification *s*. The latent variable can be described as:

$$I^*_{is} = \beta_s \chi_i + \varepsilon_{is} \quad (1)$$

χ represents a vector of explanatory variables and ε is unobserved factors that are assumed to be independent and identically distributed random variables with zero mean. Land tenure certification is defined as: s = O_forest if households only have forestland tenure certificate, s= O_farm if households only have farmland tenure certificate, s= both if households have both forestland and farmland certificates, s= w/0 if households without any certificates. The factors of households are distributed with different certificates can be stated by a multinomial logit model drawing from McFadden (1973) as followed

$$(Probility\ of\ household\ i\ has\ land\ tenure\ certificate\ s) = \frac{\exp(\beta_s \chi_i)}{\sum_{r=w/o,o\_farm,o\_forest}^{both} \exp(\beta_r \chi_i)} \quad (2)$$

We employ the multinomial endogenous switching regression to estimate land tenure certificate effects on ratio of land use size between other cash crops and rubber based on Dubin and McFadden (1984) and Bourguignon et al. (2007). This model helps to correct for self-selection bias. We estimate a ratio outcome equation for each of the land tenure certification scenarios as follows:

$$R_{i\,o\_forest} = Q_i a_{o\_forest} + \mu_{o\_forest} \quad \text{if } R^*_{o\_forest} > \frac{\max}{s \neq o\_forest}(R^*_{o\_forest}) \quad (3a)$$

$$R_{i\,o\_farm} = Q_i a_{o\_farm} + \mu_{o\_farm} \quad \text{if } R^*_{o\_farm} > \frac{\max}{s \neq o\_farm}(R^*_{o\_farm}) \quad (3b)$$

$$R_{i\,both} = Q_i a_{both} + \mu_{both} \quad \text{if } R^*_{both} > \frac{\max}{s \neq both}(R^*_{both}) \quad (3c)$$

$$R_{i\,w/o} = Q_i a_{w/o} + \mu_{w/0} \quad \text{if } R^*_{w/o} > \frac{\max}{s \neq both}(R^*_{w/o}) \quad (3d)$$

Q_i refers to all the explanatory variables included in χ_i, as we measured the ratio of other cash crops relative to rubber, R_{o_forest}, R_{o_farm}, R_{both}, $R_{w/o}$ represent the ratio outcome for each land tenure certificates among the household respectively. μ_{o_forest}, μ_{o_farm}, μ_{both}, $\mu_{w/0}$ are the error terms distributed with zero mean and equal variance. R_{o_forest}, R_{o_farm}, R_{both}, $R_{w/o}$ are only observed when $R^*_{o\_forest} > \frac{\max}{s \neq o_{forest}}\left(R^*_{o_{forest}}\right)$, $R^*_{o\_farm} > \frac{\max}{s \neq o_{farm}}\left(R^*_{o_{farm}}\right)$, $R^*_{both} > \frac{\max}{s \neq both}(R^*_{both})$, $R^*_{w/o} > \frac{\max}{s \neq both}(R^*_{w/o})$ separately. Hence, if the errors ε's and μ's are not independent and are correlated, the OLS coefficient estimates of equation (3a), (3b), and (3c) will be inconsistent. For the consistent estimation of α_s, selection correction terms generated from the selection equation (2) needed to be included. For this, we apply the Normalized Dubin McFadden (DMF2) model which allows for linearity of errors in the outcome equation and by construction makes the errors ε's and μ's independent. Based on DMF2 model, the equation (3a), (3b) and (3c) are identified as:

$$R_{i\,o\_forest} = Q_i a_{o\_forest} + \delta_{O\_forest}\,\gamma_{0\_forest} + \Omega_{0\_forest} \quad \text{if } R^*_{o\_forest} > \frac{\max}{s \neq o\_forest}(R^*_{o\_forest}) \quad (4a)$$

$$R_{i\,o\_farm} = Q_i a_{o\_farm} + \delta_{O\_farm}\,\gamma_{0\_farm} + \Omega_{0\_farm} \quad \text{if } R^*_{o\_farm} > \frac{\max}{s \neq o\_farm}(R^*_{o\_farm}) \quad (4b)$$

$$R_{i\,both} = Q_i a_{both} + \delta_{both}\,\gamma_{both} + \Omega_{both} \quad \text{if } R^*_{both} > \frac{\max}{s \neq both}(R^*_{both}) \quad (4c)$$

$$R_{i\,w/o} = Q_i a_{w/o} + \delta_{w/o}\,\gamma_{w/o} + \Omega_{w/o} \quad \text{if } R^*_{w/o} > \frac{\max}{s \neq w/o}(R^*_{w/o}) \quad (4d)$$

Where $\gamma_r$means the covariance between ε's and μ's, δ_r refers to the inverse mills ratios calculated from equation (2) and Ω_r are error terms with mean value zero computed drawing from the DMF2 model of Bourguignon et al (2007). To account for the heteroskedasticity, arising from the generated regressors (δ_r), the standard errors are bootstrapped in equation (4a), 1 (4b) and (4c).

Based on this method, selection instruments have to be decided which will affect the issuance of land tenure certificates but don't influence ratio outcome. According to this concept, the share of households owning land certificates in the village in 2012 is chosen as instrument variable in our analysis.

(b) Counterfactual analysis

Following Carter and Milon(2005), Di Falco and Veronesi(2014), a treatment effects is computed to estimate the actual and counterfactual analysis under different land tenure certificates scenarios as follows: The households with both land certificates and households with only- forest land certificate remaining actual certification status(actual):

$$E(R_{i\,both}|R_i = both) = Q_i a_{both} + \delta_{both}\,\gamma_{both}$$

(for households with both certificates remaining both) (5a)

$$E\left(R_{i\,o\_forest}\middle|R_i = O\_forest\right) = Q_i a_{0\_forest} + \delta_{o\_forest}\gamma_{o\_forest}$$

(for households with only forest certificate remaining the same) (6a)

The households with both land certificates and households with only- forestland certificate choosing none certificates (counterfactual)

$$E(R_{i\,none}|R_i = both) = Q_i a_{none} + \delta_{none}\,\gamma_{none}$$

(for households with both certificates would have none certificate) (7a)

$$E(R_{i\,none}|R_i = O\_forest) = Q_i a_{none} + \delta_{none}\,\gamma_{none}$$

(for households with only-forestland certificate would have none certificate) (8a)

ATT effects are calculated as the differences between equation (5a) and (7a), (6a) and (8a) respectively. The same calculation method is applied to households with both certificates would have only-forestland certificate or only farmland certificate. And also, households with only forestland certificate or only farmland certificate would have no certificates.

For ATU effects, household with none certificates choose none certificates are actual effects (actual)

$$E(R_{i\,none}|R_i = none) = Q_i a_{none} + \delta_{none}\,\gamma_{none}$$

(for households with none certificate remaining none) (9a)

Household with none certificates would have both certificates or only farmland certificates.

$$E(R_{i\,both}|R_i = none) = Q_i a_{both} + \delta_{both}\,\gamma_{both}$$

(for households with none certificate would have both) (10a)

$$E\left(R_{i\,o\_farmland}\middle|R_i = none\right) = Q_i a_{o\_farmland} + \delta_{o\_farmland}\,\gamma_{o\_farmland}$$

(for households with none certificate would have farmland certificate) (11a)

ATU effects are calculated from the difference between equation between (10a) and (9a), (11a) and (9a). The same approach is used for only forestland or farmland- certified households would have both land tenure certificates.

4. RESEARCH AND DATA

(a) Study area

Xishuangbanna (XSBN) is a Dai Ethnic Autonomous Prefecture, which is located in the southernmost of Yunnan province, China (Figure 1). It borders Myanmar and Laos and is an area with great biological and cultural diversity. XSBN covers 19,150 km^2, wherein about 95% of the area is covered by mountain and hill with altitude ranging from 475 to 2430 meters above sea level (MASL).

Since 1950s, rubber has been planted and gradually become a successful industry in XSBN (Guo et al., 2002), which has provided more stable income for smallholder rubber farmers since 1980 (Fu et al., 2009). Intrigued by high profitability of rubber, natural tropical forest was largely cleared and converted to rubber cultivation (Xu et al., 2005), resulting into unclear land ownership (Min, 2017). By the end of 2004, the rubber plantation area of state farms (51.5%) was 85,143 ha (Fu et al., 2009). However, rubber price has decreased dramatically since 2011, smallholder rubber farmers turn to plant other cash crops (e.g. as tea, banana, mango) as alternatives. The changes in cultivation structure among different cash crop changes also have relied on the changes in land policy changes and land tenure reform. Stable land tenure can guarantee farmers' land use rights and then influence farmers' decision on how they arrange their land. Chinese Government has introduced long-term certificates to improve land tenure security under the "Rural Land Contract Law" promulgated in 2002, which allow individuals to hold forestland up to 70 years and farmland up to 30 years with a possibility of a renewal of the certificates (Yin et al., 2013). After that, XSBN government also has taken actions to issue forestland and farmland certificates to farmers to clarify unclear land ownership.

A comprehensive socioeconomic panel survey was undertaken in 2013 and 2015 from 612 smallholder rubber farmers in XSBN. In the survey, smallholder rubber farmers were asked about the previous crop production years 2012 and 2014 respectively. A household survey questionnaire was used to collect panel data about socioeconomic characteristics of household members, land use types, rubber and other cash crop activities, off-farm activities. Furthermore, a stratified random sampling method was employed in order to guarantee the representative of smallholder rubber farmers in XSBN. XSBN governs a city (Jinghong) and two counties (Menghai, Mengla). By considering the rubber planting area per capita and the distribution of rubber areas with each city, 42 villages from 8 townships (Fig.1) within above one city and two counties

were selected randomly. Then a total of 612 households among these selected 42 villages were randomly chosen and interviewed in 2012.And in 2015, we tracked the same household as those in 2012. Because of lost contact of one household in 2015, 611 households were interviewed.

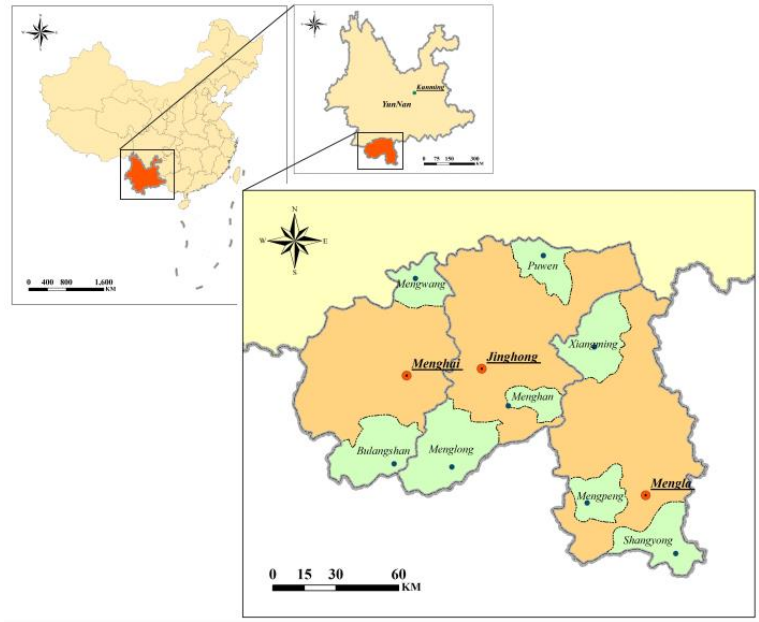
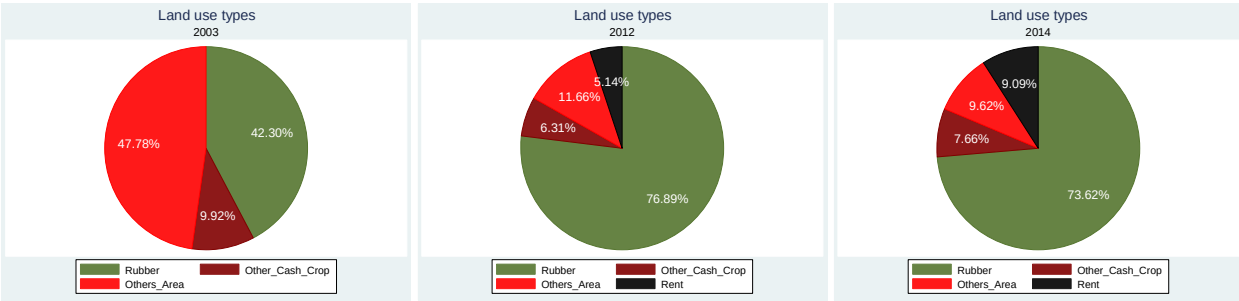


Figure1. Location of research area and sample distribution

(b) Descriptive analysis

Based on the data we have collected, in the section we statistically describe land use changes since 2003, the ratio of rubber and other cash crops and the variables we used in our analysis.



Source: Author's calculation

Figure2. Land use changes in 2003, 2012, 2014

It was noted from figure 2 that there are four different categories in terms of land use in XSBN: namely (a) rubber land, (b) other cash crop land, (c) other areas and (d) rent out land. Specifically, rubber land means the land used for planting rubber while other cash crop land means land used for planting other cash crops, exclude rubber, e.g. banana, tea etc. Rent land represents the total areas of rent-out land. Other areas contain vacant land, original forest, plantation forest, field crops land and some other areas. In sum, they are the areas which exclude the land employed to plant rubber, banana, and tea etc. other cash crops and rent out.

Furthermore, there were significant land use changes in 2003, 2012, 2014 in XSBN. In 2003, major land use type was other areas type with 47.78% of total land area, which was followed by rubber land usage, 42.30% of total land area. And other cash crop accounted for only 9.92%.Land rental market was not active and mature in 2003, therefore, no household rent out their land. In 2012, with the issuance of land certificates to local households in XSBN, and boundary between the land plots becomes clearer. As a result, land for planting rubber outweighs that for other areas. The land employed to rubber has increased by 35% in 2012 while land for other areas has dropped to 11.66% from 47.78% in 2003. Also, with land rental market being well-organized, 5.14% of local land was rented out. When it comes to 2014, the proportion of rubber land use has decreased from 76.89% to 73.62%. Contrarily, other cash crop percentage has increased to 7.66% from 6.31%. The rent-out land percentage is still increasing to 9%.

Overall, land employed for planting rubber has reached a peak in 2012; correspondingly, land use percentage of other cash crop was lowest in 2012 and then increase in 2014. Households get more land from other areas to plant rubber, other cash crops and rent out the land, the proportion of other area thus is smallest in 2014.

Table1. The ratio of other cash crops and rubber

	Ratio of other cash crops and rubber	
	2012	2014
Average	0,19	0,25
w/o. land certificate	0,31	0,29
only arable land certificate	0,24	0,36
only forest land certificate	0,13	0,18
both land certificates	0,19	0,22

Source: Author's calculation

Table1 presents the comparison between the land used to cash crop and rubber cultivation under different land certificate scenarios. There are total 4 land certificate scenarios, namely household with (a) only arable land certificate, (b) only forest land certificate, (c) both land certificates, and (d) household without any land certificates. It was observed in the sample that the average ratio of other cash crops and rubber land use is 0.19 in 2012 and 0.25 in 2014.To be specific, the ratio of other cash crops and rubber land in the household with only arable land certificate has increased from 0.24 to 0.36. While the ratio between the cash crops and rubber land in the household with only forest land certificate also increased, from 0.13 to 0.18. For household with both land certificates, the ratio also increased slightly from 0.19 to 0.22. On the contrary, the ratio in the household without land certificates decreased from 0.31 to 0.29. From here, we can make an assumption that household with land certificates prefer to plant other cash crops than rubber. However, how large different land certificate scenarios make a contribution to cash crop cultivation is still not certain.

Table2. Definition of variables used in regression analysis

Variables name	Description
Dependent variable	
Ratio of other cash crops and rubber	The ratio of other cash crop and rubber in years
Independent variables	
Land characteristics	
Share of rubber land in higher slope	% of rubber land whose slope is higher than 45 degree
Share of rubber land in good quality	% of rubber land which has a good quality
Average rubber age	Average age of rubber trees in years
Average rubber seed	Average rubber seed planted per hectare
Lowland	Altitude of the household land (< 600 MASL)
Household head characteristics	
Female head (yes = 1)	If the household head is a female (yes = 1, no = 0)
Age	Age of household head
Education	Education of the household head in years
Marital status(yes = 1)	Marital status of household head (yes = 1, no = 0)
Social organization (yes = 1)	If the household head is a member of any social organization (yes = 1, no = 0)
Household characteristics	
Dai ethnicity (yes = 1)	If the ethnic group of the household is Dai (yes = 1, no = 0)
Total household size	Total number of members in household
Average household wealth (log)	Log of household wealth per capita
Average land area (log)	Log of land area per capita
Share of rubber area	Ratio of rubber area and total land area
Share of harvesting rubber area	Ratio of harvesting rubber area and total land area
Shock (yes = 1)	Has the household experienced any shocks in years (yes = 1, no = 0)
Village characteristics	
Community house (yes = 1)	If the village has a community house (yes = 1, no = 0)
Geographical postion (yes = 1)	Geographical position:whether close to river and plain area(yes=1,no= 0)
Irrigation land (ha)	Land area under irrigation in the village (ha)
Good road (yes = 1)	If the village has access to good road (yes = 1, no = 0)
Distance to County	Distance to the center of the county
Rubber price(in USD)	Average rubber price in the village in years (in USD)

Source: Author's calculation

Table 2 describes the variables. The ratio of other cash crops and rubber is the dependent variable. It needs to be noted that ratio of other cash crops and rubber refers to how much of land used to plant other cash crops is compared to the land used to plant rubber. Dependent variables comprise land characteristics, household head characteristics, household characteristics and village characteristics.

Table3. Descriptive Statistics of the variables included in the model

	W/O certificate				Only farmland certificate				Only forestland certificate				Both certificates			
	2012		2014		2012		2014		2012		2014		2012		2014	
Variables	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Rubber land in higher slope	36,24	42,39	27,95	42,69	29,43	39,16	31,29	39,99	36,75	42,78	36,24	42,39	35,39	41,74	32,93	41,02
Good quality of rubber land	32,45	45,18	44,06	49,24	33,15	45,45	31,78	45,35	31,81	45,01	32,45	45,18	30,31	44,00	29,66	43,60
Rubber age	13,52	6,47	11,48	5,63	10,37	5,99	11,79	5,98	11,58	6,13	13,52	6,47	10,47	5,56	12,23	5,81
Rubber age^2	224,4	212,9	162,6	183,6	143,2	171,3	174,6	186,3	171,5	176,2	224,4	212,9	140,4	154,2	183,3	181,0
Rubber seed	39,98	29,32	40,60	25,84	36,30	12,80	35,82	15,63	41,35	30,15	39,98	29,32	36,53	18,71	36,53	20,42
Lowland	0,25	0,43	0,09	0,30	0,22	0,41	0,21	0,41	0,24	0,43	0,25	0,43	0,16	0,37	0,17	0,38
Female head	0,08	0,28	0,09	0,30	0,09	0,28	0,10	0,30	0,07	0,26	0,08	0,28	0,05	0,22	0,06	0,23
Age of HH head	46,97	9,90	46,53	9,68	48,06	10,81	47,73	11,02	47,01	9,74	46,97	9,90	49,02	11,03	48,80	10,92
Age^2	2303	986	2255	900	2425	1063	2398	1098	2304	971	2303	986	2523	1152	2500	1131
Education	4,49	3,45	4,44	3,66	4,33	3,85	4,31	3,92	4,34	3,43	4,49	3,45	4,44	3,47	4,51	3,46
Marital status	0,96	0,20	0,84	0,37	0,97	0,16	0,93	0,25	0,99	0,07	0,96	0,20	0,98	0,15	0,94	0,23
Social organisation	0,31	0,46	0,34	0,48	0,26	0,44	0,33	0,47	0,24	0,43	0,31	0,46	0,21	0,41	0,22	0,42
Dai ethnicity	0,59	0,49	0,38	0,49	0,61	0,49	0,61	0,49	0,59	0,49	0,59	0,49	0,58	0,49	0,58	0,49
Household size	5,14	1,37	4,59	1,39	5,08	1,55	5,21	1,57	5,03	1,37	5,14	1,37	5,32	1,44	5,52	1,46
Household wealth(ln)	8,54	1,39	8,43	1,25	8,77	1,24	8,59	1,23	8,77	1,25	8,54	1,39	8,78	1,05	8,49	1,28
Land area(ln)	-0,48	0,90	-0,36	0,86	-0,59	0,92	-0,54	0,94	-0,56	0,88	-0,48	0,90	-0,26	0,72	-0,27	0,72
Rubber area (%)	0,76	0,23	0,70	0,24	0,83	0,19	0,76	0,24	0,86	0,18	0,76	0,23	0,76	0,18	0,72	0,22
Harvesting rubber area(%)	0,41	0,34	0,21	0,28	0,40	0,32	0,39	0,35	0,47	0,36	0,41	0,34	0,37	0,28	0,41	0,32
Shock	0,42	0,49	0,44	0,50	0,39	0,49	0,44	0,50	0,47	0,50	0,42	0,49	0,48	0,50	0,52	0,50
Community house	0,92	0,27	0,59	0,50	0,11	0,31	0,89	0,32	0,07	0,26	0,92	0,27	0,13	0,34	0,96	0,19
Geographical position	0,16	0,37	0,06	0,25	0,23	0,42	0,23	0,42	0,16	0,37	0,16	0,37	0,24	0,43	0,24	0,43
Irrigation land	26,94	34,68	18,51	14,66	49,02	60,57	31,91	44,54	36,47	51,88	26,94	34,68	55,84	69,84	43,65	68,87
Good road	0,11	0,31	0,09	0,30	0,13	0,33	0,17	0,37	0,09	0,29	0,11	0,31	0,08	0,27	0,17	0,38
Distance to county	68,67	44,05	73,22	23,02	75,71	43,31	72,89	39,16	78,78	47,70	68,67	44,05	84,11	50,43	79,25	46,61
Rubber price	0,75	0,45	0,61	0,47	1,31	0,84	0,71	0,44	1,59	0,91	0,75	0,45	1,43	0,82	0,82	0,41
ccode1	0,11	0,31	0,44	0,50	0,18	0,38	0,18	0,38	0,11	0,31	0,11	0,31	0,09	0,28	0,09	0,28
ccode2	0,54	0,50	0,53	0,51	0,46	0,50	0,46	0,50	0,54	0,50	0,54	0,50	0,36	0,48	0,36	0,48
No. of observations	32		32		181		180		190		190		209		209	

Source: Author's calculation

The descriptive statistics of dependent variables are presented in Table 3.It is noted that farmers with both certificates are the most in our sampling farmers. With the issuance of the land certificates promoted by Chinese government, more and more farmers are engaged in certifying their land. As a result, there are only 32 farmers who don't have any kind of certificates in our samples. The farmers with only forestland certificate have the highest proportion of rubber land whose slope is higher than 45 degree. In terms of rubber age, it has reached the productive phase, which could be harvested, among the four scenarios. Female household head accounts for small percentage in our samples. Farmers with both certificates are less engaged in any social organization. Majority of farmers with only farmland certificate are Dai ethnicity group. Almost more than 70% of land in all groups is used to

plant rubber and rubber area in 2014 is less than that in 2012 among all the groups. For the rubber that can be harvested, the area among the farmers with both certificates in 2014 is higher than that in 2012. The area in the rest groups in 2014 is less than that in previous time. The villages with more farmers with both certificates can get more access to good quality of the road. Average rubber price in the villages with more farmers only owing forestland certificate is the highest.

5. RESULTS

(a) Determinants of the existence of land certificates

Selmlog command (Bourguignon et al., 2007) was used to estimate multinomial endogenous switching model. The results are presented in table 4 and the type of households without any land certificates is the base category.

Rubber age is positively with the availability of forestland certificate while age of household head is negatively correlated, mainly because young household head is open-minded and prefers to accept new policy. Membership in social groups is positively correlated with the existence of both certificates. Furthermore, household with bigger size, more wealth, and larger land area are more likely to get both farmland and forestland certificates. This could be because the land is allocated to farmers according to the household members in China. Bigger household size means larger land area to some extent. The larger land area, the more land types.

Table4. Multinomial logit selection equation

Base category- None certificate	Only farmland certificate		Only forestland certificate		Both certificates	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Rubber land in higher slope	-0,004	0,005	-0,003	0,005	-0,004	0,005
Good quality of rubber land	0,000	0,004	-0,00004	0,004	-0,001	0,004
Rubber age	0,16	0,12	0,22 **	0,12	0,26 **	0,12
Rubber age^2	-0,004	0,004	-0,01	0,004	-0,01 *	0,004
Rubber seed	0,01	0,02	0,01	0,02	0,02	0,02
Lowland	0,07	0,54	0,04	0,52	-0,36	0,53
Female head	0,38	0,54	0,16	0,52	0,05	0,56
Age of HH head	-0,30 *	0,15	-0,29 **	0,15	-0,27 **	0,15
HD_Age2	0,003 *	0,002	0,003 **	0,002	0,003 *	0,002
Education of HH head	0,02	0,05	0,04	0,05	0,02	0,05
Marital status	0,15	0,72	0,45	0,73	0,29	0,78
Social organisation	0,72 *	0,39	0,58	0,38	0,79 **	0,39
Dai ethnicity	0,21	0,50	0,22	0,49	0,50	0,50
Household size	0,20	0,14	0,14	0,13	0,26 **	0,14
Household wealth(ln)	-0,02	0,13	-0,02	0,13	0,00 **	0,13
Land area(ln)	0,24	0,25	0,23	0,25	0,58 **	0,25
Rubber area(%)	0,12	0,84	0,10	0,82	-1,45	0,82
Harvesting rubber area(%)	0,01	0,72	-0,13	0,68	-0,11	0,71
Shock	-0,55	0,36	0,02	0,35	-0,23	0,36
Community house	-0,62	0,49	-1,08 **	0,48	-0,88 **	0,51
Geographical position	0,20	0,50	-0,16	0,49	-0,003	0,50
Irrigation land	0,0004	0,004	0,00	0,00	0,003	0,004
Good road	-0,66	0,52	-0,77	0,51	-0,73	0,52
Distance to county	0,01	0,01	0,01	0,01	0,01	0,01
Rubber price	0,49	0,46	0,78 *	0,46	0,57	0,46
ccode1	-0,72	0,86	-1,40 *	0,85	-1,92 **	0,88
ccode2	-0,73	0,57	-0,83	0,56	-1,02 *	0,56
year2	0,13	0,60	1,76 ***	0,59	0,60	0,62

Selection instruments									
Cert_Share_2012	0,09	***	0,01866	0,09	***	0,02	0,10	***	0,02
Constant	-0,57		3,46951	-1,85		3,42	-2,40		3,44
Wald Chi-square test	21.22	***		21.96	***		23.85	***	
No. of observations				1223					
Log pseudolikelihood = -1297.197			Pseudo R2 = 0.1239						

Note: * indicates significance at the p<0.10 level, ** at the p<0.05 level, and *** p<0.01 level.
Source: Author's calculation

The result of multinomial endogenous regression model is presented in Table 5. We implemented linear-linear specification to get the result. Results indicate that households with a higher share of rubber land are unwilling to plant other cash crop even though the rubber price is low. Cert_Share_2012 is an instrumental variable which is defined as the share of households owning land certificates in the village in 2012.The Wald test on selection instruments, Cert_Share_2012, is significant in multinomial logit model, and does not influence the ratio outcome, which makes our model more robust.

Table 5. Multinomial endogenous switching regression

Dependent variable	None certificate		Farmland certificate		Forestland certificate		Both certificates	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err	Coef.	Std.Err.
Rubber land in higher slope	0,001	0,01	-0,004	0,01	0,001	0,001	0,0001	0,001
Good quality of rubber land	-0,003	0,005	-0,003	0,00	8.78e-06	0,001	-0,0001	0,001
Rubber age	0,02	0,43	-0,11	0,29	-0,01	0,03	-0,04	0,04
Rubber age^2	-0,002	0,01	0,004	0,01	0,0001	0,001	0,001	0,001
Rubber seed	0,01	0,03	-0,002	0,02	-0,0004	0,002	0,0002	0,004
Lowland	0,01	1,57	0,36	0,58	-0,03	0,09	-0,20	0,21
Female head	-0,09	1,68	-0,01	0,60	-0,04	0,12	-0,04	0,18
Age of HH head	-0,07	0,38	-0,04	0,11	0,001	0,02	0,005	0,02
Age^2	0,001	0,004	0,00	0,00	-0,00002	0,0002	-0,0001	0,0002
Education of HH head	-0,01	0,08	0,04	0,04	0,01	0,01	0,002	0,01
Marital status	-0,16	2,15	0,37	1,04	-0,04	0,26	-0,23	0,45
Social organisation	-0,11	0,87	-0,25	0,48	-0,02	0,10	0,02	0,11
Dai ethinicity	0,28	1,30	-0,26	0,37	-0,05	0,06	-0,05	0,10
Household size	0,04	0,49	-0,02	0,12	-0,01	0,03	-0,01	0,04
Household wealth(ln)	-0,03	0,44	0,02	0,19	-0,01	0,03	0,02	0,05
Land area(ln)	0,13	0,52	0,29	0,34	-0,02	0,06	-0,05	0,12
Rubber area(%)	-0,71	1,87	-3,08	1,52	-0,52 **	0,21	-0,79	0,47
Harvesting rubber area(%)	0,22	1,30	0,33	0,70	0,02	0,10	-0,04	0,15
Shock	-0,24	0,72	-0,18	0,33	0,02	0,07	-0,08	0,07
Community house	0,04	0,65	0,35	0,74	-0,01	0,14	-0,06	0,13
Geographical position	-0,06	1,67	-0,11	0,56	-0,02	0,12	0,03	0,15
Irrigation land	-0,001	0,02	0,001	0,00	-0,0004	0,001	0,0001	0,00
Good road	0,26	1,34	0,64	0,75	0,06	0,11	-0,01	0,15
Distance to county	0,002	0,01	0,00	0,00	0,0001	0,001	0,0005	0,00
Rubber price	-0,07	0,69	-0,43	0,74	0,07	0,08	-0,08	0,14
ccode1	0,24	3,57	0,74	1,47	0,11	0,23	0,24	0,30
ccode2	-0,07	2,49	-0,004	0,48	0,02	0,07	0,16	0,14
year2	-0,14	0,78	-0,54	0,90	0,07	0,15	0,05	0,18
Selection bias correction terms								
_m0	0,04	0,78	2,65	3,20	-0,14	0,45	1,04	0,87
_m1	1,03	7,16	1,68	2,50	-0,30	0,99	0,88	1,51
_m2	0,03	5,03	0,09	6,65	0,14	0,31	0,21	1,37
_m3	0,84	4,33	2,89	4,13	-0,28	0,79	0,02	0,40
_cons	2,65	14,81	4,39	3,60	0,35	1,03	1,57 **	1,03

Note: * indicates significance at the p<0.10 level, ** at the p<0.05 level, and *** p<0.01 level.
Source: Author's calculation

(b) Results of certification impacts using counterfactual estimations

The results of the counterfactual estimations and land certification impacts are showed in Table 6 and Table 7. Table 6 describes the ATT effects of ratio between other cash crops and rubber

under actual and counterfactual scenarios. We compare e.g., the ratio of other cash crops relative to rubber when farmers have both land tenure certificates with the counterfactual ratio if farmers would have none certificate. Table 7 presents the ATU effects, wherein we make a comparison between the actual ratio among households without any certificates and the counterfactual ratio in case households would have both certificates.

ATT results show that the ratio of other cash crops relative to rubber will respectively rise by 2 % and 28% if households with both land tenure certificates would have been certified as sole forestland or farmland tenure certificate. ATT results also show that ratio can decrease by 5% and 16.7% respectively if sole forestland or farmland tenure certified household would have none certificates. If the households with forestland tenure certificate were assigned to only have farmland tenure certificate, the ratio will increase by 11%. Overall, we find that household with only farmland tenure certificate prefer to plant more other cash crops.

In terms of ATU results, we find that if the only forestland- or farmland-certified households could have been issued both land tenure certificates, the ratio will decrease by 5% and 16% respectively. If the households without any certificates were assigned to have both land tenure certificates, the ratio will drop significantly by 24%. Also, if the households without any certificates were assigned to sole forestland tenure certificate, the ratio between other cash crops and rubber decrease by 1.7%. On the contrary, if the household without any certificates would have sole farmland tenure certificate, the ratio will increase largely 30%.

Hence, ATT ad ATU results show that expansion of other cash crop takes place in households with either (a) only farmland certificate or (b) only forestland certificate. What's more, the households with only farmland tenure certificate plant relatively more other cash crops than the household with forestland tenure certificate. Households with both types of land tenure certificates and those without tenure certificate are less likely to expand other cash crops. This is mainly because the farmland tenure certificate is more flexible than forestland tenure certificate. If one land is certified as farmland and it still has the chances to change to be forestland tenure certificate. However, once one land is assigned as forestland tenure certificate, it only can be a forestland and have no opportunities to change to farmland tenure certificate. Furthermore, the transition from rubber to other cash crops is not only subject to the availability of land use certificates but is also influenced by the prior share of rubber land. If the household with both land tenure certificates obtain more rubber which could be harvested, the farmers are less likely to plant other cash crops.

Table 6. ATT effects of farmland and forestland certification

	Actual			Counterfactual			ATT	
Average treatment effects on the treated (ATT)		Mean	Std.Err.		Mean	Std.Err.	Mean	Std.Err.
Ratio of cash crop and rubber	Both certificates remain Both	0.20	0.012	If both certificates become none	0.22	0.025	-0.013	0.025
	Both certificates remain Both	0.20	0.012	If both certificates become farmland certificate	0.49	0.039	-0.28	0.035
	Both certificates remain Both	0.20	0.012	If both certificates become forest certificate	0.23	0.009	-0.021***	0.007
	Forest certificate remain forest	0.15	0.010	If forestland certificate become none	0.10	0.025	0.050***	0.024
	Forest certificate remain forest	0.15	0.010	If forestland certificate become farmland certificate	0.26	0.040	-0.11***	0.036
	Farmland certificate remain farmland	0.30	0.044	If farmland certificate become none	0.13	0.023	0.167***	0.043

Note: * indicates significance at the p<0.10 level, ** at the p<0.05 level, and *** p<0.01 level.
Source: Author's calculation

Table 7. ATU effects of farmland and forestland certification

	Counterfactual			Actual			ATU	
Average treatment effects on the untreated (ATU)		Mean	Std.Err.		Mean	Std.Err.	Mean	Std.Err.
Ratio of cash crop and rubber	If none certificates become both certificates	0.06	0.031	None certificates remain none	0.30	0.044	-0.24***	0.040
	If farmland certificate become both certificates	0.14	0.270	Farmland certificate remain farmland	0.30	0.830	-0.156***	0.038
	If forestland certificate become both certificates	0.10	0.013	Forest certificate remain forest	0.15	0.010	-0.052***	0.008
	If none certificates become forestland certificate	0.28	0.029	None certificates remain none	0.30	0.045	-0.017	0.028
	If farmland certificate become forestland certificate	0.19	0.010	Farmland certificate remain farmland	0.30	0.044	-0.11***	0.039
	If none certificates become farmland certificate	0.60	0.128	None certificates remain none	0.30	0.045	0.30***	0.107

Note: * indicates significance at the p<0.10 level, ** at the p<0.05 level, and *** p<0.01 level.
Source: Author's calculation

6. SUMMARY AND CONCLUSIONS

In this study, we analyze the impact of forestland and farmland tenure certification on cash crop expansion. The household is divided into 4 types, namely, (1) households with only farmland tenure certificate, (2) households with only forestland tenure certificate, (3) households with both farmland and forestland tenure certificates and (4) households without any land certificates (as the base group). We use a panel dataset collected from 612 smallholder rubber farmers in XSBN, China to estimate the ratio of other cash crops relative to rubber among the household with different land tenure certificates. Multinomial endogenous switching model with counterfactual analysis is implemented to estimate different certification effects.

Our findings show that rubber age, membership in social groups, is positively with the availability of sole forestland certificate while age of household head is negatively correlated. Household with bigger size, more wealth, and larger land area are more likely to get both farmland and forestland tenure certificates. A key finding is that households with only farmland tenure certificate are more likely to plant other cash crops compared with rubber. Also, the result from counterfactual analysis also confirm that if farmland tenure certificate could have been certified to the households without any certificates, the ratio of other cash crops relative to rubber in these households would increase a lot. In our assumption, we assume that households with both tenure certificates plant more other cash crops. However, the result reveals that it's the households with only farmland tenure certificate cultivate more other cash crops. This can be attributed to the flexibility of farmland tenure certificate. If the land in the household is certified as farmland, even though the duration of owing of the farmland certificate is only 30 years, it still has the chances of changing to forestland. However, once the land is certified as forestland, it doesn't have any possibility to change to forestland certificate.

Nowadays, the issuance of forestland and farmland certificates could enhance tenure security, and guarantee farmers' right to dominate their own land. With rubber price decreasing largely, land tenure security could be an important factor that facilitates other cash crop cultivation among farmers with regards to changes.

Our results also highlight a speeding up of the land certification process in XSBN will foster diversity, improve allocative efficiency of land and contribute to agricultural diversification and economic growth.

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