IDEC DP^2 Series Vol. 9 No. 2

Does Understanding Land Tenure Security (LTS) Increase Investments in Agriculture? Evidence from Rural Households in Vietnam

Vu Ha Thu
Graduate School for International Development and Cooperation (IDEC)
Hiroshima University

Daisaku GOTO
Graduate School for International Development and Cooperation (IDEC)
Hiroshima University

Department of Development Policy
Division of Development Science
Graduate School for International Development and Cooperation (IDEC)
Hiroshima University
1-5-1 Kagamiyama, Higashi-hiroshima
7398529 Japan

Does Understanding Land Tenure Security (LTS) Increase Investments in Agriculture? Evidence from Rural Households in Vietnam

Vu Ha Thu[*†‡§] Daisaku Goto[*¶‖]

Abstract

Although previous studies have shown the importance to agricultural investments of understanding land tenure security (LTS), to date, little quantitative evidence has been published regarding the effects of understanding LTS. This study contributes to the current research by showing the causal effect on agricultural investments of understanding LTS. In detail, we examine whether understanding the increase in the duration of agricultural land-use rights improves farmers' investments in agriculture. Under the new land law passed in November 2013 in Vietnam, the usage duration of annual cropland and aquaculture land increased significantly from 20 years to 50 years, which makes Vietnam a compelling case study for testing this hypothesis. We use panel data from the Viet Nam Access to Resources Household Survey (VARHS) collected in 2010, 2012, 2014 and 2016. The balanced panel data include 1834 households. Difference-in-difference with fixed effects (DID-FE) is employed to estimate the causal impacts. We find that understanding the increase in the duration of agricultural land-use rights increases investments in irrigation/soil conservation/water conservation and the adoption of organic fertilizer, which supports the positive impacts of understanding LTS on sustainable investments.

Keywords– understanding land tenure security (LTS), agricultural investments, DID-FE, Vietnam

[*]Graduate School for International Development and Cooperation, Hiroshima University
[†]1-5-1 Kagamiyama, Higashi-Hiroshima, Hiroshima, 739-8529, Japan
[‡]hathu.bsc@gmail.com
[§]Corresponding author
[¶]dgoto@hiroshima-u.ac.jp
[‖]Network for Education and Research on Peace and Sustainability (NERPS), Hiroshima University

1 Introduction

Agricultural land tenure security (LTS) plays a crucial role in reducing poverty and achieving rural development (Higgins et al., 2018; Nguyen, 2012). LTS is defined as a degree of certainty that "a person's rights to land will be recognized by others and protected in cases of specific challenges" (FAO, 2002). According to a report by World Bank (2013), 63% of the poor have engaged in agricultural activities. Thus, agricultural land property rights are considered key factors to improve the livelihood of the poor by enhancing agricultural productivity and income from agriculture (Lawry et al., 2017).

Increased agricultural LTS is believed to incentivize farmers to invest more in agriculture, which will induce higher productivity and income from agricultural activities (Feder and Nishio, 1998; Besley, 1995). However, current empirical studies on the impacts of LTS interventions have shown mixed results. Santos et al. (2014) found significant effects of land allocation and registration programs on the adoption of fertilizers and improved seeds in West Bengal, India. Paltasingh (2018) also showed positive impacts of LTS on the adoption of modern rice technology in Odisha, Eastern India. In contrast, nonsignificant impacts on the adoption of fertilizers, manure or pesticides were found in Malawi (Mendola and Simtowe, 2015) and Fiji (Kumari and Nakano, 2016).

Several qualitative studies have pointed out that a lack of understanding LTS amongst beneficiaries of LTS interventions constrained the impacts of such interventions (Yami and Snyder, 2016; Leeuwen, 2017; Mazhawidza et al., 2011). Lack of knowledge on LTS is especially relevant in the context of developing countries that have often introduced new land laws without a sufficient focus on disseminating information and explanations about them (Deininger et al., 2008). In a review paper about the impacts of rural LTS, Higgins et al. (2018) emphasized the need for quantitative evidence about the impacts of knowledge on LTS, as most quantitative studies begin with the assumption that the respondents recognize LTS and move directly to evaluating the impacts of LTS interventions.

Despite the importance of understanding LTS that has been highlighted in the previous literature, to date, there have been only a few quantitative studies regarding the effects of understanding LTS. To the best of our knowledge, Deininger et al. (2008) was the main exception. Using cross-sectional data from Uganda, they found that legal knowledge, including awareness of land rights, restrictions on land use and recognition of women's land rights, increased land-related investments (tree plantation and soil conservation) and land productivity. In addition to the main finding mentioned above, they found interesting associations between rights to transfer land, length of occupancy and land-related investments. Rights to transfer land were positively

correlated with visible investment, such as investment in tree plantations, which was expected to affect land value. However, length of occupancy was positively associated with invisible investments, such as soil conservation, which improved soil fertility in a sustainable manner. To control for unobserved household characteristics, such as mental agility and interest in community affairs, which could affect both levels of legal knowledge and land-related investments, Deininger et al. (2008) applied an instrumental approach. The instrumental variables included three sets of retrospective variables: radio ownership and parents' educational attainment, previous land conflicts, and previous land sales market participation. However, these instrumental variables might not satisfy the exogeneity condition and exclusion restriction assumptions. To suggest further policy implications, it is necessary to rigorously investigate the causal effects of legal knowledge.

In this study, we used DID-FE with panel household data to examine whether understanding the increase in the duration of agricultural land use increased the agricultural investments of farmers. Because of the significant changes in the usage duration of agricultural land, Vietnam provides a compelling case study for testing this hypothesis. Under the new law passed in November 2013, the usage duration of annual cropland and aquaculture land in Vietnam increased from 20 years to 50 years. This study used panel data from the Viet Nam Access to Resources Household Survey (VARHS) collected in 2010, 2012, 2014 and 2016, before and after the 2013 new land law[1]. The balanced panel data included 1834 households. We found that farmers' understanding the increase in the duration of agricultural land use increased their investments in irrigation/soil conservation/water conservation and adoption of organic fertilizer.

This study contributes to the current research regarding the impacts of knowledge on LTS on agricultural investments in two ways. First, we provide quantitative evidence on the impact of understanding LTS on agricultural investments, which has received little attention in the previous literature. Our findings highlight the positive impacts of understanding LTS on farmers' investments in soil fertility, such as the adoption of organic fertilizer and spending more money and labor on irrigation/soil conservation/water conservation. Second, we use balanced panel data collected before and after the new land law, which allows us to control for both unobserved and observed time-variant variables. In addition, we check the parallel trend assumption. Thus, we can estimate the causal impacts of understanding LTS on agricultural investments.

The remainder of this paper is organized as follows: Section 2 provides background on the duration of agricultural land tenure in Vietnam. Section 3 presents the data descriptions, and Section 4 presents the methodology. The results and discussion are provided in Section 5. Section

[1]The 2014 VARHS data were used only to identify the balanced panel household data. They are not included in the main analysis because the outcome variables (household investments) in the 2014 data contained investments both before and after 2013 new land law.

6 concludes by offering recommendations and policy implications.

2 Background: Changes in agricultural land tenure in Vietnam

Since the introduction of "Doi Moi", a set of innovation reforms, in 1986, Vietnam has seen significant changes in the agricultural sector. Considerable reform regarding the duration of agricultural land-use rights was emphasized in land laws passed in 1998, 1993, and 2013.

The 1988 land law granted the transfer of land-use rights from collectives to individual households.Agricultural investment decisions and the usage of output were also privatized to farm households (Kemper et al., 2015; Menon et al., 2014). This liberalization played an important role in encouraging farmers to put effort into their lands, which contributed to the growth of Vietnam's agricultural output (Pingali and Vo-Tong, 1992). However, as the land-use rights were not tradable, many farmers felt insecure and reluctant to make long-term investments (Menon et al., 2014).

To strengthen property rights over land, the government passed a new land law in 1993 that allowed landowners to trade, transfer, rent, bequeath, and mortgage their land-use rights. The law also regulated the duration of land allocation and issued land-use certificates. Annual cropland and aquaculture land could be used for 20 years, whereas perennial cropland could be used for 50 years. These reforms were expected to increase farmers' investments in agriculture, especially durable investments. However, it was common for farmers to gradually decrease their investments according to the expiration time of their agricultural land tenure. In 2000, the share of agricultural investments in the total investment of the whole country was 13.2%; however, this percentage decreased by half in 2009 (World Bank, 2012).

To inspire the long-term investments of farmers, the 2013 land law was approved. A notable regulation in the new law was the considerable increase in the usage duration of annual cropland and aquaculture land from 20 years to 50 years. Understanding the increase in the duration of agricultural land use has the potential to reduce uncertainty and incentivize farmers to make long-term investments for two reasons. First, the longer usage term reduces the likelihood that the government will expropriate the land-use rights from the farmers and their offspring, which makes them confident in making long-term investments (Do and Iyer, 2008). In addition, farmers have more time to enjoy the fruits of their investments. Second, it is easier to obtain loans with stronger land-use rights because of their value as collateral in the credit market (Menon et al., 2014). Thus, farmers can invest in improvements with high initial costs, such as irrigation.

There have been several studies evaluating the impacts on land titling of the 1993 land law in Vietnam (Do and Iyer, 2008; Kemper et al., 2015; Menon et al., 2014). However, the impacts of understanding the increase in the duration of agricultural land use of the 2013 land law have not yet been examined. This topic is especially important in Vietnam and other developing countries where new land laws have often been introduced with limited effort to implement them or disseminate information about them. In the 2016 VARHS data, only 24.6% of the respondents understood the change in the duration of agricultural land use mentioned in the 2013 land law (within approximately three years). Thus, it is necessary to investigate the effects of understanding the increase in the duration of agricultural land use on farmers' investments.

3 Data, key variables measurement, and descriptive analysis

3.1 Data

To attain our objective, we used panel data from four rounds of the VARHS collected in 2010, 2012, 2014 and 2016, before and after the 2013 new land law. The VARHS surveys rural households in 12 different provinces from North, Central, and South Vietnam[2]. Data were collected between June and August in each survey year. The sample sizes for the 2010, 2012, 2014 and 2016 rounds were 3202, 3704, 3648, and 2669 households, respectively. The balanced panel data for the four rounds covered 1992 households. We excluded 158 households that had no agricultural land in all four rounds. Therefore, the final balanced panel data for analysis included 1834 households.

The VARHS was designed to complement the Vietnam Household Living Standards Survey (VHLSS), a national survey collected biennially by the General Statistics Office (GSO). While the VHLSS focuses mainly on reflecting consumption poverty rates, the VARHS provides detailed information on land use, labor, and credit access. Many households were surveyed in both the VARHS and VHLSS because the VARHS re-interviewed rural households selected for the VHLSS in 2002 and 2004. Tarp (2017) indicated the similarity between VARHS households and VHLSS households as well as the population census. Thus, the findings from the VARHS data can be generalized to the Vietnamese population (Tarp, 2017).

[2]The sampled provinces include Ha Tay, Lao Cai, Phu Tho, Lai Chau, Dien Bien, Nghe An, Quang Nam, Khanh Hoa, Dak Lak, Dak Nong, Lam Dong, and Long An. In 2008, Ha Tay was subsumed into Hanoi, the capital of Vietnam.

3.2 Key variables measurement

We estimated the impacts of understanding the increase in the duration of agricultural land use on investments in aquaculture, irrigation/soil conservation/water conservation, and the adoption of organic fertilizer.

The VARHS included some questions designed to identify whether a household understood the increase in the usage duration of agricultural land in the 2013 new land law (Table A.1). We selected 2 questions to categorize a household in a treated group or a control group (Table 1). The first question was whether the household had heard about the 2013 new land law. The second question was about the duration of agricultural land use rights under the new land law. A total of 452 households that answered "yes" to the first question and "50 years" to the second question were classified in the treated group. A total of 776 households that answered "no" to the first question and not "50 years" to the second question were classified in control group 1. To check the sensitivity of the results, we also compared the treated group with control group 2, which contained the 1382 remaining households after the treated households were excluded from the data. The descriptive statistics of the treated group, control group 1, and control group 2 are provided in table A.2. Table A.3 further reports the differences in the means of the selected covariates between the treated group and control group 1 and between the treated group and control group 2. In general, the treated group outperformed both control group 1 and control group 2 in terms of education of household head, dependent ratio, dummy of poor household, dummy of government officer, and expenditure on the Vietnamese New Year.

Table 1: Treatment identification

Treatment identification		Have you heard about the new land law of 2013?	
		Yes	No
What is the duration of land use rights to agricultural land?	50 years	452 households	249 households
	Not 50 years	357 households	776 households

The outcome variables included cash (thousand VND) and labour (number of days) spent on aquaculture and cash (thousand VND) and labor (number of days) spent on irrigation/soil conservation/water conservation within the previous two years[3]. Another outcome variable was cash spent on organic fertilizer (thousand VND) within the previous 12 months. All monetary values were adjusted for inflation in Vietnam. Specific descriptions of each outcome variable are provided in table A.4. Table 1 shows the descriptive statistics of the outcome variables in the four rounds: 2010, 2012, 2014, and 2016. In general, cash spent on irrigation/soil conservation/water

[3]1 USD is equal to approximately 23,000 VND

conservation and the adoption of organic fertilizer increased from 2010 to 2016, while cash spent on aquaculture fluctuated during this period.

The covariates in this study were divided into two groups: household head features and household characteristics. The household head features included age and education (years of education) of the household head. Household characteristics included family size (number of family members), expenditure on the "Tet" holiday (Vietnamese New Year holiday) (thousand VND), a dummy of government officers, a dummy of poor household, and dependent ratio. Specific descriptions of each covariate are provided in table A.5. The descriptive statistics of these variables from 2010-2016 are presented in table 2. The average age and the average years of education of the household head in 2016 were 57.23 years old and 7.62 years, respectively. On average, a household had four members and spent 4.7 million VND during the Tet holiday in 2016. The 2016 VARHS data showed that 15% of the households were poor households.

Table 2: Descriptive statistics of outcome variables by year

Outcomes	2016			2014			2012			2010		
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
Cash spent on irrigation/soil conservation/ water conservation (1,000 VND)	1,834	423.61	4512.09	1,834	340.69	4062.69	1,834	199.35	1920.20	1,834	286.94	2202.74
Labour spending on irrigation/soil conservation/water conservation (days)	1,834	1.09	3.84	1,834	1.03	5.26	1,834	2.73	11.95	1,834	6.62	17.07
Cash spent on aquaculture (1,000 VND)	1,834	258.20	3782.21	1,834	444.82	9563.89	1,834	245.54	2250.53	1,834	689.59	6592.19
Labour spent on aquaculture (days)	1,834	0.64	16.50	1,834	0.32	3.98	1,834	0.65	4.47	1,834	1.29	14.78
Organic fertilizer adoption (1,000VND)	1,834	1417.03	5414.60	1,834	1057.64	5948.45	1,834	891.98	3483.77	1,834	734.87	1996.43

Table 3: Descriptive statistics of covariates by year

Variable	2016			2014			2012			2010		
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
Age of household head	1,834	57.23	12.88	1,834	55.82	12.91	1,834	54.25	12.96	1,834	52.75	13.08
Education of household head (years of education)	1,834	7.62	3.53	1,834	7.10	3.66	1,834	6.83	3.53	1,834	6.75	3.57
Family size	1,834	4.11	1.81	1,834	4.22	1.78	1,834	4.32	1.76	1,834	4.40	1.70
Dependent ratio	1,834	0.26	0.32	1,834	0.23	0.30	1,834	0.21	0.29	1,834	0.19	0.27
Dummy of poor household	1,815	0.15	0.36	1,831	0.12	0.33	1,834	0.17	0.38	1,834	0.13	0.34
Dummy of government officer	1,834	0.06	0.24	1,834	0.06	0.23	1,834	0.04	0.20	1,834	0.06	0.23
Expenditure on Tet holiday (1,000 VND)	1,829	4660.99	4315.62	1,834	4130.04	3280.87	1,834	4142.79	3004.09	1,834	3537.91	2889.19

4 Methods

To evaluate the effects on agricultural investments of understanding the increase in the duration of agricultural land use in the 2013 new land law , we employed difference-in-difference with fixed effects (DID-FE) regression with two time periods: 2012 and 2016. The 2010 data were used to check the parallel trend assumption. The 2014 data were not included in the main analysis because the household investments (our outcome variables) in the data contained investments both before and after the 2013 new land law[4].

The following model is estimated:

$$Y_{it} = \beta_0 + \beta_1 time_t + \beta_2 household_i + \beta_3 time_t \cdot treated_i + \beta_4 X_{it} + \epsilon_{it} \quad (1)$$

where Y_{it} represents the outcome variables investments in aquaculture, irrigation/soil conservation/water conservation, and organic fertilizer adoption. $time_t$ is the dummy of periods after 2013 (after policy intervention). $time_t = 1$ indicates 2016, while $time_t = 0$ indicates 2012. $household_i$ denotes the time-invariant household-level unmeasured variable. $treated_i$ indicates the dummy of the treated group (whether the household understood the duration of agricultural land change). X_{it} includes time-variant household characteristics that can affect both treatment status and outcome variables (for example, family size, dummy of poor household, education of household head, age of household head and expenditure on Vietnamese New Year). The coefficient of interest β_3 shows the impacts of understanding the increase in the duration of agricultural land use on the outcome variable Y_{it}. In the basic DID model, the dummy of treatment status $treated_i$ was included. However, this variable was absorbed by $household_i$ because household fixed effects were controlled in our model.

The strength of our model is that both observed and unobserved time-invariant household characteristics influencing the treatment and outcome variables were controlled. In addition, we controlled for some time-variant household characteristics that could affect both outcomes and treatment status, for instance, age and education of household head, family size, expenditure on Vietnamese New Year, and dependent ratio. Thus, the potential self-selection bias was largely addressed.

DID estimates require the parallel trend assumption, which requests constant differences over time between the outcome variables of the treated group and the outcome variables of the control group in the absence of treatment (Lechner, 2010). In other words, unobserved time-variant characteristics cannot affect the treatment status and outcome variables. Although this

[4]In the questionnaire, the respondents were asked about their investments in irrigation/soil conservation/water conservation and their investments in aquaculture in the previous 2 years. They were also asked about cash spent on organic fertilizer adoption in the previous year.

assumption could not be tested directly, we checked the trend with some periods of data that were collected before the treatment implementation. In this study, the 2010 data and 2012 data, collected before the 2013 new land law, were used to examine the parallel trend assumption.

To confirm the consistency of the DID-FE estimates, we employed DID-FE with the propensity score matching (PSM) method. PSM estimates the propensity score, which is the probability that a household will understand the change in the duration of agricultural land use in the 2013 new land law given a set of covariates that cannot be affected by the understanding of the change. We used the same covariates for both DID-FE and DID-FE with PSM. The households that were outside the common support were excluded from the analysis. Thus, if the treated and control households were very different, they were eliminated from the data analysis.

5 Results and discussion

Table 3 shows the average treatment effect (ATE) results between the treated group and control group 1. Outcome variables included cash spent on irrigation/soil conservation/water conservation (thousand VND), labour spent on irrigation/soil conservation/water conservation (days), cash spent on aquaculture (thousand VND), labour spent on aquaculture (days), and cash spent on the adoption of organic fertilizer (thousand VND). All outcome variables were measured within two years after the data collection in 2016, except cash spent on adoption of organic fertilizer, which was measured within a year. Monetary outcomes were adjusted for inflation in Vietnam.

Model 1, model 2, and model 3 of table 3 report the results from DID-FE without controlling for covariates, DID-FE controlling for covariates, and DID-FE with PSM, respectively. Nine households lying outside the common support were excluded from the DID-FE with PSM estimation. As mentioned earlier, we controlled for the same covariates for DID-FE and DID-FE with PSM. The controlled covariates included age and education of household head, family size, dependent ratio, dummy of poor household, dummy of government officer, and expenditure on Vietnamese New Year.

Table 4: ATE results for comparison between treated group and control group 1

Outcome variables	DID-FE	DID-FE	DID-FE with PSM
	Model 1	Model 2	Model 3
Cash spent on irrigation/soil conservation/water conservation (1,000 VND)	601.94***	565.04***	564.78***
	(198.70)	(201.74)	(202.01)
Labour spent on irrigation/soil conservation/water conservation (days)	1.33*	1.53*	1.54*
	(0.78)	(0.80)	(0.80)
Cash spent on aquaculture (1,000 VND)	251.88	235.16	234.96
	(233.42)	(240.50)	(240.83)
Labour spent on aquaculture (days)	1.26	1.28	1.29
	(1.22)	(1.26)	(1.26)
Organic fertilizer adoption (1,000VND)	568.04**	544.96**	545.56**
	(264.14)	(270.57)	(270.93)
Controlling for household characteristics	No	Yes	Yes
Number of observations (balanced panel households)	1228	1228	1219

Note: Standard errors are reported in parentheses.
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

Table 5: Checking parallel trend assumption for comparison between treated group and control group 1

Outcome variables	DID-FE	DID-FE
	Model 1	Model 2
Cash spent on irrigation/soil conservation/water conservation (1,000 VND)	-106.2	-105.95
	(163.58)	(165.82)
Labour spent on irrigation/soil conservation/water conservation (days)	-0.54	-0.71
	(1.28)	(1.27)
Cash spent on aquaculture (1,000 VND)	-187.9	-185.99
	(370.33)	(374.8)
Labour spent on aquaculture (days)	-0.43	-0.49
	(0.47)	(0.48)
Organic fertilizer adoption (1,000VND)	56.57	42.85
	(183.62)	(185.93)
Controlling for household characteristics	No	Yes
Number of observations (balanced panel households)	1228	1228

Note: Standard errors are reported in parentheses.

Regarding investments in irrigation/soil conservation/water conservation, we found robust, positive and significant impacts in all three models. Households that understood the increase in the duration of agricultural land use increased their cash spent on irrigation/soil conservation/water conservation by 565,040 VND compared with households that did not understand the increase in the duration of agricultural land use. The results from DID-FE without controlling for covariates (model 1) and DID-FE with PSM (model 3) also showed increases of 601,940 VND and 564,780 VND, respectively. All estimates were significant at 1%. In addition, we found an increase in labour spent on irrigation/soil conservation/water conservation by 1.33 days, 1.53 days, and 1.54 days for model 1, model 2, and model 3, respectively. All estimates were significant at 10%.

In addition, we found robust, positive and significant impacts on organic fertilizer adoption. This finding indicated that the increase in the duration of agricultural land use increased the cash spent on the adoption of organic fertilizer by 568,040 VND in model 1, 544,960 VND in model 2, and 545,560 VND in model 3. In other words, households that understood the increase in the usage duration of agricultural land spent approximately 544,960 VND more on organic fertilizer adoption than households that did not understand the change. All results were significant at the 5% level.

Our findings were consistent with those of Deininger et al. (2008). Using cross-sectional data from Uganda, they found positive impacts on soil conservation and number of trees planted for 5 years of legal knowledge, including awareness of land rights and restrictions on land use as well of recognition of women's land rights. Besley (1995) theoretically and empirically proved the relationship between greater LTS and incentives for long-term investments and sustainable land management. In this study, the usage duration of annual cropland and aquaculture land increased significantly from 20 years to 50 years. The longer usage term decreased the probability that the land-use rights would be expropriated by the government, which made the farmers feel secure and confident in making long-term investments (Do and Iyer, 2008). In addition, farmers have more time to enjoy the fruits of their labor, which might encourage them to maintain and improve soil fertility for longer cultivation periods. As a result, positive significant impacts were found regarding sustainable agricultural investments such as cash spent on irrigation/soil conservation/water conservation, labour spent on irrigation/soil conservation/water conservation, and cash spent on the adoption of organic fertilizer.

To check the sensitivity of our results, we also compared the treatment group and control group 2. The results are shown in appendix table A.6. In general, the findings were consistent with those from the previous comparison between treatment group and control group 1. We observed increases of 515,930 VND and 1.30 days in cash and labour spent on irrigation/soil

conservation/water conservation, respectively. The estimates were significant at 10% in all models. Although there was an increase in cash spent on the adoption of organic fertilizer, the impact was nonsignificant. In addition, the results from the comparison between treatment group and control group 2 had lower coefficients than those from the comparison between treatment group and control group 1. This difference could be interpreted as follows. Control group 2 included households that said that they did not know about the 2013 land law, but they gave a correct answer to the question about the duration of agricultural land use, which might constrain the impacts of knowledge on the increase in the duration of agricultural land use. The respondents might know a little about the law but might not be confident in their knowledge; thus, they might have answered that they had not heard about the changes in the 2013 land law. In addition, control group 2 included households that answered "yes" to the first question and "100 years" to the second question. Those households might know of the increase in the duration of agricultural land use, but they did not know the exact extent of the new duration. Therefore, the inclusion of those households in control group 2 might underestimate the impacts of their understanding of the increase in the duration of agricultural land use.

The parallel trend is the most critical assumption of DID. We tested this assumption using the 2010 and 2012 data, collected before the 2013 new land law. Table 4 shows the test for comparison between the treatment group and control group 1. The results indicated that the parallel trend assumption was satisfied. There were no statistically significant differences in any outcome variables between 2012 and 2010.

6 Conclusions and policy implications

This study aimed to examine the impacts of understanding the increase in the usage duration of agricultural land on sustainable investments in irrigation/soil conservation/water conservation and the adoption of organic fertilizer. We used VARHS panel household data collected in 2010, 2012, 2014 and 2016, before and after the implementation of the 2013 new land law. DID-FE was employed to estimate the causal impact of understanding the change in the duration of agricultural land use. To check the sensitivity of the DID-FE estimates, we applied DID-FE with PSM. The parallel trend assumption was also examined using the 2010 and 2012 VARHS data. We found that households that understood the increase in the usage duration of agricultural land spent more money and labour input on irrigation/soil conservation/water conservation than households that did not understand the change in the duration of agricultural land use. In addition, the former spent more cash on organic fertilizer adoption than the latter.

Our findings provide causal evidence to support the impacts of LTS knowledge on agricul-

tural investments, which have remained unclear in the previous literature. However, in our data, only 24.6% of households understood the increase in the duration of agricultural land use within approximately three years (from November 2013 to the data collection period in 2016). Thus, policymakers should pay more attention to improving farmers' knowledge of LTS. This implication is especially significant for developing countries that have introduced new land laws without paying attention to implementing them. Improving farmers' knowledge about LTS could increase their investments in sustainable agriculture, which contributes to the second aim of sustainable development goals (SDGs), which focus on ending hunger and promoting agricultural sustainability.

The external validity of this study might be limited to the 12 provinces surveyed in the VARHS. However, as discussed in section 3, the VARHS data showed similarities with the VHLSS data and population census. Therefore, we can extrapolate the findings from the VARHS data to the Vietnamese population (Tarp, 2017).

Due to the limitations of the questionnaire survey, we could not distinguish when the household had heard of and understood the change in the duration of agricultural land use between November 2013 and the data collection period in 2016. Thus, the treated households might have learned of and understand the increase in the usage duration of agricultural land at different times, which could constrain the impacts. However, we conducted several approaches to guarantee the consistency and reliability of our findings. We compared the treated group with control group 1 and control group 2. DID-FE with PSM was also applied to verify the sensitivity of the DID-FE estimates. Additionally, we carefully checked the parallel trend assumption. In general, the assumption was satisfied, and the results were consistent.

Acknowledgements

The authors wish to thank the Institute of Policy and Strategy for Agriculture and Rural Development (IPSARD) and Nguyen Thi Bich Ngoc for providing the data. We also thank the TAOYAKA Program of Hiroshima University. Any remaining errors are the sole responsibility of the authors.

Appendix

Table A.1

Table A.2

Table A.3

Table A.4

Table A.5

Table A.6

Table A.7

References

Besley, T. (1995). Property rights and investment incentives: theory and evidence from Ghana. *Journal of Political Economy* 103, 903–937. DOI: 10.1086/262008.

Deininger, K., Ali, D. A., and Yamano, T. (2008). Legal Knowledge and Economic Development: The Case of Land Rights in Uganda. *Land Economics* 84, 593–619. DOI: 10.3368/le.84.4.593.

Do, Q. and Iyer, L. (2008). Land Titling and Rural Transition in Vietnam. *Economic Development and Cultural Change* 56, 531–579. DOI: 10.1086/533549.

FAO (2002). "Land Tenure and Rural Development". FAO Land Tenure Studies No. 3.

Feder, G. and Nishio, A. (1998). The benefits of land registration and titling: Economic and social perspectives. *Land Use Policy* 15.1, 25–43. DOI: 10.1016/S0264-8377(97)00039-2.

Higgins, D., Balint, T., Liversage, H., and Winters, P. (2018). Investigating the impacts of increased rural land tenure security: A systematic review of the evidence. *Journal of Rural Studies* 61, 34–62. DOI: 10.1016/j.jrurstud.2018.05.001.

Kemper, N., Ha, L. V., and Klump, R. (2015). Property Rights and Consumption Volatility: Evidence from a Land Reform in Vietnam. *World Development* 71, 107–130. DOI: 10.1016/j.worlddev.2013.11.004.

Kumari, R. and Nakano, Y. (2016). Does land lease tenure insecurity cause decreased productivity and investment in the sugar industry? Evidence from Fiji. *Australian Journal of Agricultural and Resource Economics* 60, 406–421. DOI: 10.1111/1467-8489.12133.

Lawry, S., Cyrus, S., Ruth, H., Aaron, L., Donna, H., and Farai, M. (2017). The impact of land property rights interventions on investment and agricultural productivity in developing countries: a systematic review. *Journal of Development Effectiveness* 9, 61–81. DOI: 10.1080/19439342.2016.1160947.

Lechner, M. (2010). The Estimation of Causal Effects by Difference-in-Difference Methods. *Foundations and Trends in Econometrics* 4, 165–224. DOI: 10.1561/0800000014.

Leeuwen, M. van (2017). Localizing Land Governance, Strengthening the State: Decentralization and Land Tenure Security in Uganda. *Journal of Agrarian Change* 17.1, 208–227. DOI: 10.1111/joac.12143.

Mazhawidza, P., Manjengwa, J., and Colaition, I. L. (2011). "The social, political and economic transformative impact of the Fast Track Land Reform Programme on the lives of women farmers in Goromonzi and Vungu-Gweru Districts of Zimbabwe". Research report. URL: https://idl-bnc-idrc.dspacedirect.org/handle/10625/47626.

Mendola, M. and Simtowe, F. (2015). The welfare impact of land redistribution: Evidence from a quasi-experimental initiative in Malawi. *World Development* 72, 53–69. DOI: 10.1016/j.worlddev.2015.02.010.

Menon, N., Van Der Meulen Rodgers, Y., and Nguyen, H. (2014). Women's land rights and children's human capital in vietnam. *World Development* 54, 18–31. DOI: 10.1016/j.worlddev.2013.07.005.

Nguyen, T. T. (2012). Land Reform and Farm Production in the Northern Uplands of Vietnam. *Asian Economic Journal* 26, 43–61. DOI: 10.1111/j.1467-8381.2011.02067.x.

Paltasingh, K. R. (2018). Land tenure security and adoption of modern rice technology in Odisha, Eastern India: Revisiting Besley's hypothesis. *Land Use Policy* 78, 236–244. DOI: 10.1016/j.landusepol.2018.06.031.

Pingali, P. L. and Vo-Tong, X. (1992). Vietnam: Decollectivization and Rice Productivity Growth. *Economic Development and Cultural Change* 40.4, 697–718.

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

Tarp, F. ( ) (2017). *Growth, Structural Transformation, and Rural Change in Viet Nam: A Rising Dragon on the Move*. Oxford University Press (OUP). DOI: 10.1093/acprof:oso/9780198796961.001.0001.

World Bank (2012). Revising the land law to enable sustainable development in Vietnam.

World Bank (2013). The State of the Poor: Where Are The Poor, Where Is Extreme Poverty Harder to End, and What Is the Current Profile of the World's Poor? *Economic Premise*, 1–8. URL: www.worldbank.org/economicpremise.

Yami, M. and Snyder, K. A. (2016). After All, Land Belongs to the State: Examining the Benefits of Land Registration for Smallholders in Ethiopia. *Land Degradation and Development* 27, 465–478. DOI: 10.1002/ldr.2371.

Table A.1: VARHS questionnaire related to 2013 new land law

1	Have you heard about the new Land Law from 2013?	1. YES 2. NO>>Q3
2	How much do you know about the new land law?	1. NO KNOWLEDGE AT ALL 2. LITTLE KNOWLEDGE 3. SOME KNOWLEDGE 4. SUBSTANTIAL KNOWLEDGE
3	What is the duration of Land Use Rights to agricultural land? ASK EVEN IF ANSWER TO Q1 IS "NO"	1. 10 YEARS 2. 20 YEARS 3. 50 YEARS 4. 100 YEARS 5. DO NOT KNOW
4	When the government confiscates a plot of land, and there is no other land available for compensation, what compensation is the land user entitled to? CHOOSE ONE ASK EVEN IF ANSWER TO Q1 IS "NO"	1. NO COMPENSATION 2. HALF THE MARKET VALUE OF THE LAND 3. THE MARKET VALUE OF THE LAND 4. ONE AND A HALF TIMES THE MARKET VALUE OF THE LAND 5. COMPENSATION IS ARBITRARILY DECIDED BY LOCAL AUTHORITIES 6. DO NOT KNOW
5	From which sources have you mainly heard about these issues (mentioned in Q3-4)? STATE TWO MOST IMPORTANT	1. HAVE NOT HEARD ABOUT THESE ISSUES 2. TV, RADIO, NEWSPAPER, INTERNET 3. PUBLIC LOUDSPEAKERS 4. FRIENDS AND FAMILY 5. MEETING ARRANGED BY COMMUNE AUTHORITIES TO INFORM ABOUT LAW 6. EXTENSION AGENT/AGRICULTURAL ORGANISATION 7. OTHER GROUPS OR MASS ORGANIZATIONS 8. OTHER

(Source: 2016 VARHS questionnaire)

Table A.2: Descriptive statistics of treated group, control group 1, and control group 2

Variable	Treated group			Control group 1			Control group 2		
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
Age of household head	452	57.15	11.79	776	57.41	13.74	1,382	57.26	13.22
Education of household head (years of education)	452	8.25	3.22	776	6.64	3.82	1,382	7.42	3.60
Family size	452	4.28	1.73	776	4.07	1.95	1,382	4.05	1.84
Dependent ratio	452	0.23	0.29	776	0.28	0.33	1,382	0.27	0.32
Dummy of poor household	446	0.08	0.27	767	0.24	0.43	1,369	0.18	0.38
Dummy of government officer	452	0.09	0.29	776	0.03	0.17	1,382	0.05	0.22
Expenditure on Vietnamese New Year (thousand VND)	450	5553.89	4211.76	773	3901.23	4818.56	1,379	4369.62	4310.61

Table A.3: Covariate comparison among groups

Variable	Treated group vs control group 1		Treated group vs control group 2	
	Mean difference	Std. Err.	Mean difference	Std. Err.
Age of household head	-0.11	0.70	-0.26	0.77
Education of household head (years of education)	0.84***	0.19	1.61***	0.21
Family size	0.23**	0.10	0.20*	0.11
Dependent ratio	-0.04**	0.02	-0.05**	0.02
Dummy of poor household	-0.10***	0.02	-0.16***	0.02
Dummy of government officer	0.04***	0.01	0.06***	0.01
Expenditure on Vietnamese New Year (thousand VND)	1184.27***	232.71	1652.66***	273.04

Table A.4: Description of outcome variables

Outcome variables	Description
Cash spent on irrigation/soil conservation/water conservation (1,000 VND)	Cash spent on irrigation/soil conservation/water conservation show the total cash the households spent on all irrigation and soil and water conservation improvements (for example, rock bunds, soil bunds/grass lines, terraces, brick walls, irrigation systems and other related investments) during the previous 2 years.
Labour spent on irrigation/soil conservation/water conservation (days)	Labour spent on irrigation/soil conservation/water conservation show total days of labor spent by the households on all irrigation and soil and water conservation improvements during the previous 2 years.
Cash spent on aquaculture (1,000 VND)	Cash spent on aquaculture indicate the total cash the households invested in aquaculture (for example, ponds and shrimp farms) during the previous 2 years.
Labour spent on aquaculture (days)	Labour spent on aquaculture indicate total days of labour spent by the households on investments in aquaculture during the previous 2 years.
Organic fertilizer adoption (1,000 VND)	Organic fertilizer adoption show the value of the organic fertilizer used by the households during the previous 12 months.

Table A.5: Description of covariates

Covariates	Description
Household head features	
Age of household head	Age of household head
Education of household head (years of education)	Education of household head (years of education)
Household characteristics	
Family size	Number of family members in the household
Dependent ratio	Ratio of number of dependent people [age <6 or age >60]/Family size
Dummy of poor household	Whether a household is catergorized as a poor household or not
Dummy of government officer	Whether a household has at least a member working in the public sector
Expenditure on Tet holiday (1,000 VND)	Expenditure on Vietnamese New Year (Lunar New Year)

Table A.6: ATE results for comparison between treated group and control group 2

Outcome variables	DID-FE	DID-FE	DID-FE with PSM
	Model 1	Model 2	Model 3
Cash spent on irrigation/soil conservation/water conservation (1,000 VND)	543.62**	515.93*	515.15*
	(266.26)	(269.76)	(270.36)
Labour spent on irrigation/soil conservation/water conservation (days)	1.16*	1.3*	1.31*
	(0.69)	(0.70)	(0.70)
Cash spent on aquaculture (1,000 VND)	329.28	283.59	284.06
	(212.54)	(204.87)	(205.33)
Labour spent on aquaculture (days)	1.31	1.34	1.34
	(0.92)	(0.95)	(0.95)
Organic fertilizer adoption (1,000 VND)	435.9	376.69	376.27
	(316.78)	(323.63)	(324.35)
Controlling for household characteristics	No	Yes	Yes
Number of observations (balanced panel households)	1834	1834	1818

Note: Standard errors are reported in parentheses.
* Significant at the 10% level.
** Significant at the 5% level.

Table A.7: Checking parallel trend assumption for comparison between treated group and control group 2

Outcome variables	DID-FE	DID-FE
	Model 1	Model 2
Cash spent on irrigation/soil conservation/water conservation (1,000 VND)	-209.79	-207.52
	(156.44)	(158.3)
Labour spent on irrigation/soil conservation/water conservation (days)	-0.45	-0.49
	(1.12)	(1.12)
Cash spent on aquaculture (1,000 VND)	-46.9	-26.87
	(373.06)	(377.3)
Labour spent on aquaculture (days)	0.25	0.26
	(0.83)	(0.84)
Organic fertilizer adoption (1,000VND)	-224.02	-217.79
	(195.37)	(196.97)
Controlling for household characteristics	No	Yes
Number of observations (balanced panel households)	1834	1834

Note: Standard errors are reported in parentheses.