The Demand for Loans for Major Rice in the Upper North of Thailand

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Abstract

Though Thailand is the largest rice exporting country, its yield is relatively low. This might be a result of the under use of purchased input factors. Amongst other factors, high input prices and capital constraints could be some reasons. The latter could be removed by loans providing favorable market conditions exist. This paper seeks to investigate factors affecting the decision to borrow, and the demand for loans, for rice. The Tobit type-II models are estimated using the survey data collected from 656 rice farmers in the Upper North of Thailand in 2004. It is found that significant factors affecting the decision of borrowing include; the land planted to rice, dummy variable for off-farm income sources, and annual interest rates. In the second step, the farmers who borrowed from the rural financial sources, including 202 and 250 farmers from Chiang Mai and Chiang Rai respectively, are considered. According to the OLS estimation, only the land planted to rice has a positive significant effect on the amount of loans for major rice. Further, the interest rate affects the probability of loans but has no impact on the amount of loans, for rice.

Keywords: Upper North of Thailand, Tobit type-II model, Probability of loans for rice, Amount of loans, Rural financial sources.

1. Introduction

Thailand has been the largest rice exporting country. Its share 23.8 per cent of the world export market in 2000 even though its production is far lower than many countries e.g. China, India etc. (USDA, 2005). This is due to national sizes of production areas and yields. On average, the major rice (wet season) crop in Thailand yielded 386 kg/rai (6.25 rai=1 hectare) in 2002 (Ministry of Agricultural and Co-operatives, 2004). The province which gains the highest average yield is in the central plain with 739 kg/rai while the potential of rice yield could exceed 1000 kg. There are several factors attributed to this yield gap. Farming in Thailand characterizes over use of labour but under use of other purchased inputs such as fertiliser. One of the reasons hypothesized is capital constraint and high input prices.

Since rice is the only staple crop in the Thai diet, it is grown in all regions for home consumption, and in the past, the surplus has been for market. There is no exception to this in the North despite of its mountainous topography. Chiang Mai (CM) and Chiang Rai (CR), the

northmost provinces, were selected for this study to represent typical rice farming for consumption and market since they cultivate the largest production areas (46.7 per cent of the total rice area of the nine provinces) of the Upper North sub-region (which are 60 per cent of the northern region)

Since capital is very important for rice production, and loans are a significant source of it, then the demand for loans should be investigated. The demand for loans can be interpreted from the borrower's participation in the decision to borrow. Therefore, it is inappropriate to identify loan demand using information only on observed loan amounts as in some previous studies such as Pani (1966). The decision, as to whether borrowers want to borrow or not, should be considered in the context of demand analysis. This decision (of borrowers) depends on the borrower's economic endowment and opportunities. However, the estimates of credit demand are often biased, due to data truncation as a result of omission of non-borrowers, non-separability of the production and consumption decisions among rural households (Elhiraika and Ahmed, 1998), and the use of models that do not correct for selectivity bias, and the use of data that do not account for the existence of multiple loans (Nagarajan et al., 1998).

In early studies on rural credit in Thailand, various topics were of interest, including the structure of the rural financial market (e.g., Maireang, and Jiaraphan, 1999 and Thailand Development Institute, 1998), and the development of the rural financial institutions (e.g., Chearmuengphun, and Sriwichailamphan, 2001). However, previous studies on demand for loan for rice in Thailand, from our knowledge, were very limited. There is some literature which concentrated on the probability of borrowing such as Tupphun, and Tupphun (1998), who applied the logit model to estimate factors affecting the probability of household borrowing from formal and non-formal financial sources in the North and North East of Thailand.

The questions being posted are: do the inputs prices, (e.g. chemical fertiliser price, interest rate) affect the amount of loans needed by rice farmers? What other factors could have an influence on the amount of loans needed for rice production? Therefore, it is crucial to understand what factors determine the amount of loans needed by rice farmers and the direction and magnitude of the effects. The results would lead to policy consideration for rural financial loans promotion. Further, the limited dependent variable model, which has been widely applied to demand for loans, is applied to cope with the data. In this paper, the Tobit type-II model is considered since it is believed that the interest rates from rural financial sources are predetermined rather that are endogenously determined (because this is a micro analysis and farmers are price takers) in which the Tobit type-III is more appropriated.

This paper is organized as follows: section 2 presents material studied, area description, methods and techniques; section 3 presents results; section 4, discussion is given. Section 5 summarizes the conclusions.

2. The econometric model

The technique used in this study is the Tobit type-II model, which was classified by Amemiya (1984) (Verbeek, 2004; p. 228). This model is used to account for the sample selection problem. It is associated with data whose values of the regressand are not available from some observations, although values of regressors are available for all the observations (Gujarati, 1995; p. 576). The dependent variable has zero values for a substantial part of the survey data but is positive for the rest of the data. The Tobit type-II model consists of a linear equation for the amount of loans (Verbeek, 2004; pp. 228-232)

$$y_i^* = x_{1i}'\beta_1 + \varepsilon_{1i}, \quad (1)$$

where x_{1i} denotes a vector of exogenous variables and y_i^* represents the value of loan of the i th farmer. The loan, y_i^* is not observed for farmers who do not borrow. To describe whether a farmer borrows or not a second equation is specified, which is the binary choice model.

$$h_i^* = x_{2i}'\beta_2 + \varepsilon_{2i}, \tag{2}$$

$$y_i = y_i^*, h_i = 1 \qquad \text{if } h_i^* > 0 \tag{3}$$

$$y_i \text{ not observed, } h_i = 0 \qquad \text{if } h_i^* \le 0, \tag{4}$$

where h_i indicates whether farmer is borrowing or not borrowing. y_i denotes the i th farmer's amount of loan. The distribution assumption on the unobserved errors $(\varepsilon_{1i}, \varepsilon_{2i})$ is a bivariate normal with expectations zero, variances σ_1^2, and σ_2^2 and covariance, σ_{12}. The signs and magnitude of the β-coefficients may differ across the two equations. To estimate the parameters, the Heckman two-step method, proposed by Heckman (1979), is often used and based on the following regression

$$y_i = x_{1i}'\beta_1 + \sigma_{12}\lambda_i + \eta_i \tag{5}$$

where

$$\lambda_i = \frac{\phi(x_{2i}'\beta_2)}{\Phi(x_{2i}'\beta_2)}$$

where $\eta_i = \varepsilon_{1i} - E\{\varepsilon_{1i} | x_i, h_i = 1\}$. Given the assumption that the distribution of ε_{1i} is independent of x_i, η_i is uncorrelated with x_{1i} and λ_i. The λ_i can be estimated by Probit maximum likelihood applied to the selection model since there is the unknown element β_2 in λ_i. Although, Heij et al. (2004) stated that this method is not efficient because the two separate steps avoid the parameter restrictions $(1/\sigma)\beta$ and the error terms in the second step

are non-normal and heteroskedastic, this method is useful to obtain consistent initial coefficients. This alternative estimation method is based on the idea that censored data can be seen as a combination of binary response, followed by a linear relation $y_i = x_{1i}'\beta_1 + \sigma_{12}\lambda_i + \eta_i$ on the truncated sample of observations. Then the first step can be estimated by ML in the Probit model and the second step which considers the truncated sample of observations with $y_i > 0$, can be estimated by OLS.

In practice, the term, $\phi(x_i'\beta)/\Phi(x_i'\beta)$, is known as the inverse Mill's ratio or the Heckman's lambda. This expression for the truncation bias is specific for the normal distribution of the error term ε_i. The first step is to estimate the bias-correlation term (or Heckman's lambda) by maximum likelihood Probit model. The next step is to estimate the model using ordinary least squares with the estimated bias term as an explanatory variable using only the observations in the truncated sample with $y_i > 0$.

The Tobit type-II model can be specified as equation (1) to (4). The Probit model of the access to loans for rice production is applied in the first step because the parameter estimates obtained give information about the socioeconomic factors affecting the decision to get loans. The probability of the demand by the households for production loans is assumed to be dependent on ten variables involving the total area planted to rice, ratio of land owned to land planted to rice, dummy variable for off-farm income sources with a value of 1, if farmers have off-farm income sources, and 0, otherwise, household size, age of the head of household, formal education level of the head of household, annual interest rate of loans, price of rice, price of fertilizer formula 16-20-0, and price of rice seed.

For the second step of the Tobit type-II model is preferred in order to identify the factors influencing the amount of loans for rice. Eleven explanatory variables are included in this

model comprising ten explanatory variables which are the same as those in the probability of loans for the rice model, together with one explanatory variable related to the present value of machinery and equipment used in rice production plus the bias correction term, λ, in the second step of the Heckman two-step method.

There are some explanatory variables that affect the amount of loans needed for rice in addition to those for modeling the probability of loans. The agricultural net worth of farm machinery and equipment measures the present value of the machinery and equipment used in the rice production. It is believed that this variable affects the amount of agricultural loans.[1] The education level of the head of household is not included in explaining the demand for loans for rice because it is believed that the amounts of loans needed are associated with the inputs that affect rice product directly. The possible effect of the income of farmers in the previous year is not considered, because no data were collected for previous incomes.

3. The data and empirical results

Data for the study were collected from Chiang Mai and Chiang Rai provinces, which were selected as representative of the Upper North. Both provinces combined into 46.7 per cent of the sub-regional total planted area to rice in 2002. Chiang Mai province is representative of the Upper-middle-level yield areas, with a yield of 572 kg/rai. Chiang Rai is representative of the Middle-level yield areas, with a yield of 443 kg/rai. A summary of the data for the different variables, in the probability of loans and demand for loans for rice models in Chiang Mai and Chiang Rai, are presented in Table 1. The summary statistics are presented for the separated provinces, involving 331 farmers from Chiang Mai and 325 from Chiang Rai. The summary statistics of the sample farmers in Chiang Mai are similar to those in Chiang Rai

[1] Kochar (1997) took the value of physical assets inherited by the household into account and found that it had a significant effect.

with respective average loan amount of 9,504 and 10,166 baht. The average land planted to rice was very close in both provinces with the maxima of 30 and 38 rai in Chiang Mai and Chiang Rai, respectively. About 70 per cent of the farmers in the sample in both provinces operated small farms, which have land planted to rice of between 1-10 rai (6.25 rai =1 hectare). The average ratio of land owned to land planted in Chiang Mai was lower than that in Chiang Rai with about 52 and 63 per cent in Chiang Mai and Chiang Rai, respectively. It was found that landless farmers were about 40 and 35 per cent of the sample in Chiang Mai and Chiang Rai, respectively. These farmers rented land or cultivated other's land free of charge.

The average agricultural net worth of farm for the sample in both provinces was similar, with the maxima of 53,000 and 76,000 baht in Chiang Mai and Chiang Rai, respectively. It was found that 50 per cent of the sample farmers in Chiang Mai and Chiang Rai provinces had minimal agricultural asset net worths of less than 2,100 and 2,800 baht respectively. This implies that rice production, in the sample, tend to use labour-intensive production methods due to the size of operation. For household characteristics, including household size, ages of the head of household, and highest formal education level, the mean values were very close in both provinces.

The average annual interest rate[2] was 11.2 per cent in Chiang Mai and 10.8 per cent in Chiang Rai. The maximum interest rate in both provinces were different namely 36 and 30 per cent in Chiang Mai and Chiang Rai, respectively. The price of major rice obtained by farmers was quite close with the average price of 6.8 and 6.3 baht per kilogram in Chiang Mai and

[2] The highest interest rate in each village has been applied as the representative for the non-debtor farmers since it is believed that farmers in the same village confront the same interest rate given by rural financial sources. Moreover, the farmers who did not borrow might want to borrow if the interest rate was not too high.

Chiang Rai, respectively (a 7.4 per cent spread). Moreover, the average prices of fertiliser and seed in both provinces were almost identical since the two provinces are neighbours.

Table 1: Summary Statistics of Key Variables for Rice Farmers in Chiang Mai (CM) and Chiang Rai (CR)

Variable	Sample Mean		Sample Standard Deviation		Minimum		Maximum	
	CM	CR	CM	CR	CM	CR	CM	CR
Amount of loans for rice (baht)	9,504	10,166	12,986	10,567	0	0	100,000	67,500
Land (rai)	9.1	10.1	7.3	6.9	1	2.0	70	38.0
Land ratio (owned to planted, per cent)	51.5	56.4	46.6	45.9	0	0	100	100
Agricultural Net Worth of Farm (baht)	5,573.6	6,483	8,940.8	11,012	0	0	53,000	76,430
Household size (persons)	4.0	4.2	1.3	1.3	1	2	9	9
Age (years)	54	49	11	10	27	23	97	85
Education (years)	4.7	4.5	2.0	2.2	0	0	16	16
Annual interest rate (per cent)	11.2	10.8	6.6	6.8	1.5	1.5	36	30.0
Output price (baht/kg)	6.9	6.3	1.5	1.0	3.8	4.0	14.8	13.3
Fertiliser price (baht/kg)	8.2	7.9	1.1	0.8	4.2	5.0	13.0	11.0
Rice seed price (baht/kg)	10.7	10.9	3.9	3.4	3.3	4.5	25.0	23.0

The estimation of borrowing decision (Probit) for rice loan demand, and rice loan demand (Tobit type II) are presented in Table 2. The empirical results of the borrowing decision indicate that the variables the dummy for off-farm income source and annual interest rate are

statistically significant to explain the probability of loans at the five per cent level of significance for Chiang Mai province. Both variables have significant negative impacts on the probability of responding to loans for rice production with the coefficient of -0.41 and -0.176 for the dummy for off-farm income source and the annual interest rate, respectively. This implies that the farmer who has off-farm income tended to have a smaller probability of borrowing money for rice than did the others. Further, the higher interest rates which were experienced by rice farmers, tended to be associated with a lower probability of obtaining a loan for rice, than others applicants.

For Chiang Rai province, the empirical results indicate that the land planted to rice and the annual interest rates have significant effects at the five per cent level, with the coefficients of 0.058 and -0.159. The higher land area planted to rice, associated with a higher probability of obtaining a loan for rice production. In contrast, the farmers who confront higher interest rates are likely to have less probability to borrow money for rice production.

From the probability of loans model estimates, it is shown that factors affecting the decision to borrow include only production and farm characteristics. However, the household characteristics have no significant effects on the probability of obtaining loans for rice. It may be presumed that since this loan is associated with rice production, so factors which related to the production directly, affect the decision to borrow rather more than others. Moreover, due to the fact that most farmers have insufficient household savings; loans from financial institutions are crucial for rice production. The annual interest rate has a significant negative effect on the probability of obtaining loans by farmers in both provinces, which is consistent with the previous studies on demand for loans such as those by Kochar, 1997; and Nagarajan et al., 1998.

Table 2: Estimation of Borrowing Decision (Probit) for Rice Loan Demand and Rice Loan Demand (Tobit Type II)

Variable	Borrowing decision (Probit)		Loan Demand (Tobit)	
	Chiang Mai (331)	Chiang Rai (325)	Chiang Mai (202)	Chiang Rai (250)
Constant	2.03 (1.14)	3.18 (1.52)	-7,886.3 (9,846.1)	4,300.0 (8,411.4)
Land planted	0.025 (0.016)	0.058 (0.021)	710.5 (117.8)	794.9 (98.3)
Land ratio (owned to planted)	-0.0028 (0.0020)	-0.0020 (0.0025)	11.0 (20.1)	4.3 (13.2)
Off-farm income source	-0.41 (0.18)	0.17 (0.21)	-606.5 (1,898.5)	1,291.7 (1,105.9)
Agricultural net worth	-	-	0.148 (0.092)	0.019 (0.053)
Household size	0.065 (0.069)	-0.005 (0.075)	105.9 (659.6)	-130.1 (415.6)
Age	-0.011 (0.0085)	-0.007 (0.011)	29.2 (88.7)	83.5 (57.0)
Education	0.059 (0.051)	-0.004 (0.056)	-	-
Annual interest rate	-0.176 (0.021)	-0.159 (0.017)	110.0 (648.8)	-72.3 (292.9)
Output price	0.056 (0.059)	-0.19 (0.12)	707.0 (609.0)	-970.6 (795.3)
Chemical fertiliser price	-0.034 (0.079)	0.03 (0.13)	899.8 (754.9)	387.5 (723.7)
Rice seed price	0.029 (0.023)	0.042 (0.029)	107.3 (238.0)	128.2 (171.4)
λ	-	-	-3,652.7 (5,914.2)	-1777.2 (4,268.6)
$\hat{\sigma}_1$	-	-	11725.0	8501.0
Implied ρ	-	-	-0.312	-0.209
Log-likelihood	-138.20	-98.07	-2,169.4	-2,609.27
Chi-square	166.2	155.0	-	-
R^2	-	-	0.268	0.315
Pseudo R^2	0.334	0.322	-	-
McFadden R^2	0.376	0.441	-	-

Note: The numbers in parentheses are standard errors.

In this study, a number of household characteristics such as farm size, and formal education level of the head of household are included as per some previous studies (Crook et al., 1992; Pal, 2002; Manrique and Ojah, 2004) but the findings of this study reveal different results from the previous studies. Family size normally has a negative effect to explain the probability of choice in Crook et al. (1992) and Pal (2002), but has no significant impact in this study. Moreover, education level of the head of household also has a significant impact on the probability of holding consumer debt in Manrique and Ojah's study (2004), but does not have significant effect on the probability of loans in this study. It is presumed that those studies take into account multiple purposes loans including loans for consumption and others. Family size and education level may affect the probability of those loans because larger family size results in more consumption needed, while higher education tends to lead to have higher future income. In addition, interest rate is also included in the earlier studies on demand for loans, and was found a negative significant effect on the probability of loan in this study, which was the same as the studies of Kochar, 1997, Nagarajan et al., 1998 and Elhiraika and Ahmed (1998).

The empirical results of the demand for loans for rice is also displayed in Table 2. The results indicate that t statistic on the coefficient for $\hat{\lambda}$ do not reject the null hypothesis of no correlation in both provinces, while the estimation results imply estimated correlation coefficients, ρ s of only -0.312 and -0.209 for Chiang Mai and Chiang Rai, respectively. This means that the sample selection term λ does not have significant impact on the amount of loans.

According to the OLS estimates of the models, the only factor that affects the amount of loans of the farmers significantly in both provinces is the land planted to rice with the coefficient 710.5 and 794.9 for Chiang Mai and Chiang Rai, respectively. These mean that

when land planted to rice is increased by one rai, then the amount of loans needed by rice farmer increases by 710.5 baht for farmers in Chiang Mai and 794.9 baht for farmers in Chiang Rai. However, it is found that the interest rate has no significant effect on the amount of loans for rice, but is significant on the decisions to borrow. This is likely to be because, if farmers find that the interest rate is too high for them, they would make a decision to decline the borrowing. On the other hand, if they accept it, the factor influencing the amount of the loans is the land area under rice, since the higher land area under rice tends to need higher money for production.

From the empirical results presented above, only the input price of money capital (interest) has a significant impact on the probability of loans, but does not have any impact on the demand for loan for rice. The results reveal that only land area under rice has significant impact on the loan demand for rice. It implies that the amount of loans for rice is presumably because of an increase in the amount of input application. It is not just because the increase in the input price encourages higher amount of loans needed for rice.

4. Conclusion

In this paper, the demand for loans for rice are examined using sample data in the Upper North of Thailand based on a limited dependent variable models approach. Accordingly, the Tobit type II model is considered to estimate loan demand functions for rice farmers.

The empirical results of the probability of loans models show that the annual interest rate has significant impact on the probability of loans for rice in both provinces. Meanwhile, other variables which have significant effects on the probability of loans for rice are different in both provinces, namely, the dummy variable for off-farm income sources is significant for Chiang Mai while land planted to major rice is significant for Chiang Rai. For demand for

loans analysis, the Tobit type-II using the Heckman two-step estimation is estimated. The farmers, who borrowed from the rural financial sources, including 202 and 250 farmers from Chiang Mai and Chiang Rai, respectively, are analysed in the OLS estimation. According to the OLS estimation, only the land planted to rice has a positive significant effect on the amount of loans for rice in both provinces. The price of money capital (interest rate) shows the impact on only the probability of loan rather than the loan demand. This indicates that an increase in price does not discourage the loan demand for rice. For further study, more variables might affecting the amount of loans for rice such as the income from the previous, year etc., which should be included to get a more appropriate demand of loans model.

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