Dose Incentive Really Matter for Forestry-management Incentive Programs? An Evidence from NIPF Landowners' Re-enrollment Decisions to a Joint Thinning Program in Ehime, Japan

Yohei Mitani[a*], Naoyuki Izumi[b], and Kohei Suzuki[a]

三谷　羊平・泉　　尚行・鈴木　康平：森林管理インセンティブプログラムに経済的インセンティブは本当に有効か？
久万林業活性化プロジェクトの再契約に関する私有林所有者の意思決定を事例とした検証

近年、私有林における森林保全や持続可能な林業を目指した自発的インセンティブプログラムが注目を集めている。欧米では、私有林所有者のプログラムへの参加行動に関する研究が盛んに行われている。プログラム参加者の再契約行動を理解することは、長期的な保全や持続的な管理を達成するために重要である。しかしながら、再契約行動に関する研究は世界的に数少ない。そこで本論文では、再契約行動に関する理論分析と、愛媛県久万高原町における「久万林業活性化プロジェクト」の契約者データを用いた計量分析を行った。その結果、契約期間中に森林の共同管理が実際に実施された契約者の方が、再契約する確率が高くなることが示された。

1. Introduction

The majority of forestland is owned by non-industrial private forest (NIPF) landowners in the United States and Japan (Birch, 1996; Japanese Forest Agency, 2006). The direct regulation approach has not been successful in providing right incentives for forest conservation and sustainable forestry on private land since serious conflicts erupted between NIPF landowners and the government in many countries (Shogren and Tschirhart, 2001; Hanley et al., 2012). Voluntary incentive programs have been increasingly and intensively used in recent years for forest conservation and sustainable forestry on NIPF land. To achieve efficient program design, policy makers need to know whether a program provides right incentives to landowners (Hanley et al., 2012). A large literature investigates landowner's participation behavior in such a program (Langpap and Kim, 2010). Langpap and Kim (2010) provide an excellent review of these literatures and conclude that, for forest management programs, economic incentives alone are not effective, and the landowners' lack

a) Division of Natural Resource Economics, Graduate School of Agriculture, Kyoto University, Kyoto 606-8502, Japan.

*) Corresponding author. Voice: +81-75-753-6193. Email: yomitani@gmail.com

b) The Norinchukin Bank.

of knowledge about such programs makes a difference.

However, a very few literature exists on the renewing behaviors even though understanding whether program participants extend their contracts or not will become crucial for achieving a long-term, sustainable goal. To our best knowledge, Cooper and Osborn (1998) is the only paper published up to now that analyzes re-enrollment decisions by participants (i.e. contract holders) of incentive programs. They use a survey of the US Conservation Reserve Program (CRP) participants to investigate the effect of the amount of compensations on their reported re-enrollment decisions. Their discrete choice analysis of contract holders' contingent behavior confirms the positive effect of the CRP rental compensation on contract renewal. Based on their estimates, the authors simulate re-enrollment levels in response to the different levels of rental rates and suggest that achieving near 100% contract renewal would be expensive for the society.

In this paper we use actual contract data from Kuma Joint Thinning Incentive Program in Ehime, Japan to explore re-enrollment decisions by participants. We first develop a theoretical model of a program participant's decision to extend their incentive program contract. We show how program incentives can affect owner's utility and investigate the effect of participant's experience of the incentive program implementation during the previous contract period on their extension decision. Our econometric analysis of actual contract data supports our theoretical prediction suggesting that the past experience of implementation of the incentive program increases the likelihood of re-enrollment.

To our best knowledge, this is the first paper to utilize actual contract data to analyze the effect of the previous incentive provision to contract holders on their re-enrollment decisions in joint forest management incentive programs. A data source for this kind of study can be categorized into three classes: actual decisions gained from a contract database of existing programs; reported actual decisions with regard to existing programs (typically gained from survey responses); stated contingent decisions with regard to hypothetical programs (gained from survey responses). Most papers published in the field of forest economics use either reported actual decisions regarding existing programs (Nagudabi et al., 1996; Sun et al., 2007; Fortney, 2009) or stated contingent decisions regarding hypothetical programs (Thomas et al., 2002; Arano et al., 2004). Mäntymaa et al. (2009) utilize actual contract data of a pilot conservation program in Finland though the dataset has a limited sample size of 37 participants. We use actual contract data with enough sample size of 936 all contract holders at the time of March 2011 whereas a limitation of this class of data is limited information about landowners and forestland characteristics.

The paper proceeds as follows: an introduction to the study area and joint forest management incentive program, theoretical framework for modeling re-enrollment decisions, data and econometric modeling, and results. The paper closes with concluding remarks.

2. Study Area

Our study site, Kuma municipality (Kumakougen-cho in Japanese), is located in the center of Ehime prefecture in Shikoku Island where is about 600 km southwest of Tokyo (Figure 1). Kuma municipality has 43,023 ha private forestland, which is 83.3 percent of the total forestland and 73.7 percent of the total land in the municipality (Census of Agriculture and Forestry, 2005). Forestry activity in the area had been successful until 1980s because of increasing domestic timber demands associated with the economic growth of Japan. However, many private forest landowners lost their motivation for timber productions as timber prices began to decline. Joint forest management has received increasing attention recently in Japan since economies of scale reduce operating costs and one can expect efficient management. In 2006, the Kuma Forest Association started to provide the *Kuma Joint Thinning Incentive Program* (KJTIP) to NIPF landowners of the municipality, which has been a pioneer in Japan.

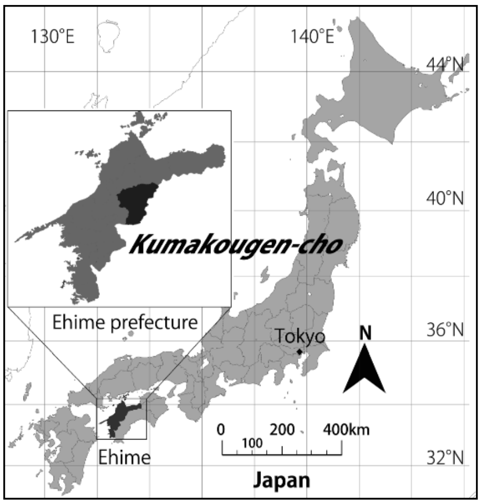

Figure 1 : Location of Study Site

Forest owners first take the initiative to show their willingness to provide areas available for the KJTIP to the Kuma Forest Association while the association encourages landowners to participate in the program. When a 5-year-contract is made between a landowner and the association, the ownership remains with the owner but she needs to give up all rights to forestry activities for 5 years. The association manages the enrolled forestland instead of the owner. The joint management activity that the association provides is thinning. The association investigates whole enrolled lands and decides the target area to implement thinning. After setting priority area for implementation, the association sometimes re-encourages neighboring landowners of the target area to enroll in the program. Joint thinning operations can be implemented if the number of participants in the target area or the total

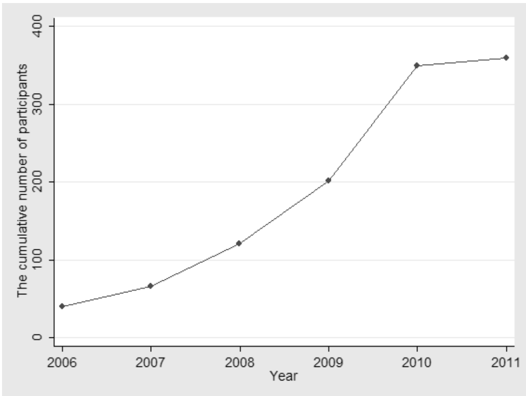

Figure 2：The Cumulative Number of Participants

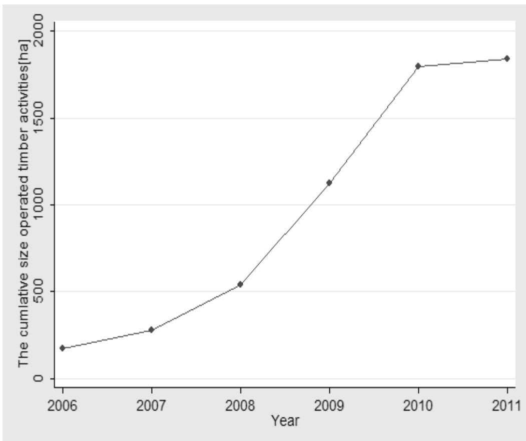

Figure 3：The Cumulative Area of Thinning Operation Implemented enrolled area reaches a certain threshold. The association calculates the cost to implement and offers the participants to accept it. If landowners accept the proposal, the association places an order with a forestry firm to operate thinning activity. After timber productions are sold, the association takes a margin and pays back the rest of profits to the owners.

Since the KJTIP was proposed in 2006, the number of participants and the size of enrolled area where thinning operation was implemented have been increasing as shown in Figures 2 and 3. The association concerns whether program participants renew their contacts or not since the contact period is 5 years and the original contacts need to be renewed for long-term, sustainable healthy forest management. This paper explores what motivates participants to extend their original contracts.

3. Theoretical Modeling of Re-enrollment Decisions

In this section, we develop a theoretical model of a NIPF landowner's decision to renew their incentive program contract. We show how program incentives affect owner's utility and investigate the effect of owner's experience of the incentive program implementation during the previous contract period on their extension decision. Since 2006 until March 2011, program participants have made a decision whether to extend their original 5-year-contract or not to extend but stay in it.

The Kuma Joint Thinning Incentive Program (KJTIP) is characterized by 1) participant's input to the program (i.e. any cost associated with the program participation), 2) mechanism of joint thinning implementation, and 3) incentives that participants benefit from the implementation.

The participant's input to the program is defined as C, which would be determined by the acre enrolled (size) and contract period (length). This input represents any cost associated with the program participation, which depends on the contract length and size enrolled in the program. Let RT(C) denote the income revenues from restricted timber and/or non-timber production when forestland is enrolled in the program with the input level C. We assume that increasing input C (i.e. bigger acre and/or longer length) reduces timber/non-timber income RT, i.e. $\partial RT(C)/\partial C<0$. Thus, the opportunity cost of program participation is represented as the income difference between participation of input C and no participation of input 0: $\Delta(C) = RT(0) - RT(C)$. For any positive C, $\Delta(C)$ is greater than or can be equal to 0. No opportunity cost, $\Delta(C) = 0$, implies no timber/non-timber revenue from the enrolled forestland.

Participants can receive incentives only when joint thinning is implemented on the enrolled forestland. In other words, landowner's benefit from program participation is conditional on the implementation. A mechanism of KJTIP requires enough continuous (neighboring) enrolled forestland for joint thinning to be implemented by the Kuma Forest Association. Individual participation does not assure the implementation of joint thinning on her enrolled forestland. Therefore, the KJTIP causes the "assurance problem," where individual inputs are only worthwhile if neighbors also participate, so community members need to assure each other that they will participate in order to assure the benefit from participation (Isaac et al., 1989). Let d_t be a dummy variable indicating joint thinning implementation in year t where $d_t = 1$ if implemented while $d_t = 0$ if not implemented.

Monetary incentive that a participant receives from her input C in year t is defined as $I(C \mid d_t)$. We assume that $I(C \mid d_t)$ satisfies the followings. First, participants receive positive benefit when joint thinning is implemented on the enrolled forestland C: $I(C \mid 1) > 0$. Second, participants receive no benefit when joint thinning is not implemented: $I(C \mid 0) = 0$. Third, given joint thinning is implemented, higher inputs (e.g. bigger acres enrolled) induce more benefit to a participant: $\partial I(C \mid 1)/\partial C>0$. A mechanism of KJTIP implies that the probability of implementation, $\pi = Pr[d=1]$, increases with the number of participants in a community defined as a zip code area, $N^{Par}{}_{ZIP}$ i.e. $\partial\pi_{ZIP}/\partial N^{Par}{}_{ZIP} > 0$.

Let us assume that a participant has an increasing indirect utility function of the monetary income given enrolling C, M(C), and non-market value of forestland, W, given the thinning implementation d_t: $V(M(C), W \mid d_t)$. Normalized monetary income M with her inputs of C is defined as a sum of the restricted timber/non-timber revenues, RT(C), and the value of incentives received from enrolling C, $I(C \mid d_t)$: $M(C) = RT(C) + I(C \mid d_t)$.

Consider a participant's decision whether to renew her original contract (R) or not to renew but stay in it (S), where the renewed inputs (C^R) are greater than or at least equal to the original inputs (C^S): $C^R \geq C^S$.[1)] Since there exists uncertainty for participants over the implementation of joint thinning, we consider participant's expected utility for a coming year over program implementation. The expected utility when a participant renews her contract is defined as follows:

$$E(V^R) = \pi\, V[RT(C^R) + I(C^R \mid 1) \mid 1\,] + (1 - \pi)\, V[\, RT(C^R) \mid 0\,], \qquad \text{Eq.(1)}$$

where π is the probability of implementation. The expected utility when a participant stays in the contract is defined as follows:

$$E(V^S) = \pi\, V[RT(C^S) + I(C^S \mid 1) \mid 1] + (1 - \pi)\, V[\, RT(C^S) \mid 0\,]. \qquad \text{Eq.(2)}$$

Assuming that landowners maximize their utility, a participant is willing to extend her contract (for an additional five years and additional acres enrolled) if the participant's utility with the renewal is greater than or equal to her utility without the renewal:

$$E(V^R) \geq E(V^S). \qquad \text{Eq.(3)}$$

A participant renews her contract if the following expected utility difference is greater than or equal to zero:

$$\begin{aligned} &E(V^R) - E(V^S) \\ &= \pi \{ V[\, RT(C^R) + I\,(C^R \mid 1) \mid 1\,] - V[\, RT(C^S) + I(C^S \mid 1) \mid 1\,] \} \\ &\quad + (1 - \pi) \{ V[\, RT(C^R) \mid 0\,] - V[\, RT(C^S) \mid 0\,] \} \qquad \text{Eq.(4)} \\ &= \pi \Delta V(d{=}1) + (1 - \pi)\, \Delta V(d{=}0). \end{aligned}$$

For $C^R > C^S$, the utility difference given the implementation $\Delta V(d=1)$ will be positive as long as $|\partial RT(C)/\partial C| < \partial I(C|1)/\partial C$, which should be satisfied given utility maximizing owner's participation. For $C^R > C^S$, the utility difference given no implementation $\Delta V(d=0)$ will be negative. For $C^R = C^S$, the both utility difference with and without the implementation, $\Delta V(d=1)$ and $\Delta V(d=0)$, is 0. Thus, $\Delta V(d=1) \geq 0$ and $0 \geq \Delta V(d=0)$.

Finally, we consider the effect of owner's experience of the incentive program implementation during the previous contract period on their extension decision. Let $d_{t^*<t}$ be an indicator equaling 1 if thinning incentive program was provided on her enrolled forestland by the time of the extension decision and 0 otherwise. Assume that a subjective probability of thinning implementation within one year after the extension is a function of the participant's past experience of the implementation: $\pi(d_{t^*<t})$. We assume the following:

$$\pi(1) > \pi(0). \qquad \text{Eq.(5)}$$

This assumption implies that participants who had an experience of thinning implementation on her enrolled forestland in the previous contract period have higher subjective probability of implementation (i.e. higher expectation about incentive provision) than participants who had an experience that thinning incentives was not provided.

We investigate the effect of participant's past experience of incentive provision on her re-enrollment decision. Consider the difference-in-difference of the expected utility:

$$\begin{aligned} \Delta DEU(d_{t^*<t}) &= \{E(V^R \mid d_{t^*<t}{=}1) - E(V^S \mid d_{t^*<t}{=}1)\} - \{E(V^R \mid d_{t^*<t}{=}0) - E(V^S \mid d_{t^*<t}{=}0)\} \\ &= \{\pi(1) - \pi(0)\}\, \Delta V(d{=}1) + \{\pi(0) - \pi(1)\}\, \Delta V(d{=}0). \qquad \text{Eq.(6)} \end{aligned}$$

This is interpreted as the difference of the likelihood of re-enrollment between past experiences of implementation. From Eq. (4) and Eq. (5), $\Delta DEU(d_{t^*<t}) > 0$. This leads us to the following theoretical prediction:

Prediction

If the participant's past experience of incentive provision increases her subjective probability of incentive provision in a coming year, then the past experience of implementation of the incentive program increases the likelihood of re-enrollment: If $\pi(1) > \pi(0)$, *then* $Pr[\{E(V^R \mid d_{t^*<t}=1) - E(V^S \mid d_{t^*<t}=1)\}] > Pr[\{E(V^R \mid d_{t^*<t}=0) - E(V^S \mid d_{t^*<t}=0)\}]$.

4. Econometric Analysis

In this section, we utilize actual contract data from the Kuma Joint Thinning Incentive Program (KJTIP) in Ehime, Japan to empirically analyze re-enrollment decisions made by participants.

Data Source and Description

The actual contract data used in this paper comes from the 2010 Participant Database (which contains all participants from 2006 to March 2011) prepared by the Kuma Forest Association. The database contains 936 participants at the time of March 2011 with landowner's name, address, membership information, enrolled size in acres, enrolled year, operation size in acres, and operation year (Izumi, 2012). This is the first paper to use actual contract data to examine re-enrollment decisions while a limitation of our data is that most participants were in the middle of the 5-year contract period at the time of March 2011.

Table 1 shows the variables used for our empirical analysis, their descriptions, mean, and standard deviation. Our dependent variable (*Renew*) is the NIPF landowner's decision whether to extend her original contract or not. Renew = 1 if the participant has renewed it until March 2011. A key independent variable of interest is *Implement* indicating a participant's experience of implementation of thinning before re-enrollment decisions are made (i.e. $d_{t^*<t}$ in Section 3). Our theoretical analysis in the previous section suggests that *Implement* has a positive effect on the probability of the extension, i.e. the expected sign of the coefficient of *Implement* is positive. Table 2 is a cross-table of *Renew* by *Implement*, indicating that the probability of *Renew* = 1 is higher when *Implement* = 1 than when *Implement* = 0. Our actual contract data provides landowners' actual decisions with real contexts while only a few characteristics variables are available.

Table 1 Variable Definitions and Descriptive Statistics

Variable	Descriptions	Mean	Std. Dev.
Renew	Dummy: Renew a contract	0.08	0.27
Implement	Dummy: Implementation of joint thinning practice	0.38	0.49
Member	Dummy: Member of forest organization	0.67	0.47
Residence	Dummy: Resident in Kuma-kogen municipality	0.43	0.49
ContSize	Size under contract at the beginning (hectors)	8.73	21.1
N^{Par}_{ZIP}	Number of participants in each ZIP code area	10.1	15.0

Table 2 Cross-table of Dependent Variable by Independent Variable

	Renew		
Implement	0	1	Total
0	545 (94%)	32 (6%)	577 (100%)
1	317 (88%)	42 (12%)	359 (100%)
Total	862 (92%)	74 (8%)	936 (100%)

Estimation Strategy

We show an empirical econometric model based on the theoretical model presented in the previous section. Participant's utility is decomposed as $V_i = x_i \beta + \varepsilon_i$, consisting of an observable part by the researcher and unobservable random part. The probability that participant *i* renews her contract is described as $\Pr[V_i^R > V_i^S] = \Pr[\varepsilon_i^R - \varepsilon_i^S > x_i(\beta^S - \beta^R)]$. Assuming that the $\varepsilon_i^R - \varepsilon_i^S$ has a normal distribution, we employ the probit model for our baseline empirical estimation.

There are two modeling concerns considered in our empirical analysis to reach an appropriate estimation strategy, which provides unbiased and consistent estimates allowing us to infer the causality between participant's past experience of incentive provision and her re-enrollment decision: 1) accounting unobservable variations across local communities and 2) addressing the possible endogeneity of past incentive provision (i.e. implementation).

Panel Effect Across Communities

Kuma town consists of thirty-three ZIP code based local communities, in which there are around 100 NIPF landowners. These communities share several features of forestland and landowner characteristics, including landscape, topography, land use, history, community size, typical occupations, and social interaction within a community. The actual contract data does not provide these variables, which may affect landowner's decisions. Econometric model needs to account for these unobservable community-level variations. We control for community-level unobservable variations with panel data models. We follow the standard procedure to find the appropriate econometric model, i.e. a test for random effects against fixed effects and test for random effects over simple OLS.

First, we run a Hausman test where the null hypothesis is that the preferred model is ZIP-code-specific random effects logit versus the alternative ZIP-code-specific fixed effects logit (i.e. H_0: the ZIP-code-specific errors are not correlated with the independent variables). The test statistics ($\chi^2(3)=2.98$, p-value = 0.39) does not reject the null, supporting the random effects specification. Model 2 in Table 3 reports the estimation results of ZIP-code-specific random-effects probit. Second, we run a Breusch-Pagan Lagrange multiplier (LM) test to decide if a random effects panel specification is better than non-panel standard specification, where the null hypothesis is that variances across ZIP-code communities is 0 (i.e. no significant difference across communities). To implement this LM test, we employ a linear probability model estimated with OLS and ZIP-code-specific random effects linear regressions. The test statistics ($\chi^2(1)=1.78$, p-value = 0.18) fails to reject the null, suggesting that the ZIP-code-specific random effects model is not appropriate. In other words, no significant panel effect across communities is found. These test results lead us to a simple robust standard error probit model reported in Model 1 in Table 3.

Endogeneity

Causality is difficult to establish if there exists a possible endogeneity within a model of the re-enrollment decision that includes the implementation of thinning (i.e. past incentive provision) as a covariate. The past incentive provision variable might be an endogenous regressor because of unobservable landowner heterogeneity driving both *Implement* and *Renew* or omitted variables correlated with both Implement and Renew. Since our data has very limited information about landowner characteristics, the endogeneity possibility might induce a serious problem.

To address the endogeneity of implementation, we employ a bivariate probit approach, which is a two equation binary outcome model with correlated error covariance. We estimate the following recursive bivariate probit model with exclusion restriction and test the endogeneity of implementation using information provided by this model:

$\Pr[Renew_i=1] = \Pr[a_R + \beta_R Implement_i + \varepsilon_{Ri} > 0]$ and $\Pr[Implement_i=1] = \Pr[a_{IMP} + \beta_{IMP} N^{PAR}_{ZIPi} + \varepsilon_{IMPi} > 0]$, where $\mathrm{Corr}(\varepsilon_{Ri}, \varepsilon_{IMPi}) = \rho$. We use the number of program participants in a ZIP-code community (N^{PAR}_{ZIPi}) as an instrument (i.e. exclusion restriction), which is not weak instrument based on the result of F-test of instrument (Fstats = 15.28).

First, we run a test of no correlation between two errors where the null hypothesis is $\rho = 0$, using an asymptotic z-test for the significance of the estimated correlation parameter ρ. The z-test of the estimate ($\rho^* = -0.297$; z-value= -0.99, p-value= 0.32) failed to reject the independence of two errors. Second, we run the likelihood ratio test, where we compare the log-likelihood of the bivariate probit with the sum of the log-likelihoods of the two single probit. The test statistics ($\chi^2(1)=0.98$, p-value = 0.32) supports two separate probit models. In short, we conclude that implementation variable is exogenous thus two independent robust standard error probit models are appropriate. Model 3 in Table 3 reports the probit estimation result where the dependent variable is *Implement*.

Results

Econometric considerations provided in the previous subsections suggest Model 1 reported in Table 3 to be used for interpretation. Note that the estimates from both Model 1 and Model 2 with ZIP-code-specific random effects are consistent with each other in terms of sign, magnitude, and statistical significance. The result shows that the variable of interest, *Implement*, has a statistically significant positive effect on the likelihood of re-enrollment at the 1% error level, indicating that the past experience of implementation provides (relatively) strong explanatory power for the likelihood of re-enrollment. This is consistent with our theoretical investigation. The all other variables except for constant provide no explanatory power for the likelihood of extension decisions, suggesting that additional characteristics variables are necessary for further investigation. The estimation result of Model 3 indicates that the probability of the past implementation is higher for members of the forest organization and increases with the acres under contract at the beginning and the number of participants in a ZIP code based community.

We also estimate the marginal effects of the discrete change of the dummy variable of interest (*Implement*) from 0 to 1 at the average *Implement* (which is 0.38): the marginal effects of *Implement* = 0.06 (S.E.=0.019 ***). The marginal effects in the probit model provide the discrete change in the probability for dummy variables. The participant's past experience of incentive provision will increase the probability of re-enrollment by 6 percent.

Table 3　Estimation Results

Dependent	Model 1 Robust Probit *Renew*			Model 2 Random-effect Probit *Renew*			Model 3 Robust Probit *Implement*		
	Coef	S.E.		Coef	S.E.		Coef	S.E.	
Implement	0.401	0.124	***	0.403	0.127	***			
Member	0.163	0.150		0.166	0.147		0.201	0.097	**
Residence	0.084	0.132		0.073	0.145		-0.047	0.140	
ln(*ContSize*)	-0.072	0.044		-0.064	0.042		0.082	0.030	***
N^{Par}_{ZIP}							0.012	0.005	***
Constant	-1.006	0.439	**	-1.125	0.450	**	-1.391	0.316	***
Var(ε_{ZIP})				-2.807	1.203				
LogLikelihood	-250.7			-250.1			-607.5		
Nobs	936			936			936		

Note: *** $p < 0.01$; ** $p < 0.05$

5. Concluding Remarks

The majority of forest land is owned by non-industrial private forest (NIPF) landowners in the United States and Japan. Voluntary incentive programs have been increasingly and intensively used in recent years for forest conservation and sustainable forestry on NIPF land, and a large literature investigates landowner's participation behavior in such a program. However, a very few literature exists on the renewing behaviors even though understanding whether program participants extend their contracts or not will become crucial for achieving a long-term, sustainable goal. To achieve efficient program design, policy makers also need to know whether a program provides right incentives to landowners.

This paper uses actual contract data from Kuma Joint Thinning Incentive Program in Ehime, Japan to explore re-enrollment decisions by participants. We first develop a theoretical model of a program participant's decision to extend their incentive program contract. We show how program incentives affect owner's utility and investigate the effect of participant's experience of the incentive program implementation during the previous contract period on their extension decision. Our econometric analysis of actual contract data supports our theoretical prediction suggesting that past experience of implementation of the incentive program increases the likelihood of re-enrollment. More specifically, our probit model indicates that the participant's past experience of incentive provision will increase the probability of re-enrollment by 6 percent.

NOTES

1) In this paper, we consider a short-term utility maximization where landowners take only coming one year into account, where only enrolled acres matter but not the contract length.

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