CHAPTER II

METHODOLOGY

This chapter is devoted to narrate the method and analytical framework of the study. In the first part, the scope of the study as well as method of collecting data will be presented. Then, the profit and variable input demand models will be described. Finally, notations in calculating cost and return, and the approach to analyzing cost-effective policy alternatives will also be explained.

2.1 Scope of the Study

Estimation for profitability, variable input demand and others in this study will focus only on Winter-Spring paddy[1] grown in the dry season in the Mekong Delta, Vietnam. This growing season is important in terms of total production, high yield, good quality for exporting, as well as a stable source of income for paddy growing farmers. The Mekong Delta was chosen for conducting research since it is the main area which has rice surplus for exporting, and shares for more than 50% of total paddy production (General Statistical Office, 1992).

2.2 Data Collection

2.2.1 Sampling Procedure

[1] The Winter-Spring paddy denoted for paddy grown at the beginning of the dry season (Nov.-Dec.) and harvested three months later (Feb.-Mar.)

Data relating to paddy output and inputs are collected by interviewing a sample of individual farms from 6 subdistricts in 4 provinces of the Mekong Delta. Since the population of paddy growing farmers is large and distributed over a wide area, the multi-stage sampling method is more appropriate for collecting data. First, a purposive selection of provinces which predominate Winter-Spring paddy in the region was made. Yield, cultivated area, and proximity to central markets were the major criteria for the first stage selection. However, production environment, ecological region, income distribution were also considered as far as possible. The following provinces were chosen: Dongthap, Angiang, Tiengiang and Haugiang (Figure 3).

Second, based on different proximity to markets, six subdistricts which are the main growing areas of these provinces were selected at the second stage.

Third, at least three villages far from each other in each subdistrict were chosen. 30 households in the subdistrict were randomly selected and interviewed.

2.2.2 Information to be Collected

Production data at household level: area cultivated, rice varieties, yield, cropping patterns, input utilization, prices of inputs and output, volume marketed, etc.

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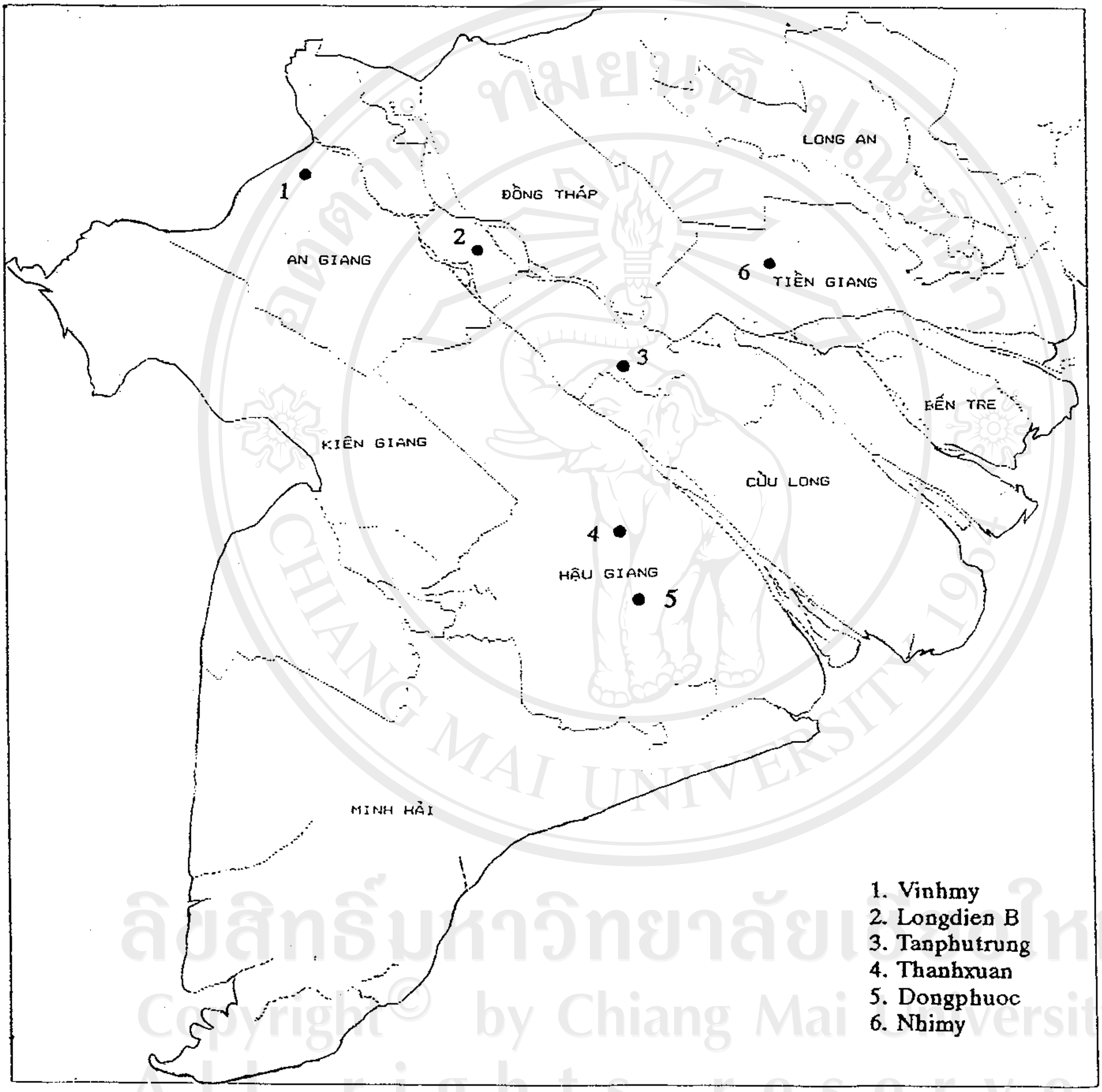

Figure 3. Map of the Mekong Delta Showing the Study Area

Socio-economic profile: Farm and off-farm income, farm size, factor endowments (labor, land, etc.), household size, number of years in farming, number of years of schooling, credit interest rate, etc.

2.3 The Theoretical Model

In order to derive variable input demands and output supply for rice production in the study area, a normalized restricted profit function developed by Yotopoulos and Lau is employed. The theoretical framework of this method is as follows (Lau and Yotopoulos, 1972):

It has been shown that for a profit-maximizing, price taking firm with a production function with the usual neoclassical properties

$$(1) \qquad V = F(X_1, \ldots, X_m; Z_1, \ldots, Z_n)$$

Where V is output, X_i represents variable inputs, and Z_k represents fixed inputs of production

Profit (defined as current revenue less current total variable costs) can be represented by the following equation:

$$(2) \qquad P' = pF(X_1, \ldots, X_m; Z_1, \ldots, Z_n) - \sum_{i=1}^{m} C_i' X_i$$

Where p' is profit, p is the unit price of output, and C_i' is the unit price of the *ith* variable input. The fixed costs are ignored since they do not affect the optimal combination of the variable inputs.

By dividing the equation (2) by p , the normalized or the "Unit-Output-Price" profit function (UOP profit function) is defined as follows:

$$(3) \qquad P = \frac{p'}{p} = F(X_1, \ldots, X_m; Z_1, \ldots, Z_n) - \sum_{i=1}^{m} C_i X_i$$

Where C_i is defined as the normalized price of the *ith* input

$$(4) \qquad C_i \equiv \frac{C_i'}{p} \qquad i = 1,\ldots,m.$$

The marginal productivity conditions given the levels of technical efficiency and fixed inputs for a profit maximizing firm are:

$$(5) \qquad \frac{\partial F}{\partial X_i} = C_i \qquad i = 1,\ldots,m.$$

Equation (5) may be solved for the optimal quantities of variable inputs, denoted X_i^*'s , as functions of the normalized prices of the variable inputs , and of the quantities of fixed inputs.

(6) $$X_i^* = f_i(C, Z) \qquad i = 1,\ldots,m$$

Where C and Z without subscripts denote vectors of normalized input prices and quantities of fixed inputs, respectively

By substitution of (6) into (2) one gets the restricted profit function:

(7) $$\Pi = p[F(X_1^*, \ldots, X_m^*; Z_1, \ldots, Z_n) - \sum_{i=1}^{m} C_i X_i^*]$$

(8) $$\Pi = G(p, C_1', \ldots, C_m'; Z_1, \ldots, Z_m)$$

Which gives the maximized value of the profit for each set of values { $p;C';Z$ }. The restricted profit function is homogenous of degree one in output and variable input prices, and thus the normalized restricted profit function (The UOP profit function) is given by:

(9) $$\Pi^* = \frac{\Pi}{p} = G^*(C_1, \ldots, C_m; Z_1, \ldots, Z_n)$$

From the UOP profit function the firm's factor demand functions, X_i^*'s, and the firm's supply function, V^*, can be derived directly by using the Hotelling's lemma (Lau, 1978)

$$(10) \qquad X_i^* = -\frac{\partial \Pi^*(C, Z)}{\partial C_i} \qquad i = 1, \ldots, m$$

This also implies that the UOP profit function is decreasing and convex in the normalized prices of variable inputs.

$$(11) \qquad V^* = \Pi^*(C, Z) + \sum_{i=1}^{m} \frac{\partial \Pi^*(C, Z)}{\partial C_i} . C_i$$

2.4 Model Specification

2.4.1 The Translog Variable Profit Function

Two functional forms are applied at the first stage of the study: Cobb–Douglas and Transcendental Logarithmic (translog) functions. The Cobb–Douglas form is relatively compact and requires less computer work. The translog profit function would have general advantages such as partial elasticities of substitution between inputs and present various opportunities for examining the economic decision making system of individual farmers

(Sidhu and Banaante, 1981). Moreover, the translog will reduce to the Cobb–Douglas case when coefficients of all second–order terms in the translog function equal zero. Therefore, the hypothesis of Cobb–Douglas will be tested through imposing relevant restrictions on the translog profit function. The equation of the normalized restricted translog profit function can be written as

$$(12) \quad Ln\Pi^{*} = \alpha_0 + \lambda D_i + \sum_{i=1}^{n} \alpha_i LnC_i + \sum_{k=1}^{m} \beta_k LnZ_k + \frac{1}{2}\sum_{i=1}^{n}\sum_{h=1}^{n} \gamma_{ih} LnC_i LnC_h + \frac{1}{2}\sum_{k=1}^{m}\sum_{j=1}^{m} \psi_{kj} lnZ_k LnZj + \sum_{i=1}^{n}\sum_{k=1}^{m} \delta_{ik} lnP_i LnZ_k$$

Where $\gamma_{ih} = \gamma_{hi}$ for all *h,i*, and the function is homogenous of degree one in prices of all variable inputs and output. The definitions of the variables and notations used are as follow: Π^{*} is the restricted profit (total revenue less total cost of variable inputs) normalized by the price of output P_y; C_i is the price of variable input X_i normalized by P_y; Z_k is the *k*<u>th</u> fixed inputs; $i = h = 1,2,3,..., n$ *and* $k = j = 1,2,3,...m$; *Ln* is the natural logarithm; D_i (i=1,2) is dummy variable reprented for farm size and $\alpha_0, \lambda, \alpha_i, \beta_k, \gamma_{ih}, \delta_{ik}, \psi_{kj}$ are the parameters to be estimated.

Testing for equal relative economic efficiency between small– and large–farm groups involves examining whether parameters of the UOP profit functions of the small and large farms are the same. This is equivalent to testing whether the dummy variable coefficient, λ ,is zero.[2]

2.4.2 Variable Input Share Equations

Differentiating the translog profit function a system of variable input/output ratio equations can be derived (Diewert, 1974 and Sidhu and Baanante, 1981)

(13) $$S_i = -\frac{C_i X_i}{\Pi^*} = \frac{\partial Ln\Pi^*}{\partial LnC_i} = \alpha_i + \sum_{h=1}^{n} \gamma_{ih} LnC_h + \sum_{i=1}^{n} \sum_{k=1}^{m} \delta_{ik} LnZ_k$$

Where S_i is the ratio of variable expenditures for the <u>ith</u> input to restricted profit.

From this, the demand equation for the <u>ith</u> variable input will be

(14) $$X_i = \frac{\Pi^*}{C_i}\left(-\frac{\partial ln\Pi^*}{\partial LnC_i}\right)$$

The estimating-form will be:

(15) $$LnX_i = Ln\Pi^* - LnC_i + Ln\left(-\frac{\partial Ln\Pi^*}{\partial LnC_i}\right)$$

[2] For detailed methodological development and proof of this relative economic efficiency test, see Yotopoulos and Lau (1973); Lau (1978)

Under price taking behavior of the farmers, the normalized input prices and quantities of fixed factors are considered to be the exogenous variables. Moreover, there will be parameters common to these functions. Hence, the restrictions that the common parameters are equal should be imposed, and the restricted profit and variable input share equations are determined simultaneously by using Zellner's Seemingly Unrelated Estimator (SURE). The sofware package LIMDEP is employed for regression estimates.

2.4.3 Statistical Inference and the Measurement of Fit in the System of Equations

Statistical inference on the validity of parameter restrictions in systems of equations can be undertaken in a number of alternative ways. Sidhu and Baanante (1981), Sriboonchitta (1983), Rahman (1993) used the usual F-statistic as in classical regression setting. Other three common statistical tests are: The Wald (W), Likelihood ratio (LR), and Lagrange multiplier (LM). These three alternative tests can be used interchangeably because they have identical limiting distributions, and when the null hypothesis is true the dispersion among the test statistics will tend to decrease as the sample size increase (Berndt, 1991).

In practice the LR test procedure appears to be used most frequently. In addition, most computer outputs of equation system estimation providing the asymptotic t-statistics for each coefficient which are actually square roots of the Wald test statistic corresponding to the null hypothesis that particular coefficient equal zero (Berndt, 1991). Therefore, using the Wald and Likelihood ratio test procedure to test the validity of linear restrictions across the profit and the S_i input share equations and some other tests in this study is plausible.

The Wald test for testing Ho: $R\beta = r$ against the alternative H_1: $R\beta \neq r$, when Ho is true is (Judge et al, 1988) :

$$W = (R\beta_{seem}-r)'(R[x'(\hat{\Sigma}^{-1}\otimes I)X]^{-1}R')^{-1}(R\beta_{seem}-r)$$

The Wald test statistic is distributed asymptotically as a Chi-square random variable with degree of freedom equal to the difference between the number of free parameters estimated in the unconstrained and constrained models.

The Likelihood ratio test statistic is computed as (Judge et al, 1988):

$$LR = -2(LnL_0-LnL_1)$$

Where L_0 and L_1 are values of the sample maximized log-likelihood functions under the constrained and unconstrained models, respectively. The LR test statistic is distributed asymptotically as a Chi-square random variable, with degree of freedom computed in the same manner as in the Wald test.

2.5 Elasticities of Demand for Variable Inputs

Elasticities of demand for *i*th input with respect to its own price η_{ii}; to price of *h*th input η_{ih}; to output price η_{iy}; and to *k*th fixed input η_{ik} can be calculated from (15) as (Sidhu and Baanante, 1981):

(16) $$\eta_{ii} = -S_i^* - 1 - \frac{\gamma_{ii}}{S_i^*}$$

Where S_i^* is the simple average of S_i

(17) $$\eta_{ih} = -S_h^* - \frac{\gamma_{ih}}{S_i^*}$$

Where $i \neq h$

(18) $$\eta_{iy} = \sum_{i=1}^{n} S_i^* + 1 + \sum_{h=1}^{n} \frac{\gamma_{ih}}{S_i^*}$$

where $i = 1,\ldots,n;\ h = 1,\ldots,n$

(19) $$\eta_{ik} = \sum_{i=1}^{n} \delta_{ik} LnC_i + \beta_k - \frac{\delta_{ik}}{S_i^*}$$

2.6 Output Supply Elasticities

From the duality theory (Lau and Yotopoulos, 1972) the equation for output supply V can be written as (Sidhu and Baanante, 1981)

$$V = \Pi + \sum_{i=1}^{n} C_i X_i \qquad (20)$$

Then the elasticity of supply with respect to the price of the ith variable input (ε_{vi}), the own–price elasticity of supply (ε_{vv}), and elasticity of output supply with respect to the fixed inputs (ε_{vk}) are derived from (20) as follows

$$\varepsilon_{vi} = -S_i^* - \frac{\sum_{h=1}^{n} \gamma_{hi}}{1 + \sum_{h=1}^{n} S_h^*} \qquad (21)$$

Where $i = h = 1,\ldots,n$.

$$\varepsilon_{vv} = \sum_{i=1}^{n} S_i^* + \frac{\sum_{i=1}^{n}\sum_{h=1}^{n} \gamma_{ih}}{1 + \sum_{h=1}^{n} S_h^*} \qquad (22)$$

(23) $$\varepsilon_{vk} = \sum_{i=1}^{n} \delta_{ik} LnC_i + \beta_k - \frac{\sum_{i=1}^{n} \delta_{ik}}{1 + \sum_{h=1}^{n} S_h^*}$$

2.7 The Allen Elasticities of Input Substitution

Allen defines partial elasticities of substitution as

(24) $$\sigma_{ih} = \frac{\sum_{i=1}^{n} X_i f_i (F^{-1})_{ih}}{X_i X_h}$$

Where F^{-1}_{ih} is the *ih*th element of the matrix F^{-1}, and F is the bordered Hessian matrix of derivatives. $f_i = \frac{\partial y}{\partial X_i}$, $f_{ih} = \frac{\partial^2 y}{\partial X_i \partial X_h}$. Provided

$Y = f(X_1,...,X_n)$, where $f(X_1,...,X_n)$ is a production function with input X_i and output Y_i.

In the case of profit function, the elasticity of substitution (elasticity of transfarmation) is interpreted as (minus) the elasticity of a variable quantity X_i with respect to profit Π^*, for a change in another price C_h (holding constant other prices, including the variable's own price). It is also the demand cross-elasticity η_{ih}, "normalized" by the relative change in profit (Hanock, 1978). That is for input X_i and X_h

$$\sigma_{ih} = \frac{\eta_{ih}}{S_h^*} \qquad \text{for all } i \neq h \tag{25}$$

For the translog profit function the elasticity of substitution will be calculated, with the help of (17) as :

$$\sigma_{ih} = -1 - \frac{\gamma_{ih}}{S_i^* S_h^*} \tag{26}$$

2.8 Budgeting Analysis

The items included in the budgeting analysis of cost and return from production and their calculation are as follows:

Yield per acre	= Total production/Total area
Gross return	= Total production in kg x Price per kg
Net return	= Gross return - Total cost
Material input costs	= Costs of seeds (own supplied and purchased) fertilizer, pesticide, irrigation charges.
Purchased input costs	= Material inputs plus hired labor hired machine costs

Total cost	= Purchased inputs plus imputed value of family labor and tractor power supplied by households + tax
Farm family income	= Gross return - Purchased input cost
Value added	= Gross return - Material input costs
Return to labor	= (Gross return - All costs other than labor)/Total labor cost
Return to material input	= (Gross return - Labor cost)/Total cost of material inputs

The currency used in calculating cost, return, and other measurements is Vietnamese currency (VN dong). One $US approximately equal to 10,500 VN dong during survey (April, 1993). Costs and returns of production are evaluated at specific farm-gate prices.

2.9 Cost-Effective Policy Analysis

The approach used by Puapanichya and Panayotou in Thailand Food Policy Analysis (1985) will be applied to draw policy recommendations as described in objective 5. The procedure to calculate the cost-effectiveness of the policy alternative is briefly described as follow:

First, based on elasticity estimates the percentage change in input use and crop production as a result of these subsidies will be calculated. Second, using the percentages and the estimated input and production data of the sample in the dry season 1992, the absolute changes in input use and crop production are calculated, then converted to cost and value, respectively, using the corresponding post-subsidy prices. The difference between the change in costs is the benefit to the farmers from the subsidy-induced increase of production. To arrive at the total net benefit to the farmers from the subsidy, one has to add the savings in input cost and increase in output value from the pre-subsidy level of production.

Next step is to calculate the cost of subsidy to the government which equals the unit output subsidy multiplied by the post-subsidy output plus the unit input subsidy multiplied by the post subsidy input use.

Finally, the difference between the net benefit to the farmers and the cost to the government is the net social benefit (net impact of policy) of the subsidy. The cost-effectiveness is calculated as net impact of policy divided by the cost of government subsidy (Puapanichya and Panayotou, 1985).