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The Efficiency of Farmers in North-West of Iran

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INTRODUCTION

A few decades ago Iran was self-sufficient in agricultural products and was the net exporter of several agricultural products. With supply not keeping pace with the increase in demand, currently Iran is highly dependent on imports of agricultural products. To decrease dependency and achieve self-sufficiency, a policy of increasing the production could have a major role. Broadly speaking this could be done in three ways: improving the environment farmers are working in, advancement in technology, and using the resources more efficiently. To this end, the efficiency of farmers must be measured. The purpose of this paper is to attempt to measure the efficiency with reference to farmers in North-West of Iran.

II

METHODOLOGY

The measurement of productive efficiency is based on the concept of Pareto productive efficiency and Farrell's (1957) notion of relative efficiency which compares efficiency of each producer with the best practicing producers. In this study a stochastic parametric approach is used.

The stochastic parametric approach to measuring technical efficiency was first independently suggested by Aigner *et al.* (1977) and Meeusen and Van den Broeck (1977) which made it possible to estimate the mean efficiency (inefficiency) of the sample producers. Jondrow *et al.* (1982) made it possible to estimate the efficiency of the individual sample producers.

The basic structure of the model could be described with the use of a simple figure (Battese, 1992 and Coelli *et al.*, 2000). In Figure 1, the horizontal axis measures inputs (X), vertical axis measures outputs (Y), producer 1 uses X_1 inputs with observed output of Y_1, producer 2 uses X_2 inputs with observed output Y_2.

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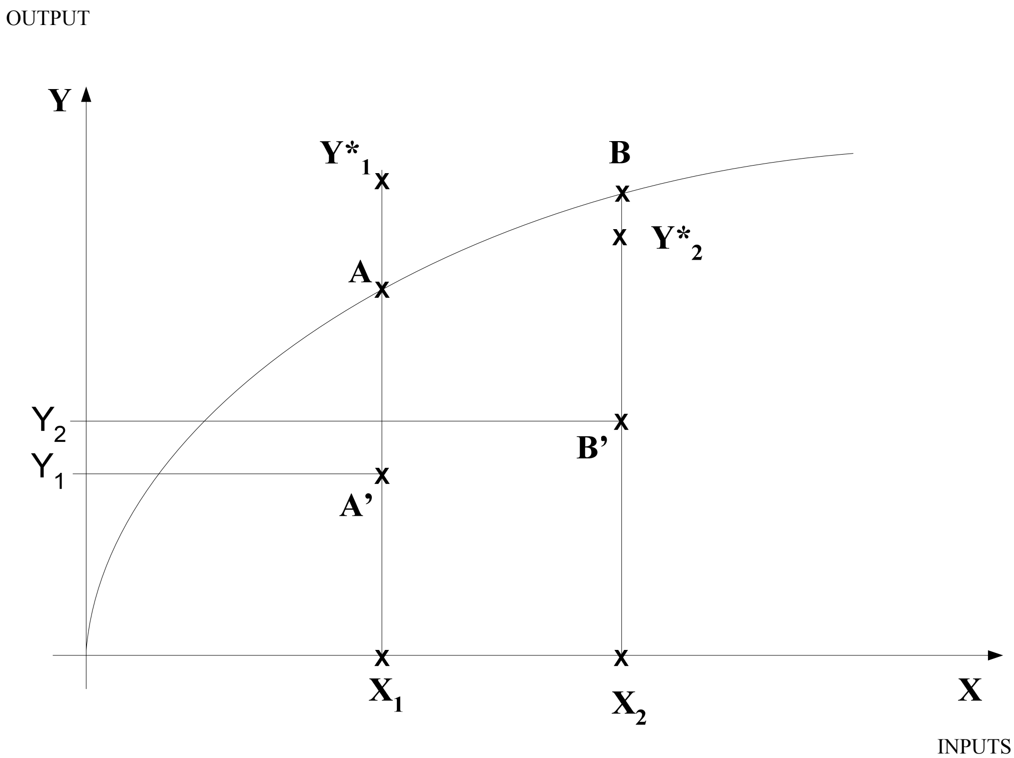

Figure 1. Basic Structure of the Model

If the producers were 100 per cent efficient and if there were no stochastic factors influencing their outputs they would have been located on the deterministic frontier production function, shown by the curve, at points A and B, respectively. But in the real world the producers may not be 100 per cent efficient and there may be some stochastic factors not under their control which in the case of producer 1 we assume that these factors contribute positively to output and therefore frontier output, Y_1^*, is above the deterministic frontier, and in the case of producer 2 uncontrollables influence output negatively and therefore frontier output, Y_2^*, is below the deterministic frontier. It should be mentioned here that Farrell was concerned with the deterministic frontier and suggested programming approach be used to estimate it. Comparing the observed inputs and outputs with frontier measures, the relative efficiencies of the producers could be measured. They are equal to X_1A'/X_1A and X_2B'/X_2B per cent for producers 1 and 2, respectively. Furthermore, if there were no controllables and if it is assumed that stochastic uncontrollable effects have a normal distribution with zero mean, then the deterministic and stochastic functions would be the same.

Following Aigner *et al.* and most studies in agriculture (Thiam *et al., 2001),* in this study, a stochastic Cobb-Douglas production function with five inputs is specified as follows:

$$LnY_i = \beta_0 + \beta_1 LnX_{1i} + ... + \beta_5 LnX_{5i} + V_i - U_i, i = 1, 2,\dots, N \qquad \dots (1)$$

where Y_i is the output and X_i's are inputs of the i-th producer (land, seed, fertiliser, machinery, and labour, respectively), β_0 is a constant and β's are coefficients to be estimated. V_i is the error term of the i-th producer for all possible effects of measurement errors and other noises, with the assumption of being independently, identically, and normally distributed with mean zero and variance σ_V^2, $N(0,\sigma_V^2)$; and U_i is a non-negative error denoting inefficiency of the i-th producer, which Aigner *et al.* assume having either the half-normal or the exponential distribution.

Following the conclusion made by Greene (1993), in this study, it is assumed to be half-normal. Using maximum likelihood (ML) method this function could be estimated.

If notation Y_i^* stands for frontier output then the efficiency measure of the i-th producer (Eff_i) is equal to:

$$Eff_i = Yi/Y_i^* = e^{-U} \qquad \dots (2)$$

Given that the random variable $e_i = V_i - U_i$ is observable, U_i could be predicted by the conditional expectation of U_i, E (U_i | Vi - Ui), Jondrow *et al.* (1982).

Given the assumptions of the model specified, the parameters of the model could be estimated using maximum-likelihood (ML) method.

Following Battese and Corra (1977), the parameters of the model are obtained considering the parameter gamma, $\gamma \equiv \sigma_U^2/(\sigma_V^2 + \sigma_U^2)$, which is bounded by 0 and 1, and $\sigma^2 \equiv \sigma_V^2 + \sigma_U^2$ is the variance of the composite error term $V_i - U_i$.

In the case of $\sigma_V^2 = 0$, γ would be equal to 1 and all the differences in error terms of the frontier production function are the results of management factors under the control of the producer and, in the case of $\sigma_U^2 = 0$, γ would be equal to zero which means all the differences in error terms of the frontier production function are the results of factors that the producer has no control on them.

γ statistic is used for hypothesis testing concerning the existence of inefficiencies. If ($H_0 : \gamma = 0$) is rejected it means that there are inefficiencies and the function could be estimated using maximum-likelihood (ML) method. If H_0 is not rejected, ordinary least squares (OLS) method gives the best estimation of the production function.

As for the determinants of efficiency measures, in a large number of studies a linear relation between the measures of efficiency and its determinants have been assumed. Because of lack of data we only test if the size of operation and relative use of machinery and labour had any relation with efficiency measures.

We specify the following relation:

$$Eff_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 \qquad \text{.... (3)}$$

where Eff_i is the efficiency measure of the i-th farmer, Z's are size and relative use of machinery and labour, respectively, and δ_0 is a constant and δ_1 and δ_2 are coefficients to be estimated. Using FRONTIER Version 4.1 software by Coelli (1996) OLS and ML estimates of production function specified were made. To estimate the relation between efficiency measures and size of the farm and relative use of machinery and labour, EViews software was used.

Data

The data used in this study are based on the results of a survey of agricultural production in the north-west of Iran in the West Azarbayjan province, bordering Iraq and Turkey. The survey is on annual crops for the year 2001. The major annual crops in the province are wheat, barley, sugar beet, sunflower, potato and tomato. In a two-stage sampling, first a random sample of villages were chosen and in the second stage, a random sample of farmers in each sample village were chosen. By interviewing the sample farmers and filling out the questionnaire the necessary data were collected. Altogether the data on 1,521 enterprises of annual crops were used in this study. The data on six variables were used to estimate the production function specified. The variables are: monetary value of output in toomans, land in hectares, and costs of seed, fertiliser, machinery, and labour in toomans. One tooman is equivalent to ten rials. Rial is Iranian monetary unit. The descriptive statistics of the data on variables are presented in Table 1. They are self-explanatory and need no further details.

TABLE 1. DESCRIPTIVE STATISTICS OF THE DATA

Statistics (1)	Output (2)	Land (3)	Seed (4)	Fertiliser (5)	Machinery (6)	Labour (7)
Mean	7,16,358.2	4.511506	58,475.24	21,496.21	69,111.13	77,061.12
Standard deviation	8,89,786.6	8.143857	75,341.12	27,460.28	80,810.16	77,762.38
Range	118,81,900	149	8,53,800	3,61,666	11,48,100	9,01,000
Minimum	23,100	1	1,200	234	1,900	1,500
Maximum	119,05,000	150	8,55,000	3,61,900	11,50,000	9,02,500

Results and Discussion

Using FRONTIER Version 4.1 software by Coelli (1996) the results of OLS and ML estimates of production function specified are presented in Table 2.

TABLE 2. OLS AND ML ESTIMATES OF PRODUCTION FUNCTION

(1)	Coefficient (2)	Standard-error (3)	t-ratio (4)	Significance(p) (5)
		The OLS estimates		
β_0 (constant)	0.2303	0.0851	2.7055	*
β_1 (land)	-0.1486	0.0172	-8.6234	*
β_2 (seed)	0.0874	0.0157	5.5509	*
β_3 (fertiliser)	0.4521	0.0178	25.3296	*
β_4 (machinery)	0.4760	0.0167	28.4298	*
β_5(labour)	0.1805	0.0146	12.3775	*
Sigma-squared	0.0318			
		The ML estimates		
β_0 (constant)	0.3132	0.0899	3.4861	*
β_1 (land)	-0.1465	0.0171	-8.5887	*
β_2 (seed)	0.0874	0.0152	5.7417	*
β_3 (fertiliser)	0.4477	0.0175	25.5479	*
β_4 (machinery)	0.4743	0.0168	28.2274	*
β_5(labour)	0.1848	0.0147	12.5965	*
Sigma-squared	0.0670	0.0157	4.2591	*
Gamma	0.5977	0.1275	4.6885	*

* Significant at 1 per cent level.

The results of ML estimates concerning gamma statistic indicate that ($H_0 : \gamma = 0$) is rejected and therefore there are inefficiencies in the production activities of the farmers in the region under study.

The negative coefficient of land indicates that it is being over used. All the coefficients of the production function are different from zero at less than 1 per cent level of significance. Since the sum of coefficients of production function is larger than 1, increasing returns to scale prevailed.

Using FRONTIER Version 4.1 software, the efficiency measures of individual sample farmers and their mean were estimated. Mean efficiency was estimated to be 93.04 per cent; 0.39 per cent of farmers had efficiencies of less than 80 per cent, 7.89 per cent of them had efficiencies between 80 and 90 per cent, and 91.72 per cent of the farmers had efficiencies more than 90 per cent.

It should be mentioned that most of the studies on the technical efficiencies of the farmers on individual crops in different countries report mean efficiency of lower than 93 per cent. For example, a recent study by Coelli *et al.* (2002) using different approach reports mean efficiency of 66.2 and 69.4 per cent in production of two different varieties of rice in Bangladesh. Battese *et al.* (1996) using stochastic parametric approach reported mean technical efficiencies of 78.9, 58.4, 57.0, and 77.5 per cent for wheat farmers in four districts of Pakistan, a neighbour of Iran. Battese and Tessema (1993) estimated the technical efficiencies of the Indian farmers in Shirapure village for ten consecutive years. They reported mean efficiencies in different years ranging from 54.8 to 93.6 per cent and, Ajibefun *et al.* (2002) report the mean technical efficiency of 74.5 per cent over all prefectures in Japan.

As to the question of farm-specific determinants of efficiency measures, because of lack of data, it was only possible to test if the size of production activity and relative use of inputs had any relation with the efficiency measures. Size has been the most widely used variable as the determinant of efficiency in the past studies of agriculture (Battese, 1992 and Coelli, 1995) with mixed results. The relation between relative use of inputs and efficiency also has been investigated in some studies. It is obvious that the decisions on size and relative use of inputs are important managerial decisions. The total costs on manure, fertiliser, chemicals, machinery, and labour as index of size and ratio of machinery costs and labour costs as index of relative use of these two important inputs were examined.

Using EViews software, F-statistic and its probability indicated that these two factors had influence on efficiency measures, but the influence was very weak. Adjusted R-squared showed that less than one per cent of the variations in efficiency measures were determined by these two factors (Table 3).

TABLE 3. RELATION BETWEEN EFFICIENCY MEASURES AND SIZE AND RATIO OF MACHINERY AND LABOUR

(1)	Coefficient (2)	Standard-error (3)	t-statistic (4)	Significance (p) (5)
δ_0 (constant)	0.927926	0.0011034	897.1303	*
δ_1 (size)	3.64E-09	3.05E-09	1.193669	NS
δ_2 (input ratio)	0.001208	0.000363	3.325199	*
R-squared	0.008572			
Adjusted R-squared	0.007265			
F-statistic	6.562068			
Prob.(F-statistic)	0.001453			
Prob.(F-statistic)	0.001453			

* Significant at 1 per cent level.
NS - Not Significant.

The positive signs of coefficients for size and input ratio indicate that the larger and more mechanised farms are more efficient. Concerning the size, this conclusion has to be taken with caution since its probability is 0.2328.

CONCLUSION

This is an exploratory study and should be considered as a first step toward measuring efficiencies of agricultural producers in the North West of Iran which is a major agricultural region and has a high potential to contribute to the goal of self-sufficiency in food for the whole country. To this end, more detailed and in-depth analysis of productive efficiency and its determinants, especially on individual crops, are needed for policy decisions. The results of this study indicate that there is some potential to increase production through enhancing the efficiency of agricultural producers.

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