CHAPTER 2. METHODOLOGY

2.1 Theoretical Framework

The amount of credit needed by a farmer is determined by levels of his existing resources and technology being employed. Assuming a profit maximizing farmer and all inputs utilization are financed by credit, the situation can be illustrated in Figure 1 (adopted and modified from Onchan, 1986);

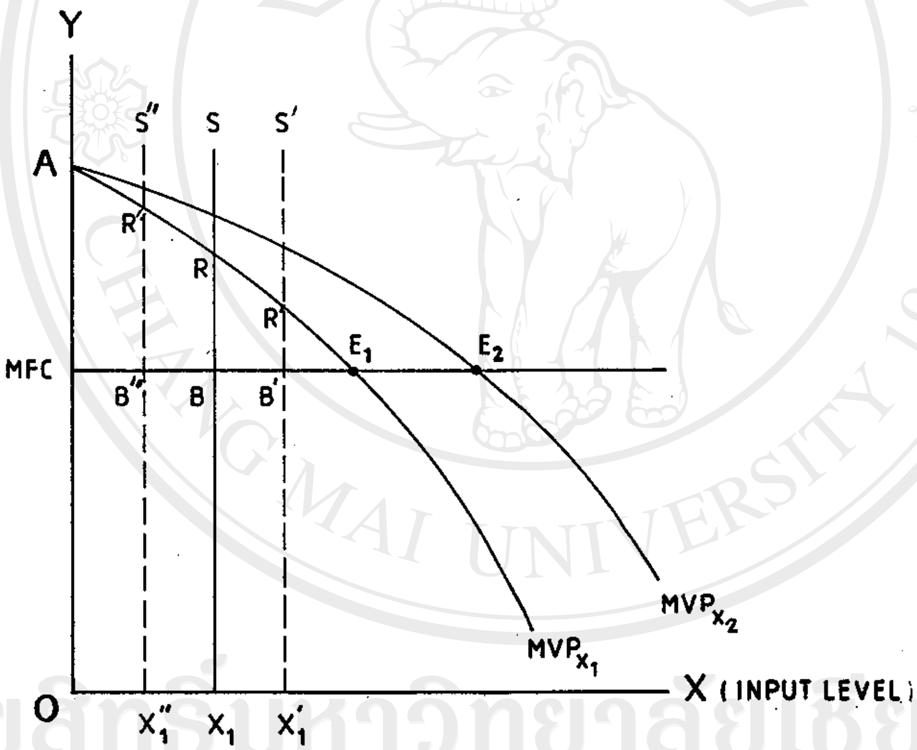

Figure 1. Credit constrained optima in the use of a variable input under current and improved technology.

where:

MVP_X - marginal value product (MPx. Py)

MFC - marginal factor cost (unit cost of input e.g. interest etc.)

E - optimum level of input application under a given technology

line $SRBX_1$ - credit restraint. Line defining the limit of access and utilization of credit either absolute as with the case of rationing (setting specific limit) or other policy intervention (e.g. concessionary type of credit) and others such as required borrowers credentials.

$MFCAE_1$ - optimum profit under current technology ($MVPx_1$) which is equal to OAE_1X_1 - $OMFCE_1X_1$ which is also analogous to return over variable cost.

Availability of credit money, allows the farmer both greater consumption and at the same time increased purchases of farm inputs thus improving the welfare of the farm household. This contention is quite consistent if at the time of the credit was made available, the farmer had adequate supply of liquidity [3] at a given price. However, the impact would be different if the farmer is faced with binding liquidity constraints. Figure 1 depicts these situations. Line $S'R'B'X'_1$ illustrates that if a farmer is faced with non-binding capital constraint, the infusion of credit money to the farm would trigger an equal or even greater than their notional input application ($SRBX_1$) while if capital constraint is binding his actual input application could be $S''R''B''X''_1$ which is less than his notional input application or even much farther from the optimum level (E_1) because part of the credit money is easily diverted to other pressing family needs.

3_/ This is defined as the cash or non-cash possesions of the farm-household for farm or non-farm related spending

The above explanation considers technology as not changing. The effect could be magnified if we consider technological change (say, $MVPX_2$), because if the farmer is faced with binding capital constraint, the more his notional input application becomes even farther from the optimum level (E_2). It is therefore important to look at this behavior carefully in order to see whether the marginal effect of credit which is to bring input levels closer to optimum is achieved. Furthermore, farm level impact reflecting this type of situation is not trivial because the effect of credit is expected to differ between liquidity constrained from liquidity unconstrained farm households.

Previous studies done to identify the effect of credit at farm level was to estimate a separate production function between borrowers and non-borrowers (e.g. David and Meyer, 1980), others did a pooling of sampled observations and estimate the production or output supply functions with credit as one of the explanatory variables. The fact that borrowers and non-borrowers respectively are not homogeneous with respect to their credit demand situation (as implied in Figure 1) pose a major weakness to these approaches. This is because; (a) many non-borrowers do not borrow because either, they have enough capital and not because they cannot obtain credit, while (b) some cannot simply borrow because they are "non-bankable". Similarly, the marginal effect of credit may actually be zero for borrowers whom liquidity is not a binding constraints (Feder et al. 1990).

Hence, any estimate that does not categorically translate these differences in farmer´s behavior in response to changes in credit needs as embodied in the household liquidity, into some kind of restrictions and specifications of the estimation, is grossly ignoring the fact that at farm level, there is a disequilibrium situation in the credit market.

2.2 Scope and Limitation

The impact of credit utilization on farm productivity in this study focuses primarily on short term loan for crop production excluding livestock, fruit trees and aqua culture. This type of loan (crop production) including vegetables, comprises about 70 percent of the total agricultural credit exposure in Chiang Mai province (BAAC, 1991). Also it narrows down to consider only two major crops, rice and soybean, because; (a) almost 60 percent of the total crop production loan in the province is absorbed in these two crops (Table 1), (b) the 7th Economic and Social Development Plan singled-out to support soybean as an important economic crop and rice as staple crop (c) these crops are predominantly cultivated by farmers across economic strata (resource rich and resource-poor farmers) in Chiang Mai province.

2.3 Data Collection

The Bank of Agricultural Cooperative (BAAC), which caters more than 80 percent of the formal borrowings of farmers in Chiang Mai province, and the agricultural officer in every district and sub-district served as the major sources of secondary information in order to know the relative distribution of target respondents in the identified study area.

Table 1. Distribution of borrowers for crop production loan in Chiang Mai Province, 1990

Crops	Number of Borrowers	Percent(%)
Rice	7882	37.40
Corn	89	0.41
Soybean	3679	19.42
Bean	177	0.93
Cereal	262	1.38
Tea and Coffee	391	2.00
Onion	1414	7.50
Garlic	3087	16.29
Tobacco	709	3.74
Potato	583	3.07
Fruits and Vegetables	1469	7.80
TOTAL	18943	100.00

Source: BAAC (Chiang Mai), 1991

Multi stage sampling was used. Which means that; firstly, a purposive selection of districts where rice and soybean are predominantly cultivated in Chiang Mai Province, was done . The criteria also included land types and income distribution of farmers. From the data of BAAC Chiang Mai, the following districts were chosen for this stage;

1. Chomtong and Doi Tao - as poorer area and basically upland land types
2. San Pa Tong and Hang Dong - for better off lowland farmers, better land types

The second stage was a random sampling of sub-districts (tambol) from each identified district, one tambon for each district.

A cluster of two villages were selected, then finally a random sample of respondents were chosen for interview. Information from the districts BAAC branch and agricultural officer in the subdistrict (tambol) was the primary guide in the sampling process.

2.4 Analytical Framework

The study assumed that all borrowers and all non-borrowers are not homogeneous with respect to their credit demand situation. That is credit transactions at household level are not necessarily at equilibrium. Which means that the amount of credit desired and offered are not always equal depending on the price and non-price restraints in the market. This could results in a binding or non-binding capital constraints to the farmers.

From the above premise, we can say that the behavior of borrowers and non-borrowers can be described as to whether; (a) demand for credit is less than or equal to credit supply, and (b) demand for credit is greater than supply. The first case describes a borrower and non-borrower with no binding capital constraint or credit unconstrained farmers and the second case are borrowers and non-borrowers with binding capital constraint or credit constraint farmers.

Hence, the bottom line of the analysis is the extent to which farmers are credit constrained or credit unconstrained. The significance of this approach is that, the independent estimate of the two cases could provide us with a more realistic separation of the marginal effect of credit on farm productivity. But from the nature of this type of analysis, correlation of the estimated error terms[4] of the two cases can not be avoided, when making a separate estimation of the output function. So we need to purge this correlation in order to have an unbiased estimate.

During the conduct of the survey, only one case is observable per respondent. Either the credit demand of the respondent is ≤ supply or demand is > supply. We can see therefore that the switch point between credit unconstrained and credit constrained farmer is when excess demand equals zero (credit demand = credit supply). So we need to define this break point. One way is to estimate an excess demand criterion up to a scale factor which can be used to estimate an identifiability restriction for the equation of the two cases in order to purge the correlation of errors and force them to separate. Unless we can impose this restriction to the equation of the two cases (credit unconstrained and credit constrained), then the conditional mean of the estimated error term of each case can not be equal to zero.

So at this point, the estimation procedure for this kind of analysis is already clear. First, is to obtain the estimate of an excess demand criterion to be used as identifiability restriction to output equations. Then next is to estimate the relevant parameters of the corrected output functions.

4_/ Correlation of error terms here, means that the probability distribution of the error of any case is affected by the occurence of the other.

2.5 Data Gathered

This study considered only two major crops (rice and soybean) cultivated by two groups of farmers borrowers and non-borrowers, as the focus of the study.

The data gathered included the following major aspects:

Socio-economic Profile - income : farm and off-farm, present and previous, farm size, factor endowments (land, labor,etc.), age and education of household head, membership to institution, township or residence, household size, number of dependents, etc.

Farm or Household Production and Consumption Data - area cultivated, crops planted, yield, input utilization, tenure status, market, etc.

Source of Credit - terms, amount availed or limit, interest rate, accessibility, savings and investment from formal and other sources, etc.

Credit Utilization and Management - purpose: agricultural, consumption, farm size, crops, frequency, utilization, mode of payment (including factors affecting choices and priorities of loan repayment) seasonality, etc.

2.6 Model Specification:

The appropriate econometric approach that this study used in order to segregate the effect of credit under the two scenarios, is to estimate the total output function of the farm using two stage-switching regression model with an endogenous switching criterion namely, Mills ratio or truncation variable (Maddala, 1983 pp. 223-228). The model postulates that the output function for any observation (i) from a given crop (rice or soybean);

(1) $$Y_{1i} = \beta_1 X_{1i} + U_{1i}$$

$$\text{iff} \quad \delta Z_i + U_i \leq 0$$

(2) $$Y_{2i} = \beta_2 X_{2i} + U_{2i}$$

$$\text{iff} \quad \delta Z_i + U_i > 0$$

Where X_{1i}, and X_{2i} and Z_i are vectors of exogenous variables; β_1, β_2 and δ are the corresponding vectors of parameters and U_{1i}, U_{2i} and U_i are random disturbances assumed to have trivariate normal distribution, Y_{1i} and Y_{2i} are two possible scenarios of dependent variables, only one is actually observed in a given household depending on the value of the unknown criterion function ($\delta Z + U_i$).

In practice, this criterion function is not directly observable. However, from the survey responses, we would know whether a given farm household is constrained or unconstrained by liquidity. Equations (1) and (2) are viewed as the output functions under credit unconstrained and credit constrained conditions respectively. The criterion for credit constrained or unconstrained is whether the demand for credit exceeds credit supply, and this is defined by the excess demand criterion $\delta Z + U_i$ in this case (Feder et al.,1990).

So the first stage of the solution is to obtain an estimated vector parameters for the excess credit demand criterion via Probit Maximum Likelihood method, using the dichotomous responses on whether a given farm household is credit constrained ($C^*_i = 0$; if $\delta Z_i + U_i > 0$) or credit unconstrained ($C^*_i = 1$; if $\delta Z_i + U \leq 0$). The Z_i vector represents both determinants of credit supply and credit demand at farm level.

The next stage is to estimate equations (1) and (2) specified under a double log (Cobb-Douglas) model (Zhang, 1991 and Sriboonruang, 1984) by least squares method, after incorporating the corresponding Mills ratio in each equation.

Lee, 1976a discussed a simple two-stage method in estimating the Mills ratio, then finally deriving the final form of equations (1) and (2). It starts with obtaining the expected values of the trivariate residuals (U_{1i}, U_{2i} and U_i). To obtain $E (U_{1i} \mid C^*_i = 1)$ we note that the conditional distribution of U_{1i} given Ui [$E (U_{1i} \mid U_i)$], is normal with mean $\sigma_{1u}U_i$ and variance $\sigma_1^2 - \sigma_u^2$.

Hence;

$$E (U_{1i} \mid \delta Z_i + U_i \leq 0) = E (\sigma_{1u}U_i \mid \delta Z_i + U_i \leq 0)$$

(3) $$E (U_{1i} \mid C^*_i = 1) = \sigma_{1u} \left[\frac{- \phi (\delta Z_i)}{\Phi (\delta Z_i)} \right]$$

also,

$$E (U_{2i} \mid \delta Z_i + U_i > 0) = E (\sigma_{2uUi} \mid \delta Z_i + U_i > 0)$$

$$(4) \qquad E (U_{2i} \mid C^*_i = 0) = \sigma_{2u} \left[\frac{\phi (\delta Z_i)}{1- \Phi (\delta Z_i)} \right]$$

let; $W_{1i} = \dfrac{- \phi (\delta Z_i)}{\Phi (\delta Z_i)}$ and $W_{2i} = \dfrac{\phi (\delta Z_i)}{1 - \Phi (\delta Z_i)}$

Where the $\phi (\delta Z_i)$ and $\Phi (\delta Z_i)$ are the conditional density and commulative distribution function respectively of a standard normal evaluated across the Z variable of the ith observation. The W_i´s are the Mills ratios while the right hand side (RHS) of equations. (3) and (4) are the identifiability restriction or truncation effects which need not be positive or negative in sign (Lee, 1978).

These truncation variables will be substituted to equations. (1) and (2) and obtain the final form of the separated output equations (eqns. 5 and 6).

(5) $Y_{1i} = \beta_1 X_{1i} - \sigma_{1u} W_{1i} + \epsilon_{1i}$ for credit unconstrained

and,

(6) $Y_{2i} = \beta_2 X_{2i} + \sigma_{2u} W_{2i} + \epsilon_{2i}$ for credit constrained

where:

σ_{1u} and σ_{2u} = covariance of the trivariate normally distributed random disturbances (U_i, U_{1i}, U_{2i})

ϵ_{1i} , ϵ_{2i} = are new residuals with zero conditional means

(7) $$\epsilon_{1i} = U_{1i} + \sigma_{1u}W_{1i}$$

(8) $$\epsilon_{2i} = U_{2i} + \sigma_{2u}W_{2i}$$

The vectors of explanatory variables (X_i) are factors influencing the output functions of both credit constrained and unconstrained farm households. Price is not used as one of the explanatory variables since this study made use of cross-sectional farm data and all respondents are exposed to the same price level. It should be emphasized also that since credit are normally made available to the farmers seasonally and on crop basis, then rice and soybean are analyzed separately and not as one cropping system. Lastly, the influence of credit is embodied under total liquidity in which the estimated parameter of this variable would imply its marginal effect to productivity.