A Test For Relative Efficiency Of Farmers Cultivating Groundnut In Tamil Nadu : A Profit Function Approach

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ABSTRACT

The term 'Efficiency' refers to the ability of the farmers to make optimal decisions with regard to resource use. Economic efficiency comprises of both allocative and technical efficiencies. The relative economic efficiency may arise due to the differences in technical and/or allocative efficiency by comparing two or more farms. In the present paper, an attempt is made to analyze and compare the relative economic efficiency of small and large farmers cultivating groundnut. The model developed by Lau and Yotopoulous has been used to measure and compare relative economic efficiency with its components - technical and allocative efficiency. It may be concluded that the test of relative economic efficiency of farmers cultivating groundnut is in favour of the small farmers. It is also inferred from the analysis that the small farmers attain higher levels of price efficiency, and they also operate at higher technical efficiency.

Keywords: Relative Economic Efficiency, Cost Price Relationship, Groundnut, Profit Function Approach
JEL Classification: B41, C21, O33, Q18,

INTRODUCTION

The term 'Efficiency' refers to the ability of the farmers to make optimal decisions with regard to resource use. Economic efficiency comprises of both allocative and technical efficiencies. Technical efficiency means that a farmer produces the highest output using the given amount of inputs. The conventional measurement of technical efficiency concentrates on the neutral shift in the production either between groups of farms or overtime. Price/allocative efficiency, on the other hand, it is concerned with allocation of the resources in the profit-maximizing sense. Economic efficiency deals with cost-price relationship of inputs and output. The relative economic efficiency may arise due to the differences in technical and/or allocative efficiency by comparing two or more farms. In the present paper, an attempt is made to analyze and compare the relative economic efficiency of small and large farmers cultivating groundnut in Madurai District of Tamil Nadu. The model developed by Lau and Yotopoulous was used to measure and compare relative economic efficiency with its components - technical and allocative efficiency.

THE STUDY AREA

Madurai district is one of the most outstanding popular districts in Tamil Nadu, where there has been significant agricultural progress, particularly in the cultivation of groundnut since 1960. One of the main crop grown in the district is groundnut, and 35 per cent of area is double cropped land. Madurai district comprises of 7 taluks. Groundnut is mainly cultivated in almost all the taluks. Among the 7 taluks in Madurai district, Melur and Thirumangalam taluks represent the largest area under groundnut cultivation. It also excels in the adoption of high yielding varieties of groundnut and technology. Further, these taluks form the most fertile areas in Madurai district, which normally cultivates crops under Vaigai and Periyar canal irrigation system. This is one of the main reasons for selecting these taluks as the study area for the recent analysis.

SAMPLE DESIGN

Multistage random sampling technique was used taking Madurai district as the Universe, the taluks and the block as the stratum, the village as the primary unit of sampling, and the groundnut cultivators as the ultimate unit. Of the seven taluks in Madurai district, Melur and Thirumangalam taluks were selected for the present study. Each taluk consists of two blocks. The revenue villages of these four blocks were arranged in an ascending order according to the area under

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groundnut cultivation in each village. Out of the total number of villages, five villages were selected from each of the four blocks, namely Melur, Kottampatti, Thirumangalam and Kallikudi for the purpose of this study. The proportionate probability sampling technique had been adopted to select groundnut cultivators from the villages of the four selected blocks in Madurai District.

METHOD OF ANALYSIS

Further, 250 sample groundnut farmers were post-stratified into two categories viz., small and large farmers. The farmers with less than five acres were grouped as small farmers and farmers with more than or equal to five acres were grouped as large farmers. Out of the 250 sample respondents, 148 (59.20 percent) cultivators came under the category of small farmers, and the remaining 102 (40.80 per cent) fell under the group of large farmers.

The analysis of variance technique was carried out to test the homogeneity of the above two categories, with respect to net income per acre, and it is presented in the Table 1.

Table 1: Homogeneity Test of Two Categories of Groundnut Cultivators

Sources	Total Sum of Squares	Degrees of Freedom	Mean Sum of Square	Calculated F-Value	Table F-Value
Between Samples	18236000	1	18236000	2963.38*	4.60
Between Villages	175700	14	12598.56	1.65**	2.53
Error	113400	14	8209.41	-	-
Total	**18525100**	**29**			

*Significant at the 5 per cent level **Not significant

Source: Survey data

It is inferred from the Table 1 that there existed significant differences between the two categories of farmer groups. So, they were treated as a separate unit for further analysis. Furthermore, there is no evidence of significant difference between sample villages in the above categories.

COLLECTION OF DATA AND PERIOD OF THE STUDY

Direct personal interview method was adopted to collect the primary data from the farmers cultivating groundnut in the study area. The survey was conducted during the months between October 2009 and March 2010 of the agricultural year 2009-10.

Particular attention was taken during the survey to collect farmer-specific prices as necessary in Profit Function analysis as mentioned by Kalirajan and Flinn (1981). The differences were observed in transport costs to the market and to some extent, by price variations due to seasonal demand.

THE ANALYTICAL FRAMEWORK

In order to determine the relative economic efficiency of small and large farmers, the following Cobb-Douglas (C-D) form of the normalized restricted profit function and factor input demand functions were used :

$$\text{Log } \pi^* = \lambda + \infty_0 {}^*D_1 + \beta_1^* \log W + \beta_2^* \log B + \beta_3^* \log F + \beta_4^* \log P + \infty_1^* \log A + \infty_2^* \log C + U \quad \ldots\ldots\ldots\ldots(1)$$

$$\left.\begin{aligned} \frac{-W X_1}{\pi^*} &= \beta_1^{*L} D_1 + \beta_2^{*S} D2 + `V_1 \\ \frac{-BX_2}{\pi^*} &= \beta_1^{*L} D_1 + \beta_2^{*S} D2 + `V_2 \\ \frac{-F X_3}{\pi^*} &= \beta_1^{*L} D_1 + \beta_2^{*S} D2 + `V_3 \\ \frac{-P X_4}{\pi^*} &= \beta_1^{*L} D_1 + \beta_2^{*S} D2 + `V_4 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

π^* = Normalized *or real (profit in ₹) ;
W = Real wages for labour (man-days) ;
B = Real bullock pair day price;
F = Real fertilizer price;
P = Real pesticides price;
A = Total area cultivated;
C = Capital flows;
X_1 = Total labour man-days utilized;
X_2 = Total bullock pair days employed;
X_3 = Total quantity of fertilizer utilized;
X_4 = Total pesticides used;
D_1 = 1 for large farmers and 0 for small farmers;
D_2 = 1 for small farmers and 0 for large farmers;
V = Random disturbance ;
λ = Constant ;
V1, V2 ….V4 = divergence between expected and realized price and statistical errors.

The above models (1) and (2) were jointly estimated by using the method of Zellner's Seemingly Unrelated Regression Estimates (SURE).

RELATIVE ECONOMIC EFFICIENCY

The hypothesis testing producers for both small and large farmers are shown below :

(i) Test of Absolute Allocative Efficiency - (Restriction I) : Farmers are absolute allocative efficient if they maximize profit (i.e. if they equate marginal value products of variable inputs to their respective opportunity costs). The null hypothesis that absolute allocative efficiency of both small and large farmers (restriction 1) was tested as:

$$H_0 = \beta_1 = \beta_1^{*L} = \beta_1^{*S} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Acceptance of null hypothesis implies that both small and large farmers had absolute allocative efficiency. Rejection of null hypothesis implies that either one or both groups failed to maximize profits. To identify the group which was allocatively inefficient, the following hypotheses were tested.

(ii) Test for Absolute Allocative Efficiency of Small Farmers - (Restriction II) : Absolute allocative efficiency of small farmers may be written as:

$$H_0 = \beta_1^* = \beta_1^{*S}, \beta_2^* = \beta_2^{*S}$$
$$H_0 = \beta_3^* = \beta_3^{*S} \text{ and } \beta_4^* = \beta_4^{*S} \ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

(iii) The Hypothesis that Large Farmers had Absolute Allocative-Efficiency : (Restriction III)

$$H_0 = \beta_1^* = \beta_1^{*L}, \beta_2^* = \beta_2^{*L}$$
$$H_0 = \beta_3^* = \beta_3^{*L}, \beta_4^* = \beta_4^{*L} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

(iv) Test for Equal Relative Efficiency of Both Small and Large Farmers : In order to test the equal relative economic efficiency of both small and large farmers, the coefficient of dummy variable D_1 in the profit function should be zero. Therefore, the null hypothesis is:

$$H_0 = \infty_0 * = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(6)$$

If the above hypothesis is not true, then the difference in economic efficiency between the groups may be due to difference in technical efficiency and for difference in allocative efficiency.

The following hypotheses are formulated for the allocative efficiency:

(v) Test for Equal Relative Allocative Efficiency of Both Small and Large Farmers : Equal relative allocative efficiency is given by:

$$H_0 = \beta_1^{*S} = \beta_1^{*L}, \beta_2^{*S} = \beta_2^{*L}$$
$$H_0 = \beta_3^{*S} = \beta_3^{*L}, \beta_4^{*S} = \beta_4^{*L} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(7)$$

(vi) Test for Equal Allocative and Technical Efficiency of Both Small and Large Farmers : The following joint restrictions are given for testing the hypothesis for equal technical and allocative efficiency of both small and large farmers :

$$H_0 = \infty_0^* = 0, \beta_1^{*S} = \beta_1^{*L}, \beta_2^{*S} = \beta_2^{*L}$$
$$\beta_3^{*S} = \beta_3^{*L}, \beta_4^{*S} = \beta_4^{*L} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(8)$$

Table 2: Joint Estimation of Cobb-Douglas Profit Function and Input Demand Equations For Groundnut

Variables	Parameters	Unrestricted	Restricted I	Restricted II	Restricted III
Profit Function Constant	Λ	6.9231	6.2315	5.4871	5.3468
Normalized wage	β_1^*	-0.5723*	-0.5172*	-0.4865*	-0.4531*
		(-7.1231)	(-6.3671)	(-8.4742)	(-6.7417)
Normalized bullock labour price	β_2^*	-0.0672	-0.0641*	-0.0521*	0.0418*
		(-5.8214)	(-7.1261)	(-4.7236)	- (-3.1267)
Normalized fertilizer price	β_3^*	-0.2814	-0.2768*	-0.2531*	-0.2472*
		(-3.4871)	(-4.1012)	(-3.6241)	(-5.4818)
Normalized pesticide price	β_4^*	-0.0712	-0.1131*	-0.1072*	-0.1193*
		(-12.3071)	(-4.7612)	(-6.6671)	(-6.1203)
Land	∞_1^*	0.7942	0.7148*	0.7012*	0.6933*
		(-6.4836)	(3.9912)	(5.6871)	(4.6313)
Capital	∞_2^*	0.2472	0.2071*	0.2172*	0.2198*
		(1.2712)	(5.6814)	(7.3671)	(5.1231)
Farm size dummy	∞_0^*	-0.1421	-0.1042*	-0.1078*	-0.1146*
		(-6.1436)	(-3.1247)	(-5.7247)	(-6.4893)
Labour share function	β_1^{*S}	-0.3972	-0.5172*	-0.4865*	-0.4961*
		(-6.1271)	(-6.3671)	(-8.4742)	(-5.1261)
	β_1^{*L}	-0.2968*	-0.5172*	-0.4865*	-0.4961*
		(7.1263)	(6.3671)	(-8.4742)	(-5.1261)
Bullock share function	β_2^{*S}	-0.0387	-0.0641*	-0.0521*	-0.0871*
		(-6.7431)	(-7.1261)	(-4.7236)	(-6.7411)
	β_2^{*L}	-0.0489	-0.0641*	-0.0672*	-0.0418*
		(-10.4231)	(-7.1261)	(-4.7436)	(-3.1267)
Fertilizer share function	β_3^{*S}	-0.2072	-0.2768*	-0.2531*	-0.2671*
		(-9.1651)	(-4.1012)	(-3.6241)	(-7.2748)
	β_3^{*L}	-0.1998	-0.2138*	-0.2368*	-0.2284*
		(-4.7142)	(-3.2751)	(-3.7249)	(-5.4219)
Pesticide share function	β_4^{*S}	-0.0948	-0.1131*	-0.1072*	-0.1127*
		(-5.6178)	(-4.7612)	(-6.6672)	(-5.7141)
	β_4^{*L}	-0.3159	-0.1392*	-0.0971*	-0.1193*
		(-6.1397)	(-4.7612)	(-4.7231)	(-6.1503)

Source: Survey data
Note: Figures in brackets represent t-value. *Indicates significant at 5 per cent level.

(vii) Test For Constant Returns To Scale : This test is for examining the assumption that the production function exhibits constant returns to scale. The following equation is given as:

$$H_0 = \infty_1 * + \infty_2 * = 1 \quad \text{.....} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

That is, the sum of the parameters of the fixed factor inputs is equal to 1.

RESULTS AND DISCUSSION

(i) Estimated Regression Results of Groundnut : These results of joint estimation of profit function (1) and input demand function (2) by using Zellner's Seemingly Unrelated Regression Estimate for small and large farmers cultivating groundnut are furnished in the Table 2.

Table 3: Tests of Hypotheses of Technical and Allocative Efficiencies of both Small and Large Farmers

Hypothesis	Null Hypothesis	Computed F-value	Critical F-value at 5% Level	Inference
H1	Absolute allocative efficiency of both small and large farmers	7.16, $F_{(6.72)}$	2.20, $F_{(3.63)}$	Rejected
H2	Absolute allocative efficiency of small farmers	2.20, $F_{(3.18)}$	2.60, $F_{(3.34)}$	Accepted
H3	Absolute allocative efficiency of large farmers	9.96, $F_{(1.57)}$	2.60, $F_{(3.43)}$	Rejected
H4	Equal relative economic efficiency of both small and large farmers	7.62, $F_{(1.64)}$	3.84, $F_{(1.63)}$	Rejected
H5	Equal relative allocative efficiency of both small and large farmers	4.78, $F_{(3.98)}$	2.60, $F_{(1.63)}$	Rejected
H6	Equal relative allocative and technical efficiency of both small and large farmers	3.82, $F_{(4.30)}$	2.37, $F_{(4.64)}$	Rejected
H7	Constant returns to scale	2.91, $F_{(1.67)}$	3.84, $F_{(1.63)}$	Accepted

Source: Survey data Note: Figures in brackets represent degrees of freedom

The results of the Table 2 reveal the results of estimation of Ordinary Least Square (OLS) and the normalized profit function and factor share equations, using Zellner's seemingly unrelated regression method (SURE). According to *a priori* economic theory, the estimated coefficients of normalized variable input prices are negative while the coefficient of fixed inputs, namely capital and land are positive for groundnut. The coefficient of dummy variable for farm size (∞_0*) is statistically significant and it is negative. It implies that small farmers producing groundnut were economically more efficient than large farmers. The small farmers were paying greater personal attention to all stages of groundnut cultivation in the study area. The family labourers working on the small farms were prepared to work on the farm. However, the large farmers were dependent on hired labour. The findings are similar to the conclusion of Lau and Yottopoulas. They found that the small farmers were relatively economically more efficient than the large farmers.

(ii) Tests of Relative Efficiency of Small and Large Farmers Cultivating Groundnut : The hypotheses of relative economic efficiency of small and large farmers cultivating groundnut discussed in section (2) from (i) to (vii) were tested by computing the F-test. The computed results are reported in the Table 3.

In the Table 3, the tested hypotheses results are explained in detail. The hypotheses were evaluated at 5 per cent level of significance. According to the table, H1 is rejected. This implies that there was a significant difference in relative economic efficiency between small and large farmers. Hence, it can be concluded that small farmers were relatively more economically efficient than large farms. This finding is in agreement with Yotopoulos and Lau (1971 and 1973), where the test of relative economic efficiency is in favor of the small farmers. H2 states and tests the absolute allocative efficiency of small farmers. This hypothesis is accepted; it indicated that the small farmers have an absolute allocative efficiency source. H3 states that there is absolute allocative efficiency of large farmers. This hypothesis is also rejected. H4 tests for equal relative economic efficiency for both small and large farmers, and the same was rejected, indicating that as a group; there exists absolute price inefficiency among all groundnut farmers in the

selected sample size. Hypothesis five (H5) states that equal relative allocative efficiency of both small and large farmers is also rejected. This was anticipated, given the test of H3 and H4. H6 tests for equal relative allocative and technical efficiency of both small and large farmers - and is rejected - indicating that both small and large farmers maximized their profits by equating the value of each factor's marginal product to the respective factor price. H7 states that there are constant returns to scale under the hypothesis of absolute price efficiency for small and large farmers. The hypothesis is accepted. This is an evidence of increasing returns to scale for technology use on all the groundnut farmers in Madurai District.

CONCLUSION

Land is unquestionably the cornerstone of agricultural production. The preceding analysis attempted to find out if there was any difference between the relative economic efficiency of small versus big farmers, given that the factors of production (agriculture land and fixed capital) were fixed and constant for both. As against the widely accepted assumption that big farmers will be more efficient in farming versus small farmers, it was found that within the ranges of observed prices of output and variable inputs, small farmers attained higher levels of price efficiency. The small farmers were also able to operate at a higher level of technical efficiency. Cost savings due to large farm lands or higher capital investment were not confirmed. The evidence implies that the reason for the relatively higher economic efficiency of small farmers could be the supervisory capacity of the farmers cultivating below 5 acres. Low efficiency is mainly attributable to management factors and not due to technological or allocated factors, which were proportional to both groups of farmers. The assumption that there is no technological advantage to either group of farmers should be borne in mind.

SCOPE FOR FUTURE RESEARCH

In future, researchers can focus on extending the survey to other districts of Tamil Nadu and other geographies. There is also scope for identifying the efficiency estimates of small farmers over a period of time, which the present paper has not been able to do. A research effort can also be taken to find out how efficiency varies across geographies across time.

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