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Agricultural Policy Misspecification in Thailand

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Abstract

Severe poverty of farmers in Thailand is visible in the form of agricultural land abandonment. The causes of land abandonment will reflect the causes of poverty and the effectiveness of government agricultural policies. This paper identifies the factors that cause agricultural land abandonment and the appropriate policy measures for effectively addressing the problem. The study utilizes the optimization method based on duality production theory with 808 parcel samples. The Simultaneous Tobit estimation was used to estimate the system of nine equations. The study identified the contributing factors for land abandonment and provides alternative directions for policy makers.

Key words: poverty, land abandonment, profit maximization, duality production theory

1. Introduction

Thai farmers have always been in poverty. They are unable to meet their family‘s basic needs from agricultural production, mainly due to low productivity, low income and inability to manage various risks such as plummeting crop prices, increasing production input prices, shortage of cash for investment, erratic distribution of rainfall and all types of land use problems, including landlessness, land rights, land infrastructure and land fragmentation. Over the years, the Thai government has implemented several

legislative actions and programs to address these factors with mixed results. Following are the key agricultural policies adopted in Thailand.

First, Several irrigation projects were constructed in the 1960s in order to solve the water supply problem but their impact at the regional level remains very limited as more than 77% of the agricultural area is still under rain-fed conditions (Royal Irrigation Department, 2011). Without water supply, farmers in these areas are unable to cultivate and produce goods for consumption or sale. The governments' budget constraints hinder the widespread construction of irrigation systems throughout Thailand. On top of this, the widespread soil acidity in many areas creates a labor transition from the agricultural to the industrial sector with the abandonment of agricultural land, even though several attempts have been made by the government to tackle the soil quality problem by establishing and developing volunteer soil doctors and learning centers at the sub-district level.

Second, The implementation of the Land Code Act of 1954, which contains procedures for issuing land title deeds ranging from full to usufruct rights for farmers, the act encourages the clearance of forest by recognizing three steps of land acquisition: occupancy, use and legal ownership (Cleary & Eaton, 1996). Under this act, agricultural land size was limited to 50 rai per household with the intention of solving the problems of land distribution and landlessness. On the contrary, however, the limitation lead to production inefficiency for certain crops and created a land fragmentation problem. The Land Institute Foundation revealed that most farmers (87%) are small parcel holders with an average farm size of less than 5 rai. Production costs increased with fragmentation (McClosekey, 1975), because small parcel size did not allow for efficient mechanization and limited choices of farming techniques. As a result, small plots were abandoned due to the complication of working fragmented land (Simon, 1987). Although the land size limit was cancelled in 1960, the fragmented and abandoned land problems remain unsolved. Recently, Reform Thailand proposed that the country revert back to the maximum land holding limit of 50 rai per household and increase land taxes to 5% for abandoned land and land over the maximum holding of 50 rai. However, there is no evidence substantiating why the land holding limit and tax rate are justified at 50 rai and 5% as well as help to improve the well-being of the farmers.

Third, In the 1970's, several government agencies[1] also carried out a land allocation program with limited success. The Agricultural Land Reform Act of 1975 created the Agricultural Land Reform Office (ALRO) in the Ministry of Agriculture and Cooperatives to implement reforms as a means of resolving the landlessness problem. However, the program led to a concentration of land held by the rich. The number of landless farmers from the ALRO program remains at over 800,000 families, while tenancy problems have worsened from 514,717 families in 1996 to 678,077 in 2004, and 1,373,145 families in 2011 (Sajjanand, 2013). Farmers perceived that the cost of production is increased from leasing cropland. Therefore, these farmers lost their motivation to continue production operations due to insecure land rights and unprofitable operations. Fourth, Implementation of the Agricultural Land Rental Act of 1981 aimed to protect tenant farmer rights, but created barriers that prevented agricultural landowners from leasing their land to more productive and efficient farmers instead. Furthermore, the act led to increased land abandonment. The minimum lease period enforced by this act was six years, which is too long. In cases where a landowner desired to sell their land, the act also stated that landowners were required to provide existing tenants with the first opportunity to purchase the land. Since tenant farmers would typically offer a price below fair market value, the land remained with the present owner who ceased agricultural operations while attempting to sell the land. Fifth, Civil and Commercial Code, Section 537-571, prohibits a landowner from evicting a tenant before the lease agreement has expired. While Section 1382 aims to reduce land abandonment by allowing land acquisition through adverse possession when an individual has peacefully enjoyed the land for ten years without the express objection of the landowner, this section has produced heated nationwide debate.

Sixth, The Agricultural Economics Act of 1979 created agro-economic zones based on soil surveys performed by the Department of Lands (DOL). The acts aimed to balance the crop supply with the market demand in order to prevent the low crop price situation. According to this act, each district and

[1] Department of Public Welfare (DPW), Department of Land (DOL), Department of Cooperative Promotions (DCP), Royal Forestry Department (RFD), War Veterans Organization of Thailand (WVO), Agricultural Land Reform Office (ALRO).

sub-district is set for a specific crop production and farmers who participate in the program will receive a guaranteed selling price of the crop through subsidized programs. Although the program can dictate crop type for specific areas, it cannot control the yield or output; crop yield depends on many uncontrollable factors such as rainfall, soil quality, temperature, pest activity and acts of nature, etc. In addition, the crop price in a competitive market cannot be controlled either domestically or globally. Successful agro-zoning in other countries comes from a different set of objectives where the primary goal for agro-zoning is to control the expansion of urban areas into agricultural areas. Therefore, the zones are use-based, not crop-based as in Thailand. Thus far, the results of a pilot project for agro-zoning in 30 provinces remain inconclusive and the crop prices are uncontrollable as previously expected, which discourages farmers from staying in the occupation.

Seventh, The Thai government implemented the Debt Moratorium Program (DMP) in 2001 to alleviate poverty among agricultural households and use a period of relief to encourage structural changes in farmers' operations. Tambunlertchai (2004) indicated that the DMP fell short of its objectives; furthermore, after two years, the program had no significant impact on its participants. While the goal of the DMP was to relieve its participants' credit constraints, its participants faced loan restrictions in the form of taking out new loans during the period of the moratorium. Therefore, these farmers used new loans from illegal lenders to finance agricultural production and end up in a larger poverty cycle. Eighth, The rice mortgage scheme was introduced in 2011 with the objective of assisting farmers by manipulating rice prices, but led to nationwide corruption and price arbitrage. The scheme failed due to enormous subsidy costs, huge amounts of rice in government storage as attempts to manipulate the international commodity market failed, and a majority of the benefits going to the millers and largest farmers who sell the most. It was proof that poor farmers received very little benefit from the scheme (Poapongsakorn, Pantakao, Nanthajit, Arunkong, and Janepeungporn, 2014).

Ninth, The current Thai government is considering the Community Land Title Act to solve landlessness and land abandonment problems with no supporting evidence on how to put the act into action and whether or not

it is the right measure to be adopted and Tenth. The government is also considering a reform of the Land and Property Tax Act to resolve the issues of landlessness, landownership concentration and land abandonment. The initiative refers to the work of Laovakul (2010) who proposed various tax rates for each category of land use based on the assumption of the annual average increase rate for land prices. It should be noted that various flaws exist when research relies heavily on assumptions.

The aforementioned series of programs and policies were implemented according to the farmers' trouble trends in each period of time, which is not the right way to solve the problem and may increase economic costs associated with policy misspecification as the programs were not based on rigorous, comprehensive quantification study. Obviously, the farmers' poverty factors the Thai government has been trying to solve are the causal factors behind agricultural land abandonment; water supply shortages and inappropriate soil quality create a transition of labor into the industrial sector and the land abandonment. Fragmented parcels have led to the abandonment of agricultural land. Leasing of crop lands increase the sense of insecurity and unprofitable farming operations which eventually led to land abandonment. Protection of tenant farmer rights led to the land abandonment of agricultural landowners. Shortage of cash for investment and low crop prices led to discouragement about staying in the farming occupation and abandonment of agricultural land. Therefore, solving the core issue of agricultural land abandonment is the way to solve the farmers' poverty problem.

Agricultural land abandonment in Thailand has drawn a lot of attention over the past decade due primarily to the over-exaggerated reporting on the amount of abandoned land. Reports routinely reference the estimate of 48 million rai of abandoned land in Thailand. Further, reports typically state that the amount of abandoned land is increasing each year (Makkarapirom, 2011), and (Sutthiwatthananiti, 2012). The Office of Agricultural Economics (OAE) defines abandoned agricultural land as agricultural land that was previously used in agriculture, but has been left idle for five or more years. Thailand owns 320 million rai of land. As of 2011, agricultural land represented 48.51% of the total land area and abandoned agricultural land represented only 1.89% or 2,879,642 rai. Further, OAE data shows that at a country level,

Table 1: Used land and abandoned land in agricultural sector from 1986-2011

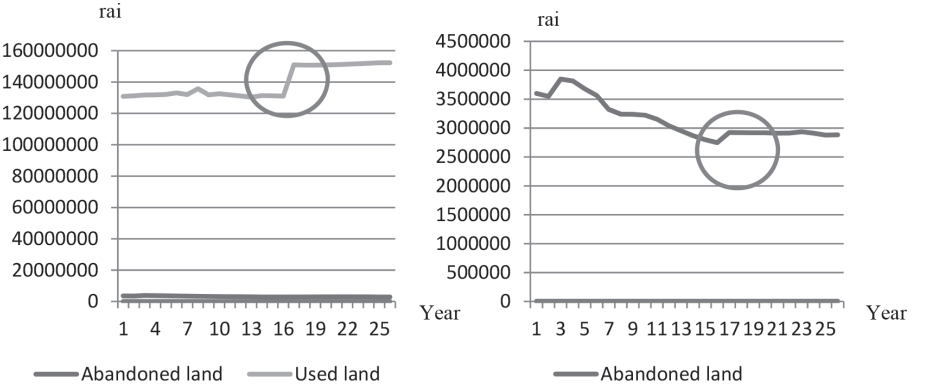
(unit: rai)

Year	Abandoned land	(%)	Used land	(%)	Total
1986	3,596,032	2.75	127,302,908	97.25	130,898,940
1987	3,546,687	2.70	127,655,935	97.30	131,202,622
1988	3,845,151	2.92	127,927,608	97.08	131,772,759
1989	3,814,397	2.89	128,016,788	97.11	131,831,185
1990	3,679,803	2.79	128,444,606	97.21	132,124,409
1991	3,560,781	2.68	129,515,407	97.32	133,076,188
1992	3,319,692	2.51	128,731,517	97.49	132,051,209
1993	3,238,848	2.39	132,513,039	97.61	135,751,887
1994	3,236,149	2.45	128,597,139	97.55	131,833,288
1995	3,221,465	2.43	129,257,105	97.57	132,478,570
1996	3,151,272	2.39	128,668,234	97.61	131,819,506
1997	3,036,300	2.32	128,071,308	97.68	131,107,608
1998	2,950,814	2.26	127,442,711	97.74	130,393,525
1999	2,864,219	2.18	128,477,165	97.82	131,341,384
2000	2,796,521	2.13	128,399,392	97.87	131,195,913
2001	2,744,835	2.09	128,315,139	97.91	131,059,974
2002	2,920,471	1.93	148,108,813	98.07	151,029,284
2003	2,916,933	1.93	147,880,123	98.07	150,797,056
2004	2,914,536	1.93	147,938,326	98.07	150,852,862
2005	2,914,530	1.93	148,008,504	98.07	150,923,034
2006	2,909,666	1.93	148,230,198	98.07	151,139,864
2007	2,911,890	1.92	148,448,812	98.08	151,360,702
2008	2,933,158	1.93	148,823,461	98.07	151,756,619
2009	2,909,243	1.92	148,933,197	98.08	151,842,440
2010	2,875,871	1.89	149,455,888	98.11	152,331,759
2011	2,879,642	1.89	149,470,172	98.11	152,349,814

Source: Office of Agriculture Economics: 2011

the amount of abandoned land has steadily declined during the period 1986 through 2011 as presented in Table 1. However, when we took a closer look at the data from the OAE, we found that there was a drastic increase in agricultural land use and abandonment during 2001-2002. Figure 1 presents the graphs that were plotted from the data in Table 1. Since land use and land abandonment have a huge variation in scale, a separate graph showing abandoned land is provided to the right. At the provincial level, three patterns of land abandonment were found; land abandonment was either increasing, decreasing, or remaining constant. Of the seventy-six provinces in Thailand, only the capital city, Bangkok, had a constant pattern of no abandoned land. Fourteen provinces appear to have a declining land abandonment trend, while the balance of sixty-one provinces have an increasing land abandonment trend.

Figure 1: Used land and abandoned land in agricultural sector from 1986-2011



Source: Office of Agricultural Economics: 2011

Although the percentage of agricultural land abandonment in Thailand is considered low, most of the area in Thailand has an increasing land abandonment trend and it creates a substantial economic loss each year. In 1998, it was estimated that an economic value added of 26,355.32 million baht was generated from the additional 3% increase in agricultural land use. (Land Institute Foundation, 2001).

The issue of agricultural land abandonment has drawn a lot of attention, but comprehensive quantification study in Thailand has never been attempted.

Most studies on agricultural land abandonment have focused on the relationship between institutional changes on land use and abandonment during the transition from the state-command to market-driven economies, particularly in post-Soviet Eastern Europe. Prishchepov, Radeloff, Baumann, Kuemmerle, and Muller (2012) indicated that strong institution and land use policies can reduce the rate of agricultural land abandonment. Baumann et al. (2011) found the most important predictors explaining substantial spatial variations in abandonment rates to be topography, soil type, population, institutional factors and economic shock. In Albania, Muller and Munroe (2008) indicated that most cropland abandonment at the onset of the transition period was concentrated in less densely populated areas but depended on economic returns after the transition period. Evidence from Romania, (Muller, Kuemmerle, Rusu, and Griffiths, 2009) showed that isolated crop lands were more abandoned than more homogenous lands, and hilly areas were more likely to be abandoned than the plains. Some researchers have indicated that the abandonment of agricultural land is mostly driven by socio-economic factors such as immigration into areas where new economic opportunities are offered to rural people, and ecological factors such as elevation and soil erosion (Benayas, Martin, Nicolau, and Schulz, 2007). However, results from Spain, (Zaragozi et al., 2012) showed only geographic factors as the important driving factor of farmland abandonment. The factors are irrigation, vegetation index, topographic wetness index and climatic index. Not much research has been conducted on agricultural land abandonment outside Europe. In Japan, (Nishihara, 2012) found agricultural land zoning policy to have great impact on land value increase and discourage the landowners from cultivating land. A small gap in the anticipation of land policy to convert agricultural zones into residential development zones prevents landowners from selling or leasing land to more efficient farmers. Evidence from Thailand (Gine, 2005) indicated that partial rights titles create a distortion of the land rental market by triggering a sense of insecurity for landowners. The landowners are more likely to lease or abandon secured plots and cultivate unsecured plots in order to avoid expropriation risks.

This paper attempts to answer two questions: (1) What are the factors that cause agricultural land abandonment in Thailand?, and (2) What measures

and policies should be adopted by the Thai government to deal with agriculture land abandonment? This paper covers all ten government policies previously discussed, namely, land infrastructure development, limited land holding, land allocation program, land rental law, adverse possession law, agricultural-zoning, debt moratorium program, price subsidy program, community land title act and reform of the Land and Property Tax Act. The following section will discuss the research scope, followed by the methodology used in this study, data, results and conclusion with a discussion on policy

2. Method

2.1 Research scope

The site for this study was Khon-Kaen Province in the northeastern region of Thailand where there is a high degree of agricultural activity and an increasing pattern of agricultural land abandonment. Khon-Kaen is quite dynamic and subject to rapid changes in all aspects, including land use and land markets. The area also has many different characteristics in terms of soil and water sources. The primary crops are rain-fed rice, cassava and sugarcane.

The factors affecting agricultural land abandonment to be measured were farm gate prices for the three major crops of Khon-Kaen (cassava, rice, and sugarcane); the price of input used in agricultural production (cash on hand, fertilizer, household labor, machine labor, pesticides, capital or agricultural machinery and loan interest rates). The physical and institutional factors are parcel size, type of property rights, main source of water supply, soil quality, distance to city, farming technology, land tax, perception of land rental and adverse possession laws. Land shares for the three major crops and land share for abandonment were also to be measured. The numbers of years in which agricultural machinery has been used were collected to calculate the present value of each agricultural machine price by the following formula: $PV = C1 / (1 + r)^n$ where C_1 is cash flow in Period 1, r is the rate of return equal to the inflation rate, and n is the number of periods.

2.2 Methodology

In this paper, a profit optimization method based on the duality production theory will be applied. This is the first attempt to apply the land use model with the land abandonment problem and take the presence of censored variables into account. Without recognizing these censored variables, the parameter estimate will be inconsistency. The profit optimization method is the most widely used method for investigating agricultural land use determinants as it can capture the decision-making processes that drive land management. The method has no limitations in terms of factor type and is not limited to an aggregate level analysis. In addition, it does not require a stack of economic data which is frequently unavailable or of poor quality in developing countries.

The duality production theory was used to obtain product supply and factor demand equations for a price taking firm by partial differentiation of profit function (Beattie, Taylor &Watts, 1985, p. 258). The agricultural land-owner makes a decision whether to use or abandon their land to maximize their long-term profit. The theoretical model adopted for this paper was built upon the Chambers and Just (1989) farm profit maximization problem. The model further developed by Fezzi and Bateman (2011) is specified in the equation (1)

$$\Pi = f(p, w, z, l_1,\ldots,l_h), \sum_{i=1}^{h} li = L \quad (1)$$

Where Π is the maximum profit associated with the vector of competitive output prices p, the vector of competitive input prices w, and the vector of quasi-fix input z which is physical and institutional characteristics with l the vector of h land use allocation and L is the total land available. Assuming the profit function to be positive, linearly homogeneous and convex in the input and output prices, the input demand and output supply equations and the optimal land use share equations can be derived using Hoteling's Lemma. Indicating with s the h land use shares corresponding to the land use allocation, the farm profit function for analysing land use is expressed as follows:

$$\Pi L\,(p, w, z, L) = \max_{s1,\ldots,sh}\left\{\Pi(p,w,z,L,s_1,\ldots,s_h): \sum_{i=1}^{h} Si = 1\right\} \quad (2)$$

Where $\Pi^L(.)$ is the profit per unit of land and s is the land use share in which all shares sum to one. According to Hotelling Lemma, the optimal quantity of i^{th} input and the j^{th} output are specified as Equations (3) and (4), respectively.

$$-x_i^L = \partial\Pi^L/\partial w_i \quad (3)$$

$$y_j^L = \partial\Pi^L/\partial p_j \quad (4)$$

Where x_i is the vector of m input and y_j is the vector of n output. The optimal land use equation can be derived recognizing that land is allocated to different uses in order to equalize marginal rent or shadow prices.

$$\frac{\partial\pi^L(p, w, z, L, s_i, \ldots, s_h)}{\partial s_1} = \frac{\partial\pi^L(p, w, z, L, s_i, \ldots, s_h)}{\partial s_i} \text{ for } i = 2, \ldots, h. \quad (5)$$

Empirical Specification: The normalized quadratic profit function was applied to multi-input and multi-output production processes and was proof outperforming all other forms used in the study (Villezca-Becerra and Shumway, 1992 and Fare, Martins-Filho and Vardanyan, 2009). The properties of the normalized quadratic profit function are that it is locally flexible and self-dual with a globally convex Hessian matrix. Defining x_1 as the numeraire good and vector of normalized net put prices represent with $p' = (p/p_1, w/p_1)$. The normalized quadratic profit function can be expressed as follows:

$$\begin{aligned}\Pi^{*\prime} = {} & a_0 + \sum_{i=2}^{m+n} a_i p_i' + \sum_{i=1}^{h-1} \beta_i s_i + \sum_{k=1}^{n} \gamma_k z_k + \sum_{i=2}^{m+n}\sum_{j=1}^{h-1} \delta_{ij} p_i' s_j \\ & + \sum_{i=2}^{m+n}\sum_{l=1}^{n} \Phi_{ij} p_i' z_l + \sum_{i=1}^{h-1}\sum_{l=1}^{n} \varphi_{ij} s_i z_l + \frac{1}{2}\left(\sum_{i=2}^{m+n}\sum_{j=2}^{m+n} \alpha_{ij} p_i' p_j' \right. \\ & \left. + \sum_{i=1}^{h-1}\sum_{j=1}^{h-1} \beta_{ij} s_i s_j + \sum_{k=1}^{n}\sum_{l=1}^{n} \gamma_{kl} z_k z_l\right) \end{aligned} \quad (6)$$

Where Π*' is the profit divided by the price of net put 1, p_i is net put price, p_i' is the normalized price (p_i/p_1, i = 2,…m+n), z_k is a vector of n quasi-fix input which includes physical and institutional characteristic variables and α_i, β_i, γ_k, δ_{ij}, ϕ_{ij}, φ_{ij}, α_{ij}, β_{ij}, and γ_{kl} are the parameters to be estimated. Linear homogeneity was imposed on the quadratic production function by normalization. Conditions for symmetry are imposed on the models with the constraints $\alpha_{ij} = \alpha_{ji}$, $\beta_{ij} = \beta_{ji}$ and $\gamma_{ij} = \gamma_{ji}$. This paper uses output price; cassava price as numeraire. The output price was, on average, a better predictor of output than the models based on input prices (Paudel & Mcintosh, 2005). Even previous work by Shumway, Saez and Gottret (1998), Shumway and Alexander (1998), and Shumway and Gottret (1991) reported that numeraire was arbitrarily chosen to be the material input. By Hoteling Lemma, input demand and output function is specified as (7) where qi is net put with positive output quantity and negative input quantities.

$$q_i = \alpha_i + \sum_{i=2}^{m+n} \alpha_{ij} p_j' + \sum_{j=1}^{h-1} \delta_{ij} s_j + \sum_{l=1}^{n} \Phi_{ij} z_l \qquad (7)$$

Optimal land use share was derived from solving the system of h-1 equations in (5) with $\sum_{j=1}^{n} s_j = 1$. At the end, there will be h reduced form equations as in (8)

$$si = \theta_i + \sum_{j=1}^{m+n} \theta_{ij} p_j' + \sum_{l=1}^{n} \eta_{ij} z_j \quad \text{for i} = 1,...,h \qquad (8)$$

where θ and η are the vector of the parameters to be estimated. The optimal land allocations depend on all the net put prices and all quasi-fix input, which includes physical and institutional characteristics.

A farmer may not plant certain crops in a particular year, thereby resulting in a zero value for the corresponding land shares and output observation. Some landowners leave their land totally abandoned which leads to a zero value in both input and output yields. By applying a traditional three-stage least square to the system of equation consisting of these censored variables leads to inconsistent parameter estimates (Amemiya, 1973). Therefore, the Tobit regression (Tobin, 1958) was used to estimate the system

of equation (7) and (8) to find factors causing agricultural land abandonment, crop supply and input use. Because of censoring, the dependent variable y is the incompletely observed value of the latent dependent variable y*. The structural equation in the Tobit model is: $y_i^* = X_i'\beta + e$ when the dependent variable is censored from below at zero as follows:

$$y_i = \begin{cases} y^* \text{ if } y^* < 0 \\ 0 \text{ if } y^* \leq 0 \end{cases} \tag{9}$$

After the system of equations has been estimated, the marginal effects of each factor will be calculated to find the effect size of each factor on the dependent variable. The following three possible marginal effects are possible: the marginal effect on the latent dependent variable; y*, the marginal effect on the expected value for y: E[y] for uncensored observations and the marginal effect on the E[y] for censored and uncensored observations. Wooldridge (2002, p. 520) and Greene (2003, p. 764) side with E[y] as the most useful component. Therefore, for this paper, the marginal effect on the E[y] for censored and uncensored observations will be determined by: $\partial E[y]/\partial xk = \phi(x_i\beta/\sigma)\beta_k$. This paper estimates one system of nine equations: the two output supply equations for rice and sugarcane (note: the price for cassava was set as numeraire because its farm gate price was the most stable among the study crop), six input demand equations (cash on hand, fertilizer, household labor, machine labor, pesticides and capital), and one land share equation for abandonment. Based on the theoretical model proposed by Fezzi and Bateman (2011), the land share for each output must be jointly estimated with the system of supply and demand equations. However, the above authors did not estimate the full model; instead, they estimated the land share equations separately because of the convergence and parameter instability problem. In contrast, the present study estimates the full model by using Seemingly Unrelated Regression analysis. According to the findings, however, all types of land shares cannot be incorporated into the system due to computation burden. Therefore, the researcher followed the suggestion of Arnade and Kelch (2007) in constructing the simplest model possible by including only land shares of interest which is the land share for abandonment.

2.3 Sampling procedure

The population consists of a number of agricultural parcels in Khon-Kaen. The total number of agricultural parcels in Khon-Kaen are 729,375, while there are 350,100 agricultural landowners (Official Information Center, Khon-Kaen Governor's Office, 2012). Multi-stage cluster sampling using probability proportional to size (PPS) was employed in this study. The total number of agricultural parcel samples was determined by the following formula: $n = (deff * Z^2pq)/d^2$ (Cochran, 1977). The United Nations Children's Fund (UNICEF) recommends design effects equal to two for sub-national estimates. The proportion, p, is 0.48 (350,100 ÷ 729,375). The margin of error is plus or minus 5 percentage point. With a 95% confidence interval, $\alpha = 0.05$, $Z = 1.96$, total sample size is 767 samples. The total number of clusters is determined by the cluster size, which typically ranges from 20-40 households with 15-20 clusters in each province, state or district (UNICEF, 1995). Due to budget constraints, this research used the cluster size of 52 with 15 clusters (767/15 = 52) which is slightly higher than the UNICEF recommendation. In each cluster, the sampling units were selected through PPS of multi-stage sampling. The following 4 stages were used for sampling: district, sub-district, village and parcel. The parcel list was attained from the office of the Sub-district Administrative Organization (Office of the SAO) tax database. Thai law requires a property declaration form every year land taxes are collected. The form called Por.Bor.Tor. 5 provides the following useful land information: landowner name, address, contact number, type of land use, land size, crops grown and location of the parcel. Simple random sampling was used to select the 52 parcels in each village. In total, there were 780 samples from 15 villages. It should be noted that there were instances where landowners owned multiple agricultural parcels. However, the random sample process selected only one parcel of the multiple parcels for the survey. While conducting the field survey on the selected samples, landowners were also interviewed for data on the other agricultural parcels. Therefore, the total sample obtained from the survey was 808 samples. Of these 808 samples, there are abandoned parcels for 118 samples and the rest 690 samples are used parcels.

3. Results

3.1 Statistic and data analysis

Descriptive statistics are presented in Table 2. As expected, this table shows that all farm gate prices of crops are low while all farm input prices are high. All crop yields were extremely low compared to the average yield from the 2012 report of the OAE. On average, cassava, rice, and sugarcane crop yields in the study area were 157.23 kg/rai, 275.66 kg/rai, and 1,716.31 kg/rai, respectively, while the average yields from the OAE report were 3,419 kg/rai, 415 kg./rai, and 12,280 kg/rai, respectively. On average, household labor used in the production process was 27 days/rai/season while the machine labor was only 7.15 hour/rai/season. This figure shows that crop production in the study area was based on labor intensive farming.

An average parcel size is around 11 rai and the standard deviation is 9.5, which indicates a wide gap between large and small parcel sizes. The minimum parcel size is 0.38 rai or 152 square-wa, and the maximum is 100 rai. Cash on hand, or the agricultural landowners' average savings 13,163.77 baht with a minimum of 3,200 baht, which is quite low. Understandably, Thai farmers are always in poverty.

Table 2 Descriptive statistics of model variables

Variable Code	Definition	Mean	Standard Deviation	Minimum	Maximum
Y_CASSAVA	Cassava yield (Kg./rai/crop)	157.23	756.87	0.00	8,570.00
Y_RICE	Rice yield (Kg./rai/crop)	275.66	360.49	0.00	2,666.67
Y_SUGARCANE	Sugarcane yield (Kg./rai/crop)	1,716.31	4,552.24	0.00	27,500.00
CASH	Cash on hand or Saving (baht)	13,163.77	8,081.99	3,200.00	61,666.67
FERT	Fertilizer (Kg./rai/crop)	41.14	32.37	0.00	250.00
LABOR	Household labor (day/rai/season)	27.00	39.50	0.00	336.00
MACHINE	Machine labor (hour/rai/season)	7.15	8.38	0.00	120.00
PEST	Pesticide (Kg./rai/crop)	0.25	0.93	0.00	16.25
CAPITAL	Capital (number of capital)	1.68	1.38	0.00	6.00
P_CASSAVA	Cassava price (baht/kg)	19.01	4.35	10.00	30.00
P_RICE	Rice price (Baht/kg.)	12.66	2.52	4.00	22.50
P_SUGARCANE	Sugarcane price (Baht/kg.)	0.98	0.17	0.60	2.00
P_CASH	Interest rate (percent)	7.82	1.93	1.00	14.00
P_FERT	Fertilizer price (Baht/rai)	165.59	26.55	60.00	320.00
P_LABOR	Household labor price (Baht/rai)	295.03	44.76	100.00	750.00
P_MACHINE	Machine labor price (Baht/rai)	407.66	257.77	100.00	1,800.00

Table 2 Continue

Variable Code	Definition	Mean	Standard Deviation	Minimum	Maximum
P_PEST	Pesticide price (Baht/rai)	407.92	224.19	31.25	1,500.00
P_CAPITAL	Land owners' machine price (baht)	80,165.47	170,447.40	0.00	1,046,249.00
SIZE	Parcel size (rai)	10.95	9.50	0.38	100.00
FULL_RIGHT	Full property right (full right = 1, otherwise = 0)	0.91	0.29	0.00	1.00
SEMI_RIGHT	Partial property right (partial right = 1, otherwise = 0)	0.09	0.28	0.00	1.00
NO_RIGHT	No property right (no right = 1, otherwise = 0)	0.00	0.04	0.00	1.00
UNDERGROUND	Main water supply from underground (underground water = 1, otherwise = 0)	0.05	0.21	0.00	1.00
RAIN	Main water supply from rain (rain =1, otherwise = 0)	0.82	0.39	0.00	1.00
RIVER	Main water supply from river (river = 1, otherwise = 0)	0.05	0.23	0.00	1.00
IRRIGATION	Main water supply from irrigation (irrigation = 1, otherwise = 0)	0.08	0.28	0.00	1.00
SOIL_LOW	Low quality of soil (low = 1, otherwise = 0)	0.18	0.38	0.00	1.00
SOIL_MED	Medium quality of soil (medium =1 , otherwise = 0)	0.57	0.50	0.00	1.00
SOIL_HIGH	High quality of soil (high = 1, otherwise = 0)	0.25	0.43	0.00	1.00
DIST	Distance to city (kms.)	54.77	35.52	0.40	144.00
TECH	Farming technology usage (yes = 1, no = 0)	0.73	0.44	0.00	1.00
RENT	Land rental law perception (yes = 1, no = 0)	0.26	0.44	0.00	1.00
POSSESSION	Adverse possession law perception (yes = 1, no = 0)	0.25	0.43	0.00	1.00
TAX	Land tax paid (yes = 1, no = 0)	0.98	0.16	0.00	1.00
S_CASSAVA	Land share for Cassava (percent)	0.05	0.20	0.00	1.00
S_RICE	Land share for Rice (percent)	0.67	0.46	0.00	1.00
S_SUGARCANE	Land share for Sugarcane (percent)	0.17	0.37	0.00	1.00
S_ABANDON	Land share for Abandoned land (percent)	0.11	0.29	0.00	1.00
PP_RICE	Rice price/Cassava price (price ratio)	7.20	2.85	2.00	20.00
PP_SUGARCANE	Sugarcane price/Cassava price (price ratio)	0.56	0.25	0.30	1.50
PP_INTEREST	Interest rate/Cassava price (price ratio)	4.38	1.67	0.50	14.00
PP_FERT	Fertilizer price/Cassava price (price ratio)	9.40	3.51	3.00	20.80
PP_LABOR	Household labor price/Cassava price (price ratio)	1.67	0.60	0.50	4.50
PP_MACHINE	Machine labor price/Cassava price (price ratio)	2.45	2.34	0.50	18.00
PP_PEST	Pesticide price/Cassava price (price ratio)	2.33	1.60	0.16	10.00
PP_CAPITAL	Capital price/Cassava price (price ratio)	4.46	10.13	0.00	104.62

In addition, the average loan interest rate was 7.82%, while the maximum rate was as high as 14%. The landowners possessed an average of two agricultural machines in which the maximum was six while the minimum was zero. The frequency analysis, which is not presented here, showed average soil quality to be moderate at 56.93% and high at 25.25%, which indicated that 80% of the parcel samples had medium to high soil quality. The main water source was from rain at 81.56 percent, followed by irrigation at only 8.29%, which indicated that most of the farmers relied on nature.

An estimation of the output supply equations in Table 3 shows that different factors affected each crop supply. All significant factors and signs were as expected. The higher rice supply came from a reduction in other types of land allocation, an increase in the water supply from irrigation system, a larger parcel size and a decrease in the property right. The coefficient of the FULL_RIGHT and SEMI_RIGHT variable suggests that those land owners who have full and semi right of property right on average tend to supply less of rice than those land owners who have no property right. This is agrees with Gine (2005) in a study indicating that a partial property right in Thailand triggers a sense of insecurity among landowners. So, they prefer to abandon the secured parcel and cultivate the unsecured plots to avoid expropriation risks. The higher sugarcane supply came from increases in agricultural machine prices that belong to the land owner, land allocation for cassava and sugarcane and decreases in property rights and loan interest rates. The more capital resources the landowner possessed, the greater the likelihood advanced agricultural machinery was utilized in sugarcane production, which resulted in higher yields. Land shares for cassava also affected the supply of sugarcane, but not land shares for abandonment. It showed that landowners still did not consider allocating abandoned land for sugarcane production, even if there was available land, which indicates that the abandoned plots must have an infrastructure problem that is too difficult to correct with the resources on hand. In contrast, greater land shares for cassava resulted in additional supplies of sugarcane because both crops grow well in poor soil quality with low rainfall and they share the same input such as agricultural machinery, production technology, fertilizer and pesticides.

Table 3 Parameter estimation of input demand, output supply, and abandoned land share equations

Variable	Output Supply Equations		Input Demand Equations						S_ABANDON
	Y_RICE	Y_SUGARCANE	CASH	FERT	LABOR	MACHINE	PEST	CAPITAL	
Intercept	1.194***	-39.544	-1.011	-62.322*	-176.908***	-0.941	-0.635	7.040	-10.167
	(0.407)	(6.115)	(0.813)	(32.364)	(41.317)	(10.260)	(1.775)	(669.793)	(0.910)
PP_RICE	0.009	0.071	-0.001	-2.203***	-2.005**	0.357	0.050	-0.103***	0.010
	(0.009)	(0.414)	(0.018)	(0.741)	(0.948)	(0.242)	(0.047)	(0.027)	(0.040)
PP_SUGARCANE	-0.043	1.987	0.151	-1.577	-7.879	-0.161	0.538	0.327	-1.457***
	(0.144)	(4.193)	(0.264)	(10.628)	(13.561)	(3.383)	(0.654)	(0.375)	(0.559)
PP_INTEREST	0.015	-0.712*	0.007	-1.84*	-1.097	-0.305	-0.033	0.022	0.069
	(0.013)	(0.410)	(0.025)	(1.001)	(1.284)	(0.323)	(0.063)	(0.036)	(0.051)
PP_FERT	-0.038	-0.926	-0.310*	13.530**	11.242	-5.140**	-0.810*	0.120	-0.212
	(0.009)	(0.288)	(0.017)	(0.689)	(0.882)	(0.224)	(0.045)	(0.026)	(0.035)
PP_LABOR	0.868	-23.990	2.412	-295.857	-77.426	-58.764	18.625	3.367	9.652
	(0.062)	(1.291)	(0.103)	(4.146)	(5.322)	(1.362)	(0.266)	(0.150)	(0.227)
PP_MACHINE	0.141	15.973	2.175	56.289	150.873*	-8.093	2.144	6.175***	2.496
	(0.009)	(0.184)	(0.015)	(0.614)	(0.785)	(0.196)	(0.038)	(0.020)	(0.034)
PP_PEST	-1.720	-50.670	5.393***	191.861**	82.900	-2.942	-5.017	2.050	11.088**
	(0.011)	(0.315)	(0.021)	(0.839)	(1.072)	(0.269)	(0.052)	(0.030)	(0.047)
PP_CAPITAL	19.724	1140.013***	-49.884*	-1496.134	-2637.352*	1516.601***	122.864	-340.594***	128.762**
	(0.002)	(0.038)	(0.003)	(0.119)	(0.152)	(0.042)	(0.008)	(0.004)	(0.006)
S_CASSAVA	-1.202***	10.076***	-0.060	-2.997	-10.949	-0.347	-0.394	-0.229	-
	(0.214)	(2.849)	(0.152)	(5.960)	(7.767)	(1.935)	(0.379)	(0.218)	-
S_SUGARCANE	-1.104***	28.582***	-0.186**	-17.045***	-12.433***	-0.012	-0.047	0.033	-
	(0.087)	(2.256)	(0.082)	(3.212)	(4.159)	(1.051)	(0.206)	(0.113)	-0.026***
S_ABANDON	-0.903***	1.953	-0.026	90.431***	81.978***	20.102***	1.640***	0.417	(0.008)
	(0.103)	(3.569)	(0.197)	(7.848)	(9.735)	(2.293)	(0.483)	(0.280)	
SIZE	0.009***	-0.073	-0.005	0.872***	1.294***	-0.006	0.011	0.008*	
	(0.002)	0.049	(0.003)	(0.130)	(0.167)	(0.042)	(0.008)	(0.004)	

Table 3 (continue)

Variable	Output Supply Equations		Input Demand Equations						S_ABANDON
	Y_RICE	Y_SUGARCANE	CASH	FERT	LABOR	MACHINE	PEST	CAPITAL	
FULL_RIGHT	-0.860**	-22.149***	0.062	26.056	143.720***	2.989	2.464	-0.097	9.859***
	(0.396)	(5.304)	(0.791)	(31.408)	(40.080)	(9.900)	(1.696)	(0.153)	(0.431)
SEMI_RIGHT	-0.892**	-17.761***	0.062	30.850	149.338***	2.928	2.166	-0.113	9.643***
	(0.396)	(5.378)	(0.794)	(31.529)	(40.231)	(9.941)	(1.704)	(0.153)	(0.479)
UNDERGOUND	0.056	0.895	-0.046	-4.111	-3.250	1.324	-0.203	-0.364**	0.538**
	(0.082)	(1.612)	(0.136)	(5.477)	(7.026)	(1.790)	(0.351)	(0.184)	(0.263)
RIVER	0.073	-0.957	-0.016	-6.129	-9.078	4.578***	-0.116	-0.159	0.415
	(0.072)	(1.875)	(0.127)	(5.078)	(6.503)	(1.702)	(0.311)	(0.176)	(0.274)
IRRIGATION	0.187***	-3.226	-0.148	0.606	5.361	0.423	-0.161	-0.394**	-0.418**
	(0.056)	(3.595)	(0.115)	(4.585)	(5.858)	(1.454)	(0.284)	(0.165)	(0.204)
SOIL_LOW	-0.037	0.094	-0.072	3.908	4.511	-0.673	0.154	-0.005	0.109
	(0.045)	(1.165)	(0.078)	(3.240)	(4.138)	(1.050)	(0.211)	(0.115)	(0.153)
SOIL_HIGH	0.033	-0.820	-0.044	0.967	6.675*	-1.767**	-0.201	0.031	-0.287*
	(0.037)	(1.467)	(0.071)	(2.863)	(3.662)	(0.912)	(0.178)	(0.106)	(0.153)
DIST	0.001	-0.006	0.001	0.033	0.189***	0.034**	-0.006**	-0.001	-0.026***
	(0.001)	(0.028)	(0.001)	(0.053)	(0.067)	(0.016)	(0.003)	(0.002)	(0.003)
TECH	0.051	2.140	-0.100	-11.516***	-2.933	-1.980**	-0.639***	-8.309	-0.098
	(0.036)	(1.395)	(0.067)	(2.764)	(3.526)	(0.887)	(0.183)	(669.793)	(0.144)
RENT	-0.037	0.404	0.079	5.190*	-4.559	-0.482	-0.281)	0.381***	0.461***
	(0.036)	(1.351)	(0.070)	(2.807)	(3.583)	(0.901)	(0.178)	(0.104)	(0.174)
POSSESSION	-0.040	-1.332	-0.178***	4.478	3.964	0.931	-0.043	-0.316***	-0.050
	(0.038)	(1.143)	(0.068)	(2.808)	(3.589)	(0.905)	(0.180)	(0.099)	(0.143)
TAX	0.058	-3.358	-0.212	-2.646	-10.871	-5.541**	-0.328	-0.698**	-0.104
	(0.094)	(4.546)	(0.181)	(7.611)	(9.804)	(2.635)	(0.522)	(0.347)	(0.385)

Note: ***, **, * statistically significant at level 0.01, 0.05 and 0.10, 808 observations, LR chi2(210) = 2741.86, Log likelihood = -13269.424 , Prob > chi2 = 0.0000, standard error are in parentheses.

Table 4: Marginal effect of land share for abandonment equation.

Variables	Land Share for Abandon	Variables	Land Share for Abandon
PP_RICE	0.001	UNDERGROUD	0.059
	(0.003)		(0.041)
PP_SUGARCANE	-0.104**	RIVER	0.041
	(0.044)		(0.036)
PP_INTEREST	0.005	IRRIGATION	-0.022**
	(0.004)		(0.009)
PP_FERT	-0.015	SOIL_LOW	0.008
	(0.003)		(0.012)
PP_LABOR	0.686	SOIL_HIGH	-0.018*
	(0.016)		(0.009)
PP_MACHINE	0.177	DIST	-0.002***
	(0.002)		(0.001)
PP_PEST	0.788**	TECH	-0.007
	(0.004)		(0.011)
PP_CAPITAL	9.151*	RENT	0.027***
	(0.001)		(0.010)
SIZE	-0.002***	POSSESSION	-0.003
	(0.001)		(0.010)
FULL_RIGHT	0.163***	TAX	-0.008
	(0.038)		(0.033)
SEMI_RIGHT	0.997***		
	(0.001)		

Note: ***, **, * statistically significant at level 0.01, 0.05 and 0.10, standard error are in parentheses

An estimation result of the input demand equations shows that pesticide price affects the quantity of fertilizer used; while the fertilizer price also affects the quantity of pesticide use, which indicates that farmers traded-off between these two types of input. As expected, the higher the price for rice, the more the landowners would invest in fertilizer, household labor and agricultural machine. Technology affects all input use with negative effects, except household labor, which indicates that better technology helps

to decrease all input use in crop production. The perception of land rental law has a positive effect on fertilizer and capital use which implies that the parcel that being used is encouraged by the law for both short and long-term investments. Landowners are inclined to cultivate the land rather than lease it to others for production.

The estimation result from the land abandonment share equation shows the factors with the greatest effect on land abandonment to be agricultural machinery prices, followed by semi-right of property right, pesticide price, full right of property right, sugarcane prices, land rental laws, water, soil quality, parcel size, and distance to city. The degree of effect from the marginal effect calculation presented in Table 4.5 indicates that if the capital price of the landowner is increased by one baht, there will be an additional 9.151 or 9 rai 151 square-wa[2] in land abandonment. This indicates that the richer landowners tend to abandon their land more quickly than the poorer landowners. During the field interview survey, these landowners were found to have the equipment necessary to accomplish all of the tasks for their enterprises, but to prefer providing a custom hiring service for others instead of cultivating the land. The services range from custom planting, harvesting or hauling. The custom hiring business not only made better use of their equipment, labor, and management resources throughout the year but it also increased their income and profits for the year and, in most cases, made the aforementioned considerably higher than crop production. The coefficient of the SEMI_RIGHT and FULL_RIGHT variable suggests that those land owners who have full and semi right of property right on average tend to abandon more of their plot than those land owners who have no property right for 0.163 and 0.997 or 398.8 and 65.2 square wa respectively. This is also agrees with Gine (2005) that a partial property right in Thailand led to the abandonment of secured parcel. If the price of pesticides increases by one baht, there will be an additional 0.788 or 315.2 square-wa in land abandonment, while a reduction in sugarcane price by one baht will result in an additional 0.104 or 41.6 square-wa in land abandonment. All of these price factors are consistent with economic theory. Relative to landowner perception

[2] 1 rai = 4 ngan = 400 square-wa = 1,600 square meters = 0.16 hectare = 1,914 square yards = 0.4 acre

of land rental laws, there will be an additional 0.027 or 10.8 square-wa in land abandonment if the laws are perceived. Relative to parcel size, if the parcel size is smaller by one rai, there will be an additional 0.002 or 3.2 square-meters in land abandonment. This is due to the production inefficiency of small parcels as reported by Simon (1987) and McClosekey (1975). The coefficient of the IRRIGATION variable suggests that those land owners who have the main water source supply from irrigation system on average tend to abandon less of their plot than those land owners whose main source of water supply are rain for 0.022 or 8.8 square-wa while those land owners who have the high quality of soil on average tend to abandon less of their plot than those land owners whose soil quality are medium for 0.018 or 7.2 square-wa. Closer distance to a city by one kilometer will generate an additional 0.002 or 3.2 square meters in land abandonment. This occurs because the economic rent and productivity of the parcels near urban areas is higher for non-agricultural activities. The summary of sign and size effect of significant variables on land abandonment share are reported in Table 5.

Table 5: Sign and size effect of significant variables on land abandonment share.

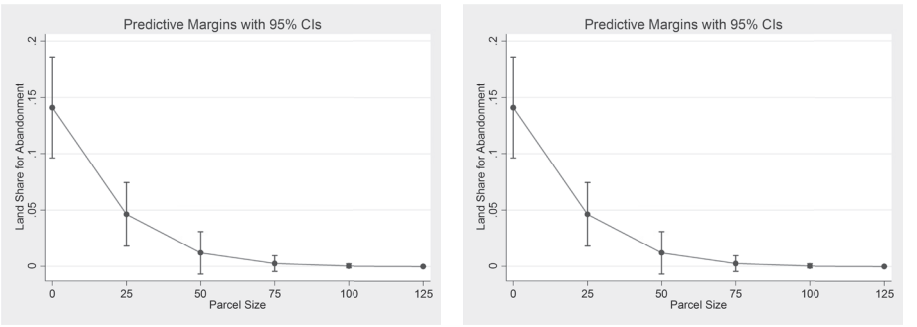
Variables	Sign affect	Size affect
Agricultural Machine price	+	9 rai 151 square-wa
Semi right of property right	+	398.8 square-wa
Pesticide price	+	315.2 square-wa
Full right of property right	+	65.2 square-wa
Sugarcane price	-	41.6 square-wa
Land rental law perception	+	10.8 square-wa
Irrigation system	-	8.8 square-wa
High quality of soil	-	7.2 square-wa
Land size	-	3.2 square-meters
Distance to city	-	3.2 square-meters

3.2 Marginal effect scenario test

The marginal effect scenario testing on the structural model provides an expected value for the dependent variable which is land share for abandonment for different values of significant variables. The purpose of this test was to find a turning point of land shares for abandonment, or a zero value of land shares for abandonment. The present study tested the following two variables: distance to city and land size. The scenario values for land size are set based on the proposed measure to limit the holding size of agricultural land at 50 rai. The scenario values for the distance to city variable were set based on the maximum distance of the parcel sample from the Khon-Kaen municipality, which is 144 km. Therefore, the scenario values for both variables were set as: land size: 0, 25, 50, 75, 100, 125 and distance to city: 0, 25, 50, 75, 100, 125, 150.

The marginal effect scenario testing on distance to city and parcel size is presented in Figure 2. The test shows that agricultural land will be fully utilized at approximately 125 kilometers from municipality and the most effective land size for agricultural production at approximately 100 rai at which point there will be no agricultural land abandonment.

Figure 2: Marginal Effect Testing



3.3 Model Validity Test

The problems of heteroscedasticity and non-normality, which lead to inefficiency and unbiased parameter estimates, are critical in Tobit setting. Both problems were tested in the present study. The overall system Heteroscedasticity test with the Breusch-Pagan LM Test indicated no system heteroscedasticity. Doornik-Hansen was used for non-normality testing under the null of non-normality and failed to accept the null, thereby indicating that the structure system is unbiased.

In addition to the estimation approach, a direct question on why the land owners decide to abandon their land was asked directly. The results showed that water, soil quality, and agricultural machine are among the highest frequency answer which is complying with the result from our structural estimation. Labor shortage is also one of the important factors for agricultural land owner to abandon their parcel for 13.72%. Interestingly, 12.83% percent of the samples intend to keep the parcel for speculation, therefore they cease the crop production while waiting for its price to rise. We found that 0.66% have other reasons to abandon their land that is not listed in our choices. They specify that the parcel belong to them are saturated all year; therefore they are unable to cultivate their land. This is another problem related to physical and infrastructure of parcel.

4. Discussion and policy implication

This study challenges key agricultural policies in Thailand. It has successfully constructed and applied an economic model to help answer agricultural policy issues. The outcome showed that the factors with the greatest effect on land abandonment are agricultural machinery prices, followed by semi-right of property right, pesticide price, full right of property right, sugarcane prices, land rental laws, water, soil quality, parcel size, and distance to city. In light of the aforementioned results, this study makes the following policy implications:

First, Relative to land infrastructure development policies such as irrigation system and soil improvement programs, both policies are the right measure for the Thai government to adopt. Although, financial limitations

have hindered the widespread construction of irrigation systems throughout Thailand, the shortage can be solved by introducing a value capture tax. Landowners who enjoy and benefit from a government-built irrigation system should return a portion of their increased profits to the government to maintain the system and build additional irrigation systems. Relative to the soil improvement program: The government has done a good job by establishing and developing volunteer soil doctors with learning centers at the sub-district level, which can be accomplished in a cost-effective manner. However, they need to be promoted more because many of the agricultural areas continue to face soil quality issues.

Second, Limited land holdings at 50 rai measure need to be revised. The results suggested that the minimum efficient parcel size for agricultural production is approximately 100 rai. Therefore, the plan of 50 rai should be reconsidered. It should be stressed that small parcel size reduces production efficiency.

Third, With the land allocation program, the full and semi right of property right factor is positively significant, which suggests that those land owners who have full and semi right of property right on average tend to abandon more of their plot than those land owners who have no property right. The result implied that the effectiveness of the land allocation program is inconclusive.

Fourth, With the land rental law, the result suggested reformation of the Agricultural Land Rental Act of 1981. The aforementioned law favors the tenants and thereby encourages land abandonment. It was effective in the past under a different social context, but is currently out-of-date and should be revised. Revising the law will not only reduce the land abandonment problem, but also encourage land use at its maximum capacity through the leasing process. Fifth, With the adverse possession law, the perception of the law is insignificant, which suggests that the law is an inconclusive policy.

Sixth, Agricultural-zoning is the right policy for the government to adopt, but should be based upon a use-based, not crop-based format. A radius of 125 kilometers from municipality is proposed for the province of Khon-Kaen. The parcels near the city should be converted to other uses more

suitable for their economic rent. This is due to uncontrollable urban development and sprawl. Therefore, legislative action should be used to manage the development and utilization of land to maximize economic return. Seventh, Concerning the debt moratorium program, the insignificance of loan interest rates suggested that the program is an inconclusive policy.

Eighth, With the price subsidy program, although the significant factors related to this policy are pesticide and sugarcane prices. Only the input price subsidy; pesticide prices can be implemented, but with caution because government intervention on output price destroys the market price mechanism and it has been proven in other parts of the world that intervening output price exacerbates the situation. Therefore, the output price subsidy should be cancelled.

Ninth, The Community Land Title Act is the right policy due to the positive significant of full and semi right of property right variables. The act should be implemented with the communal land size of 100 rai, which is the most efficient size for agricultural production based on the marginal scenario test analysis. Tenth With the Reformation of Land and Property Tax Act, the insignificance of land tax suggest that the Reformation of Land and Property Tax Act is an inconclusive policy.

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