CHAPTER II

RESEARCH METHOD

2.1 Data collection

Daklak and Gialai Provinces have 59.3% of total coffee area and 72.0 % of total Vietnamese coffee outputs were chosen for survey. The random sampling method was used to select 45 coffee-processing firms. The surveyed covered the 1998-cropping season.

A formal survey, using structural questionnaires, was conducted to gather most information needed to achieve the objectives of the study and relevant documents were also collected and reviewed.

2.1.1. Secondary data

Secondary data were drawn from relevant ministerial reports of the government, institutions, universities, and agencies. To have a better understanding of the coffee process systems in the study area, relevant publications were reviewed. Research studies on coffee plantation, annual progress reports, and biophysical, socio-economic and demographic characteristic of the study sites were collected from various resources. They includes:

1) Statistical yearbooks
2) The Ministry of Agriculture and Rural Development
3) Agriculture and rural development department of the relevant provinces and districts
4) Extension Centers
5) Statististical department of the provinces and districts
6) VINACAFE (Vietnam Coffee Incorporation)
7) VICOFA (Vietnam Coffee and Cocoa Association)
8) Tay Nguyen University
9) Coffee Cocoa Research Institute

2.1.2 Primary data

In order to get sufficient and accurate data, the local leaders and experienced people in coffee production and coffee processing were consulted for the content of the questionnaires before carrying out the actual survey. Preliminary testing of the questionnaires was conducted in six coffee processing firms and necessary changes were made.

The formal survey using structural questionnaires was conducted at processing firms to gather the major part of the information needed to achieve the objectives of this study. The collected data includes:

1) Ggeneral characteristics of the coffee processing firm such as invested capital, labors, year of establishment.

2) Coffee processing practices especially the processing methods and technologies used.

3) Types and quantities inputs used by the coffee processing firms

4) Grades of their products

5) Costs and outputs of different coffee processing firms

6) Existing technology and the firm's plans for technology in the future

7) Financial reports

8) Credit and sources of credit

9) Marketing channels

10) Price and quality of raw coffee materials and green bean coffee

11) Marketing cost, and

12) Problems in coffee production and processing

2.1.3 Sampling technique

The multi-stage sampling method was used in order to get adequate representation from the region. Firstly, the provinces were selected based on their contribution to total coffee production in the region. According to this basis, Gialai and Daklak provinces were picked as representatives of the region. After that, from a list of processing firms was selected and grouped according to the technology that they have using. A random sampling method was used to select these coffee processing firms. The study included 45 coffee processing firms. The location of the study areas is show in Figure 2.1.

2.2 Data Analysis

To achieve the objectives of this study, descriptive statistical analysis methods were used to describe the coffee processing system in the Central Highlands of Vietnam. To describe the coffee processing systems, the study focused on the components involved in coffee processing systems. The structure of coffee processing systems and internal and external factors affecting the systems was also investigated.

A margin analysis approach (MA) was also used to reflect profitability of the coffee processing systems. MA included the budgeting analysis of costs and returns from production which used some indicators, *viz.* raw material costs, other material input costs, processing costs, total costs, gross margin, net return, return to labor, return to material inputs, and profit some indicators which were calculated are:

gross revenue = total output multiple price per unit
gross margin = gross revenue minus total variable cost
total cost = variable cost plus fixed cost
net return = gross revenue minus total cost
return to input = net return plus costs of input

These indicators were also calculated for one unit of processed coffee from each different coffee processing firm.

To understand the existing coffee processing systems, this study investigated the coffee agents, marketing channels, prices combined with the quality of coffee grades, and the difference in selling prices during different quarters of the year. It also studied the selection of coffee markets involving the coffee industry in the Central Highlands.

2.2.1 Technical Efficiency Relative to a Frontier Production Function

Economic efficiency can be decomposed into two components: technical efficiency and price efficiency. A firm is said to be more technically efficient than another if it consistently produces larger quantities of outputs from the same quantities of measurable inputs. Thus, the firm which has higher profits (*i.e.* total revenue minus the total cost of the variable factors of production) within a certain specified range of output and input prices, is considered to be the more economically efficient firm (within that range of prices).

Before 1957, an unsolved problem had long been existed, *i.e.* to empirically estimate production function which has been defined in the classical manner "...the function must be so defined that it expresses the m*aximum product* obtainable from the combination (of factors) at the existing state of technical knowledge" (Carlson, 1939).

More often the empirical estimates of production functions have not utilized the above classical definition. Instead, the usual least square or ordinary least square (OLS) estimate gives an "average" or expected value of the functional relationship. Whether one would prefer an "average" versus a "maximum" estimate of the production function would likely depend upon how the function is to be used. Similarly, whether one would prefer the "efficient" unit isoquant as compared to only "average efficient" isoquant would also seem to depend on its use.

The obvious trait of the stochastic frontier model is that the error term is composed of two parts, a symmetric component and a one-side component. The symmetric component in this context refers to the error term with zero means and normal distribution, which permits random variation of the frontier across firms, and captures the effects of measurement error, other statistic noise, and random shocks beyond the firm's control. The one-side component, with half-normal distribution, captures the effects of inefficiency relative to the stochastic frontier.

Aigner *et al.* (1977), Battese *et al.* (1977), Meeusen (1977) and Kalirajan *et al.* (1982) estimated stochastic production function frontiers and estimated population average technical efficiency, but not estimates of technical efficiency for individual observations in the sample. Jondrow et al. (1982), Kalirajan *et al.* (1983, 1989), Dawson *et al.* (1991), and Johnson *et al.* (1994) studied individual firm-specific technical efficiencies using cross-section data or panel data. All the estimation methods related to technical efficiency, especially firm or farm specific technical efficiency, provides meaningful implication for policy analysis.

A nonparametric alternative to Far, Grosskopf and, Lee is model was used here and applied to a cross-section of forty-five coffee processing firms in the Central Highlands of Vietnam. By following this method, a nonparametric approach to constrained and unconstrained profit frontiers was constructed. The foregone profit is evaluated as dual evidence for the existence of expenditure constraints. Specifically, a deterministic frontier profit function is constructed with and without expenditure constraints using a programming approach. This model has a multiple output and multiple input technology without constructing indexes. The approach here yields information on the micro-level as to the expenditure constraint hypothesis.

2.2.2 Nonparametric Models

The main content of this model is as follows:

Suppose there are $k = 1, ..., K$ observation of inputs x^k, where $x^k = (x^k_1, ..., x^k_n, ..., x^k_N) \in R^N_+$ and outputs $u^k = (u^k_1, ..., u^k_m, ..., u^k_M) \in R^M_+$. These observations may be from the same firm over K periods or K firms in the same period or panel. A non-parametric frontier technology formed by the observation may be written as the boundary of

$$T = \left\{ \begin{array}{l} (x,u): \sum_{k=1}^{K} z^k u_m^k \geq u_m, m = 1,\ldots,M \\ \sum_{k=1}^{K} z^k x_n^k \leq x_n, n = 1,\ldots,N \\ z \in R_+^K, \sum_{k=1}^{K} z^k = 1 \end{array} \right\}, \quad (1)$$

Where $z = (z^1, \ldots, z^k, \ldots, z^K)$ in which z^k is intensity variable for activity k. The z variables serve to form convex combinations of the observed input and output data, which is perhaps best understood with the aid of diagram.

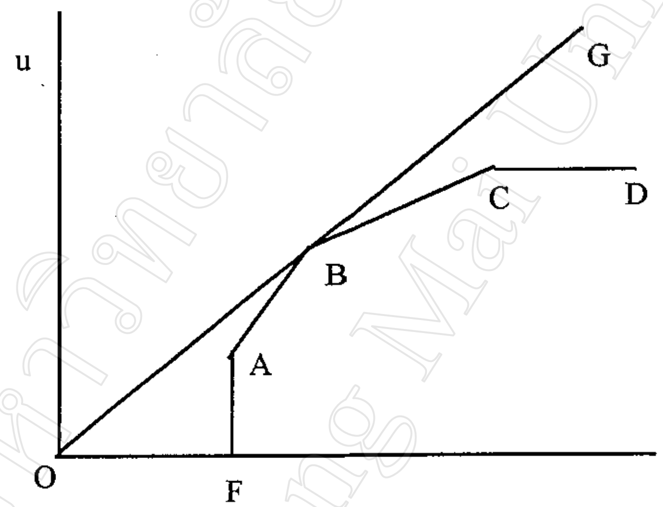

Figure 2.1. Frontier technology
(variable and constant returns)

In Figure 1, three observations of (x, u) are labeled A, B, and C. Because the intensity (z) variables sum to one, the constraints in (1) form convex combinations of the three observed points. The inequalities in the constraints yield vertical and horizontal extensions of the original points and their convex combinations, which allow for strong disposability of inputs and outputs. The technology (1) formed by these observations is bounded by the line segments *FA*, *AB*, *BC*, *CD*, and the x-axis starting at point *F*. Segment *AB* of the technology exhibits increasing returns to scale, whereas segment *BC* exhibits decreasing returns to scale. If the true technology exhibits constant returns to scale, however, the restriction $\sum_{z=1}^{k} z^k = 1$ should be dropped.

In figure 1, the new frontier technology is then bounded by *OBG* and the x-axis. In the case of the variable returns-to-scale technology, point B exhibits constant returns to scale.

Suppose that inputs can be partition into fixed inputs x^k_f and variable inputs x^k_v so that $x^k = (x^k_v, x^k_f)$ in which, variable inputs $x^k_v = (x^k_{v1}, ..., x^k_{vi}, ..., x^k_{vI})$ and fix inputs $x^k_f = (x^k_{fI+1}, ..., x^k_{fN})$. Then, output prices $r = (r_1, ..., r_M)$ and $P_v = (P_{v1}, ..., P_{vi}, ..., P_{vI})$ is price vector of variable inputs. Assume that all firms in the sample face the same input and output prices. Under this assumption the short-run profit for farm k can be calculated as the solution to the linear programming problem: see equation (2).

$$\pi_s(C^k_f) = \max_{R_m, C_v, z} \sum_{m=1}^{M} R_m - \sum_{i=1}^{I} C_{v_i} \qquad (2)$$

s.t.

$$\sum_{k=1}^{K} z^k R^k_m \geq R_{m'}, m = 1,...,M,$$

$$\sum_{k=1}^{K} z^k C^k_{v_i} \leq C_{v_i}, i = 1,...,I,$$

$$\sum_{k=1}^{K} z^k C^k_{f_i} \leq C^k_{f_i}, i = I+1,...,N,$$

$$\sum_{k=1}^{K} z^k = 1, z \in R^K_+.$$

In order to understand the programming model (2), now we consider figure 2.2. Supposed three observations of inputs and outputs are labeled A', B' and C'. The hyperplane spanned by the variable input prices is denoted by HH'. The solution 2 attained at C' in figure 2 (for the moment ignore EE'). Thus, there no constraints on the choice of variable input x_v and the output u except the technology. This problem yields the maximal short-run profit for each observation.

To introduce expenditure constraint into this model, let maximum allowable expenditure be denoted as E. The corresponding expenditure constraint for observation k can be written as:

$$P_{vi}x^{k}_{vi} + \ldots + P_{vi}x^{k}_{vi} \leq E^{k}$$

This constraint is illustrated in figure 2.2 by the area between the vertical line EE' and thee output axis. This figure shows that the expenditure constraint could lower profit relative to the unconstrained profit from program (2): The firm must choose a point like C (where C' is no longer feasible), profits fall from OH (the profit at HH' hyperplane level) to OI (the profit at II' hyperplane level). Thus, if firm face binding expenditure constrains they will be losing profits.

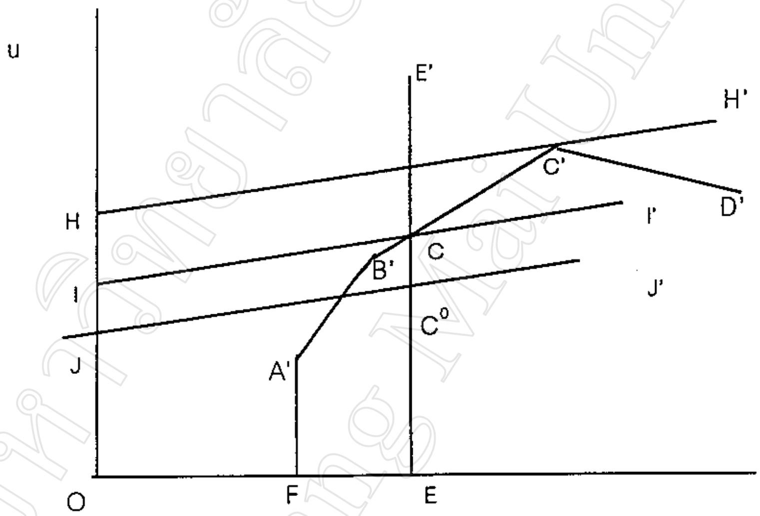

Figure 2.2 Expenditure-constrained profit maximization of a processing firm under bounded technology x

Define $R_m = r_m u_m$ and the cost of variable input v_i as $C_{vi} = P_{vi}x_{vi}$, and similarly for fixed inputs. The data now consist of $k = 1, \ldots, K$ observations of revenue $R^k = (R_1^k, \ldots, R_m^k, \ldots, R^k_M)$, variable input cost $C_v^k = (C^k_{v1}, \ldots, C^k_{vi}, , \ldots, C^k_{vI})$, and fixed input costs $C^k_f = (C^k_{fI+1}, \ldots, C^k_{fN})$. The expenditure-constrained profit-maximization problem can be expressed as:

$$\pi(C_f^k, E^k) = \max_{R_m, C_v, z} \sum_{m=1}^{M} R_m - \sum_{i=1}^{I} C_{v_i} \quad (3)$$

s.t.

$$\sum_{k=1}^{K} z^k R_m^k \geq R_m, m = 1,\ldots,M,$$

$$\sum_{k=1}^{K} z^k C_{v_i}^k \leq C_{v_i}, i = 1,\ldots,I,$$

$$\sum_{k=1}^{K} z^k C_{f_i}^k \leq C_{f_i}^k, i = I+1,\ldots,N,$$

$$\sum_{i=1}^{I} C_{v_i} \leq E^k, \quad \text{and} \quad \sum_{k=1}^{K} z^k = 1, z \in R_+^K.$$

Where E^k is maximum allowable expenditure. Then, the financial efficiency F^k can be calculated as a measure of profit lost because of the expenditure constraint as formula 4:

$$F^k = \frac{\pi(C_f^k, E^k)}{\pi_s(C_f^k)} \quad (4)$$

Where $\pi(C_f^k, E^k)$ is the expenditure-constrained profit obtained from (3) and $\pi_s(C_f^k)$ is the expenditure-unconstrained profit obtained solving (2) therefore $0 \leq F^k \leq 1$. If $F^k = 1$ means that the firm is not binding expenditure constraint.

Let A^k be actual efficiency, and π^k is observed profit. A^k is defined as:

$$A^k = \frac{\pi^k}{\pi(C_f^k, E^k)} \quad (5) \qquad 0 \leq A^k \leq 1$$

If A^k is equal to 1, it is means that firm k is actual efficiency, it's observed profit will equal (maximal potential) expenditure-constrained profit. Deviation of A^k from the unit can be interpreted as a measure of profit loss by firm k as a result of actual inefficiency evaluated at the observed expenditure level.

Whistle, O^k is overall efficiency (financial and actual efficiency)

$$O^k = \frac{\pi^k}{\pi_s(C_f^k)} \qquad (6)$$

or equivalently, $O^k = A^k * F^k$.

Overall efficiency is decomposed in actual efficiency and financial efficiency and is expressed as the product of these two efficiency measure, therefore $0 \leq O^k \leq 1$.

Now, let consider where there was not a better technology available represented by the curve F1 (*technological bounded* condition). Under this condition, if firm was not face binding expenditure constraint they can obtained profit at point C. But if the firm face binding expenditure constraint (EE') so they can only obtained profit at point B while the observed profit (real profit) is at point A.

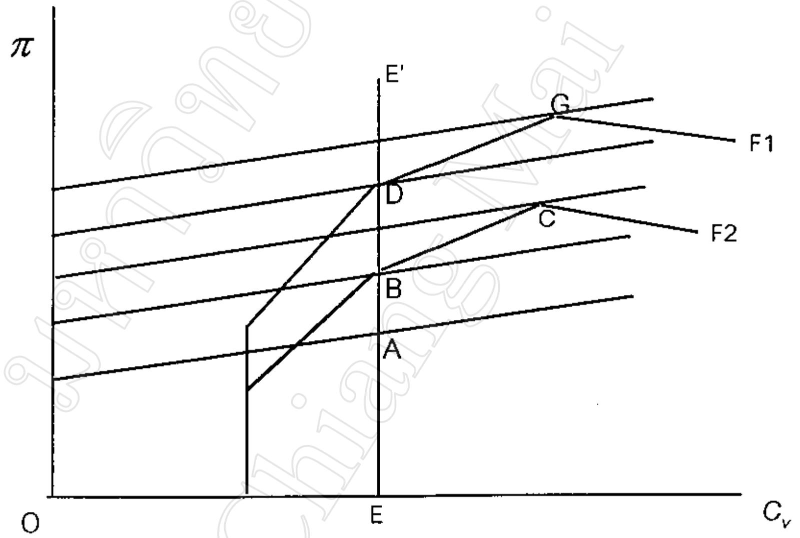

Figure 2.3 Expenditure-constrained profit maximization of a processing firm under un-bounded and bounded technology

Point A represent observed performance of processing firm (obtaining profit πa); Point B represent optimal solution of processing firm under bounded technology with expenditure constraint (obtaining profit πb); Point C represent optimal solution of processing firm under bounded technology without expenditure constraint (obtaining profit πc); Point D represent optimal solution of processing firm under unbounded technology with expenditure constraint (obtaining profit πd); Point G represent optimal solution of processing firm under unbounded technology without expenditure constraint (obtaining profit πg)

Now, let consider where there a better technology available (*technological unbounded* conditions) represented by the curve F2. Under this condition, if firm is not face binding expenditure constraint they can obtained profit at point G. But if the firm face binding expenditure constraint (EE') so they can only obtained profit at point D.

Under these conditions, the concepts of financial efficiency (F^k), actually efficiency (A^k), and overall efficiency (O^k) can be extended as:

Bounded technology	Unbounded technology
$F_b^k = \pi b / \pi c$ $A_b^k = \pi a / \pi b$ $O_b^k = F_b^k * A_b^k = \pi a / \pi c$	$F_u^k = \pi d / \pi g$ $A_u^k = \pi a / \pi d$ $O_u^k = F_u^k * A_u^k = \pi a / \pi g$

Combining these conditions, the technological efficiency of firm (T^k) is calculated as: $T^k = \pi b / \pi d$ ($0 \leq T^k \leq 1$). The criteria T^k is represented the profit loss when comparison between *technological bounded and unbounded* conditions.

2.2.3 Empirical model

A series of linear programming problems, which like nonparametric efficiency, measures to which they are related, produce individual measures of performance. Using optimising software these models were solved to identify whether an individual firm faces binding expenditure constraints and the associated loss in profits resulting from those constraints. In addition, this method allowed a measure of profit loss from deviations from profit-maximizing behavior unrelated to credit constraints.

These models were applied to 45 coffee processing firms. The data was obtained from the 1998 coffee processing crop. Under *technological bounded* conditions, all 45 firms were divided into three groups: wet, dried and mixed. This method presupposes that the same technology is available to all firms in each group, thus differences in production methods might appear as inefficiency. When *technological unbounded* conditions were considered, it was assure that all firms were free to choose technology. Choosing inappropriate technology would result in profit loss and be considered as inefficiency. Focusing on one region like Dakalk and Gia Lai should reduce price variation, which is an important consideration assuming that all firms in each group face the same range of input and output prices.

2.2.4 Descriptive statistics of the variables

To arrive at the variables and fixed input proxy variables, the data from the survey was aggregated into two fixed and six variables input cost categories.

The six variable input costs were calculated in millions Vietnamese dong (mill. VND) are:

(CV1) raw materials, which include expenditures on berry (fruit) coffee, and dried coffee;

(CV2) energy, which includes expenditures on fuel, oil, and electricity

(CV3) water costs

(CV4) other materials, which include chemicals, sacks, and expendable instruments;

(CV5) marketing costs, which include commission and transportation costs; and

(CV6) labour costs

The two fixed input costs include depreciation cost and managerial labour cost.

In the Fare and Lee model the proxy of E^k was calculated as the sum of these six expenditure categories for each observation. To avoid the substitution between raw materials, one of the largest variables, with others variables. This study classified E^k was into two kinds: E_1^k and E_2^k

Where $E_1^k = c_{v1}^k$ and c_{v1}^k is the expenditure of each firm in raw coffee materials (raw material costs).

$E_2^k = c_{v2}^k + c_{v3}^k + c_{v4}^k + c_{v5}^k + c_{v6}^k$

The two fixed input variables included:

c_{f1}^k is capital equipment (depreciation cost)

c_{f2}^k is overhead expenditures, which include accounting fee, taxes, and managerial labour cost.

There are three output items calculated in terms of value: R_1^k; R_2^k and R_3^k

Where R_1^k is the revenue of R1 grade coffee of the firm *k*

R_2^k is the revenue of R2 grade coffee of the firm *k*

R_3^k is the revenue of R3 grade coffee of the firm *k*

Based on the above setting, equation (2) and (3) were written in detail and ran into two models (the details of these models were illustrated in Chapter V).

Model (I) is used for each of three different processing groups. There are three types of processing firms, *viz.* wet, dried and mixed. The numbers of firms in these groups were 9; 27 and 9, respectively. The equation (2) and (3) were written and run seperatively for each group.

Model (II) included all forty-five processing firms (Z^k k= 1; 45), solution to this model's were used to compare the economic efficiency of different (groups of) processing firms.