CHAPTER 2 LITERATURE REVIEW

This chapter reviews studies of farm size efficiency. First, the definition of economic efficiency is introduced, then the main approaches of studying size efficiency are discussed. When reviewing past works, attention is paid to developing countries.

2.1. Introduction

Farrell (1957) defined Economic efficiency as comprised of technical efficiency (TE) and price efficiency (PE). Physical or technical efficiency is the ratio between actual output and maximum output obtainable from a given set of measured inputs. Technical efficiency is purely an engineering concept; it entirely abstracts from the effects of price. Price efficiency is defined as the ability of a firm to maximize profit, e.g. the ability to equate the value of marginal product of each variable factor of production to its price. It is purely a behavioral concept. The overall or economic efficiency (EE) is the product of technical efficiency and price efficiency.

$$EE = TE * PE \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad 2.1$$

And in terms of cost, economic efficiency is the ratio of minimum to the actual unit costs (Seitz, 1970; Lau and Yotopoulos, 1971).

Efficiency with regard to size of a firm or a farm is termed as economies or dis-economies of size. Economies of size occur when, after adjusting all inputs optimally, the unit cost (average total cost, ATC) of production can be reduced by increasing the size of the plant. Conversely, dis-economies of size occur when ATC increases as plant size increases. Economies of size result in an average cost curve being U or L shaped.

Size economies may result from technology that affects the production function and may be referred to as "technical economies of size". There may also be financial sources, such as the purchase of a large volume of inputs, at lower per unit cost. These are referred to as "pecuniary economies of size" (Wiboonpongse, 1983).

Economies of size are usually analyzed in terms of long run and short run situations. Short run economies are viewed as resulting from fuller utilization of fixed plants; long run economies are considered as resulting from efficiencies obtained by changing plant size and involve a longer time period (Madden, 1976; Wiboonpongse, 1983).

2.2. Studies of Size Efficiencies in the Developing Countries

In most developing countries, land and capital are scarce resources, while labor is abundant and wages are low. Studies have shown that smaller farmers tend to use more labor input per unit of land area by practicing intensive cropping, while larger farmers, on the other hand, use less labor by substituting capital (machinery) for labor and do less intensive agriculture. As a result, smaller farmers have higher land productivity than large ones even though the latter use more fertilizers (Murdoch, 1980; Booth & Sundrum, 1985; Bechman & Christensen 1967; Stevens, 1977). In China, it was found that land productivity was highest in medium-sized farms (about 1 hectare in the double rice or triple cropping region, and 2 hectare in northern China), while for smaller and larger farms, the land productivity was lower (Wang, 1989; Wu and Wang, 1990).

Based on these phenomena, it was believed that small farms are more efficient. It must be stressed, however, that there is no evidence that it is the small farm *per se* that makes these farms relatively more productive (Murdoch, 1980; Bachman & Christensen, 1967). Rather, it is the amount of labor and yield-increasing inputs applied to each hectare that produces large yields. There is no reason to support the claim that larger units that received the same intensity of care and input per hectare would produce lower yield (Murdoch, 1980). Indeed, data from India and Taiwan show that, when more advanced technology is available, larger farmers adopt it earlier and yield could be higher than that of the smaller farmers, even though the former do less intensive farming (Avnon, 1981; Booth & Sundrum 1985). Avnon pointed out further that factors involved in the inverse relationship between farm size and land productivity are: (a) an overwhelming importance of human labor in the production process; (b) dependence on farmyard manure for the maintenance of soil fertility; (c) primitive, labor intensive methods of irrigation; (d) a virtual absence of some markets of some inputs, such as farmyard manure; and (e) imperfections in the wage labor market.

Ghose (1979) suggested that with the introduction of chemical fertilizers, land-saving mechanization and modern irrigation equipment, the superiority of small-scale production is likely to be eroded, even if it may remain more labor-intensive than the large farms. This means that the relationship between farm size and land productivity may change from negative to positive, whilst that between farm size and intensity of labor use continues to be negative (Avnon 1981), as evidenced by Dasgupta's (1977) studies of a decade comparison in Ferozepur of India.

Heady (1967) has suggested that although large value product per acre or man is an important indicator in farm management, it is not a sufficient criterion of efficient farm technology and organization. Efficient farm technology and structure can be specified only if we consider a model of the total economy, with appropriate specification of the production function, factor supply conditions, and commodity demand for all sectors. We turn next to reviews of econometric models in studying economies of farm size.

2.3. Approaches of Empirical Studies

The empirical studies of size efficiencies have been extensively done all over the world for several decades. Three broad types of data are used to discover the nature of economies and dis-economies of farm size (Madden and Partenheimer, 1972).

2.3.1. The Economic Engineering or Synthetic Firm Approach

The analysis is designed to discover the technical economies of size under a static pure competition assumption (Raup, 1969). It is an appropriate technique to answer the question of "what is the average cost per unit of output or profit that firms of various sizes could potentially achieve using modern or advanced technologies" (Madden, 1967). This kind of analysis determines points on a series of short run average cost (SAC) curves as the basis for sketching the long run average cost (LAC) or envelop curve. Product and factor prices are assumed to be constant, and best available technical coefficients (resource requirements and expected yields) and market prices or opportunity costs for all resources are determined from selected sources such as experimental data, progressive farms, and manufacture performance data (Madden, 1967). Problems of coordinating large size of farms are frequently ignored or assumed away, occasionally, an explicit assumption is made regarding the increasing managerial burden as size increases. Studies of this type typically ignore many financial factors and dynamic growth considerations facing actual firms. Consequently, the findings must be interpreted with care since they show the ATC each firm would achieve if it organized from scratch at one size versus another (Madden et al., 1972).

2.3.2. Cross Section Data From Actual Farm Records.

At any given level of output, a wide range of average costs may be observed for several reasons such as differences in size, quality of management, technology etc. Thus a farm is frequently operating with an SAC curve that lies above the envelope curve. When a least-squares regression is fitted to the data obtained from a sample of different farmers, it is possible to see many aspects which affect economies of size, such as those associated with management or other inputs relevant to decision making. Another advantage of this approach is that the model can be used for prediction of average costs, given that the independent variables used for the prediction lie within the range of the sample values of these independent variables (Wiboonpongse, 1983).

There are several problems associated with sampling and statistical analysis. The statistical problem is that a regression function is a line passing through average points of varying sizes of firms, not a line of the technical frontier (Wiboonpongse, 1983; Madden et al., 1972). Another widely known problem arising from analysis of cross section data is the so-called "regression fallacy" (Stigler, 1958, cited from Wiboonpongse, P.35). This shows that individual firms with similar fixed resources operate at different output levels because of limitation on other resources, risk, uncertainty, and random fluctuations. This problem results in biased and inconsistent estimations of the population parameters of the relationship between cost and output (due to the error-in-variables problem).

2.3.3. Census Data on Changing Size Distribution of Farms

The term "survivor technique", developed by Stigler, has been used to see the distribution of farm size over a time span. The technique assumes that in the long run, only the most efficient size can compete, while those inefficient would be forced out of business. Consequently, time series data showing trends in size distribution of firms would reveal an increase in the number of optimal-size (lowest ATC) firms, and a decrease in larger and smaller sizes (Madden, 1972).

The advantage of this method is that it is both simple and direct. Under real-life farming conditions, however, this approach does not provide a valid indicator of the economies of farm size. LAC curves are often "flat" or nearly horizontal over a wide range of farm sizes. Furthermore, because of uncertainty, price rigidities, and resource immobility, the average revenue line lies well above the low point of the envelope curve. Since firms are motivated by total profit rather than minimum ATC, profit maximizing farmers will operate at farm size beyond the lowest point of ATC, where MC equals to price.

2.3.4. Econometric Models of Economies of Farm Size

The duality theory of production economics states that, given certain regularity conditions, there exist a cost function, a production function and a profit function which are dual to each other. This means that specification in a production function implies the particular cost and profit functions, and vice versa. Therefore, the economies of size can be investigated via any of these functions. Econometric estimation of these functions is the most common approach.

2.3.4.1. Efficiencies in terms of cost

Wiboonpongse (1983), by employing a random coefficient model, estimated size efficiencies in a multiple cropping system region of Northern Thailand, and found that in a rice-soybean system, the long run average cost could be minimized at a very small farm size. The unit cost of rice characterized an L-shaped curve within the range of 2 to 30 rai, and for soybeans, the unit cost also decreases at least up to the land holding size of 20 rai.

Another example is the study by Alcantara and Prato (1973) in the sugarcane production of Sao Paulo, Brazil. As producers face production quota, the decision of the producers is thus to minimize the cost of production. By using the generalized Cobb-Douglas production function, it was found that returns to scale increased until the point where output reached 16,100 tons, and thereafter decreased.

2.3.4.2. Efficiencies in terms of profit

Most studies of size efficiency in the developing countries have employed the profit efficiency approach. For example, Lau and Yotopoulos (1971, 1972) studied India agriculture and found that small farmers are more efficient. Sidhu (1974) compared economic efficiency of new varieties of wheat with old ones in India, in which he also found that small and larger farms performed equally well in terms of relative economic and price efficiency. Ali and Flinn (1989) studied profit efficiency among Basmati rice producers in the Pakistan Punjab by using Ordinary Least Squares (OLS) and Maximum Likelihood Estimation (MLE). They concluded that large farmers exhibit higher profit loss than small farmers, although it is not significantly different and its impact on total profit loss is small compared with other factors.

2.3.4.3. Conventional Production Function

Examples can be found in Sharma (1983) and Ulveling and Fletcher (1970). This approach is used when all firms face the same input and output prices (Doll, 1974). As the direct production function will be estimated in this study, details will be presented in a later section.