

# Inefficiency in Irish Agriculture

ANTHONY LEDDIN\*

*National Institute for Higher Education, Limerick*

---

*Précis:* The purpose of this paper is to compare the relative efficiency of two similar groups of farms in Irish agriculture. Using a restricted profit function to measure economic efficiency and both of its components, price efficiency and technical efficiency, it was found that differences in the behaviour of farm groups do exist and that both failed to maximise profits. The implications for achieving increases in the growth rate of agricultural output are noted.

## I INTRODUCTION

In recent years, the increase in the price of farm produce has given the farming community a substantial rise in farm incomes. These price increases are now, however, expected to slow down with the implication that if growth rates in farm incomes are to be maintained, then a marked increase in agricultural output will have to be achieved. Given this situation, the purpose of this paper is to identify the extent of inefficiency in a sample of Irish farms and suggest how improvements could be made.

The approach is to compare the economic, price and technical efficiency of two farm groups. The groups differ only in terms of farm size, with the Small Group consisting of farms in the 10- to 50-acre range and the Medium Group consisting of farms in the 50- to 80-acre range. Two similar groups were chosen in the belief that differences in efficiency are more likely to be explained than if two dissimilar groups were chosen.

\*I wish to thank the staff members of the Agricultural Institute in Cork for making available the data for this paper. In particular, I wish to thank D. McDermot for his valuable research assistance, D. Dineen for reading early drafts of the paper, anonymous referees for their comments and Mrs. Hayes for typing the drafts. They are not of course responsible for any remaining errors.

With regard to the efficiency concepts, economic efficiency is defined as the sum of price and technical efficiency. A farmer is economically efficient if he is both price efficient *and* technically efficient. By price efficiency is meant the classical concept of equating marginal revenue to marginal cost. The farm group that achieves this optimal rule to the highest degree is said to be the more price efficient of the two.

One farm is said to be more technically efficient than another if it consistently produces more output from a given set of inputs and prices. Technical efficiency encompasses unquantifiable factors such as entrepreneurship and education and this makes measurement difficult and ambiguous. This paper does not suggest a new measure, but instead derives the result that one group is more technically efficient than another by reference to economic efficiency. For example, if it is shown that the Medium Group is more economically efficient but has the same price efficiency as the Small Group, then the Medium Group must have greater technical efficiency. Using this approach we can contrast the farm groups' technical efficiency.

For the purpose of measuring the efficiency concepts, the method used is the restricted profit function and its corresponding input demand functions. Section II of this paper gives a general outline of this method and states the final equations to be estimated for a Cobb-Douglas production function. In Section III, the data used and the econometric results of applying Ordinary Least Squares (OLS) to the profit and input demand functions are presented. Tests of equal economic efficiency, equal relative price efficiency and equal relative technical efficiency are then carried out. We also test if either farm group perfectly achieves the price efficiency rule and we further measure the degree of homogeneity for both groups. Finally, Section IV concludes with a summary of the results and suggests how efficiency might be improved in Irish agriculture.

## II THE RESTRICTED PROFIT FUNCTION

The form the profit function takes in this paper was developed by Lau and Yotopoulos (1971 and 1973). The model is a short-run one, assuming farms operate in competitive markets and maximise profits subject to a production function of the type

$$\gamma^i = A^i f(X^i, Z^i) \quad (1)$$

where  $\gamma^i$  is the output of the *i*th type of farm (i.e., small or medium).  $A^i$  is a neutral shift parameter which may, or may not, vary between farm groups. Should  $A^i > A^j$ , then farm group *i* is more technically efficient than

farm group  $j$ . The function is dependent on variable inputs  $X$  and fixed inputs  $Z$  (both  $X$  and  $Z$  are vectors) and assumes diminishing returns in the variable inputs.

Defining short run profits as

$$\Pi^i = P_y A^i \Pi(X^i, Z^i) - P_x X^i \quad (2)$$

where  $P_x$  is a vector of input prices and  $P_y$  is the output price, we can normalise by dividing by  $P_y$  to obtain the normalised restricted (short-run) profit function or, in the terminology of Jorgenson and Lau (1974), the Unit Output Price (UOP) profit function.

$$\Pi^i = \frac{\Pi^i}{P_y} = A^i \Pi(X^i, Z^i) - q X^i \quad (3)$$

where  $q = \frac{P_x}{P_y}$  is a vector of normalised input prices. Differentiating with respect to the variable inputs, we obtain the first order conditions for a profit maximum.

$$\frac{\partial A^i \Pi(X^i, Z^i)}{\partial X^i} = q \quad (4)$$

At this point we can allow for differences in price efficiency by assuming that farms consistently under- or over-estimate input prices. Thus, instead of equating marginal product to input prices, we allow farms to equate marginal product to some multiple or a fraction of input prices,

$$\frac{\partial A^i \Pi(X^i, Z^i)}{\partial X^i} = k^i q \quad (5)$$

where  $k^i$  is a diagonal matrix with non-negative constants. If farms are perfectly price-efficient, then the diagonal elements will all be unity. Furthermore, if  $A^i = A^j$  and the matrix has unit diagonal elements, farm groups  $i$  and  $j$  have equal economic efficiency.

From the first order conditions we can derive the optimal input demand functions,

$$X^{*i} = A^i X^*(k^i q, Z) \quad (6)$$

and substituting these values of  $X$  into Equation (3) we obtain the optimal restricted profit function.

$$\Pi^{*i} = A^i \Pi^* \left( \frac{k^i q, Z}{A^i} \right) \quad (7)$$

Finally, the input demand functions can be expressed in terms of the profit function as

$$X^{*i} = - \frac{A^i}{k^i} \frac{\partial \Pi^* \left( \frac{k^i q, Z}{A^i} \right)}{\partial q} \quad (8)$$

The profit function, Equation (7), is related to  $A^i$  and  $k^i$ , but, by rearranging the input demand functions, it can be made to relate only to  $k^i$ . Thus, given the same prices and fixed inputs, the profit function can only differ between groups if there are differences in price and/or technical efficiency whereas the input demand functions can differ only if price efficiency differs.

Once the production function is specified, the corresponding profit and input demand functions can be calculated. Introducing dummy variables into these functions allows us to capture differences in price and technical efficiency between groups. The final equation to be estimated for the Cobb-Douglas production function are<sup>1</sup>

$$\ln \left( \frac{\Pi}{P} \right) = (\text{constant}) + \partial D^m + \sum_{i=1}^n a_i \ln q + \sum_{j=1}^m \beta^* \ln Z + \mu_i \quad (9)$$

$$- \frac{P_x X}{\Pi} = a_i^s D^s + a_i^m D^m + \mu_i \quad (10)$$

where  $D^m$  and  $D^s$  are, respectively, medium farm and small farm dummy variables,  $\mu$  is the disturbance term and the theory requires that all  $a < 0$  and  $\beta^* > 0$ .

### III DATA, ESTIMATION AND RESULTS

The data are drawn from the financial accounts of 49 farms in the Bandon, Dunmanway and Clonakilty regions of West Cork for the year 1977. This is a relatively rich and progressive farming district and is thus an ideal sample for the study. All farms used the "Farms Records and Accounts" booklet as prepared by the Specialist Advisory Service in the Department of Agriculture. Approximately 20,000 copies are sold each year and a grant system, as well as a recording service, is available to improve documentation of farm operations. The purpose of the accounts is to allow farmers to analyse and compare costs, revenue and profit totals within their agricultural

1. For details, see Lau and Yotopoulos (1973).

operation and is not generally intended to be used to calculate tax payments or eligibility for grants.

The farms were selected so that each was involved in the production of four outputs: cattle, dairy produce, pigs and crops. This allows not only for the calculation of a weighted average output price, but also minimises differences in farmers' production techniques. This latter point is important in suggesting explanations for differences in technical efficiency. Of the 49 farms, 23 fell into the "Small farm" category and the remaining 26 constituted the "Medium farm" group.

Given the available data, the final forms of the profit and input demand functions can be specified. These equations include five variable inputs — seed, fertiliser, feed, livestock maintenance and transport — and three fixed inputs — land, labour and capital. Typically, hire of machinery is also regarded as a variable input, but no satisfactory price could be calculated for this variable and instead it is included under the definition of capital.

Since the study is based on cross-sectional data from a small area of the country, it is possible that the variable input prices are constant within the sample. However, input prices can vary considerably depending on the timing and quantity of the purchase. The price of feed, for example, can vary between the extremes of buying large quantities at a discount from the co-operatives at the beginning of the year to buying small quantities from private suppliers at the end of the year. Similarly, fertiliser prices at the end of the year can be roughly discounted back to early year prices by using the current interest rate. Thus price differences can emerge between farms and this obviously reduces profit.

Following Equations (9) and (10), the complete list of equations to be estimated are

$$\ln \frac{\Pi}{P_y} = (\text{constant}) + \partial_1 D^m + a_1 \ln q_f + a_2 \ln q_s + a_3 \ln q_z \\ + a_4 \ln q_m + a_5 \ln q_t + \beta_1^* \ln L + \beta_2^* \ln B + \beta_3^* \ln K + \mu_1 \quad (11)$$

$$\frac{\text{value of feed}}{\Pi} = a_1^m D^m + a_1^s D^s + \mu_2 \quad (12)$$

$$\frac{\text{value of seed}}{\Pi} = a_2^m D^m + a_2^s D^s + \mu_3 \quad (13)$$

$$\frac{\text{value of fertiliser}}{\Pi} = a_3^m D^m + a_3^s D^s + \mu_4 \quad (14)$$

$$\frac{\text{value of livestock maintenance}}{\Pi} = a_4^m D^m + a_4^s D^s + \mu_5 \quad (15)$$

$$\frac{\text{value of transport}}{\Pi} = a_5^m D^m + a_5^s D^s + \mu_6 \quad (16)$$

where  $q_f$  = normalised price of feed =  $\frac{\text{value}}{\text{quantity (cwt.)}/P_y}$

$q_s$  = normalised price of seed =  $\frac{\text{value}}{\text{quantity (cwt.)}/P_y}$

$q_z$  = normalised price of fertiliser =  $\frac{\text{value}}{\text{quantity (cwt.)}/P_y}$

$q_m$  = normalised price of maintaining livestock =  $\frac{\text{cost}}{\text{number of livestock}/P_y}$

$q_t$  = normalised price of transport =  $\frac{\text{cost}}{\text{number transported}/P_y}$

$P_y$  = average output price,

$L$  = land(acres) = total area under pasture and crops with an adjustment for rough grazing,

$B$  = labour = standard man-days worked on farm,

$K$  = capital (£) = interest on net worth + interest on farm loans + hire of machinery + depreciation on buildings + machine cost,

$\Pi$  = profit = total revenue – total variable cost,

$D^m$  = Medium Farm dummy = 1 for farms > 50 acres  
= 0 for farms ≤ 50 acres,

$D^s$  = Small Farm dummy = 0 for farms > 50 acres  
= 1 for farms ≤ 50 acres,

$\mu_j, j = 1 \dots \dots 6$  = disturbance terms.

The results of applying ordinary least squares to the restricted profit function and input demand functions are given in Table 1. An F test on the profit function indicates that the hypothesis that all coefficients are zero should be rejected. The coefficient of multiple correlation,  $R^2$ , indicates that 84.7 per cent of the variation of profit is explained by the independent

variables and a t-statistic test indicates that all variables, with the exception of the seed and transport variables, are significantly different from zero at the 5 per cent significance level.

Unlike the other variables in the profit function, the seed and transport variables also have the wrong sign according to theory. In other words, the results show a positive relationship between seed and transport prices and the profit level. However, given the insignificance of the two variables, the validity of the efficiency tests should not be affected by this result.

The five efficiency hypotheses to be tested are given in Table 2. The first test, that of *equal relative economic efficiency*, is rejected at a 5 per cent significance level. Thus, the two groups do not have the same level of economic efficiency. Furthermore, the positive  $D^m$  coefficient indicates that it is the Medium Group that is the more economically efficient. The second test, that of *equal relative price efficiency*, cannot be rejected at the 10 per cent significance level for any of the variable inputs. Thus, both farm groups have an equal ability to maximise profits. The Medium Group does not have greater price efficiency.

In accordance with these two results, the third hypothesis, that of *equal technical and price efficiency* is rejected at the 10 per cent significance level. The greater economic efficiency of the Medium Group is, therefore, due to its superior technical efficiency.

Table 1: *Econometric results<sup>a</sup>*

(A) *Restricted profit function*

$$\Pi = 5.15 + .27D^m - .16q_f + .006q_s - .7q_z - .17q_m + .007q_t + .18L + .48B + .33K$$

( .76 ) ( .13 ) ( .06 ) ( .09 ) ( .15 ) ( .07 ) ( .03 ) ( .07 ) ( .20 ) ( .08 )

$$R^2 = .85 \quad N = 49 \quad F = 24.1$$

(B) *Estimated input demand functions*

Farm group	Coefficient				
	$\alpha_1$	$\alpha_2$	$\alpha_3$	$\alpha_4$	$\alpha_5$
$D^m$	-.28 (.057)	-.03 (.003)	-.16 (.016)	-.03 (.003)	-.02 (.004)
$D^s$	-.33 (.063)	-.02 (.003)	-.14 (.018)	-.03 (.003)	-.02 (.004)

<sup>a</sup> Standard errors in parentheses.

Table 2: *Efficiency Tests*


---



---

(1) <i>Equal relative economic efficiency</i>	Ho : $\partial = 0$	
	Hi : $\partial \neq 0$	
(2) <i>Equal relative price efficiency</i>	Ho : $\alpha_1^m = \alpha_1^s$	
	Hi : $\alpha_1^m \neq \alpha_1^s$	
(3) <i>Equal technical and price efficiency</i>	Ho : $\partial = 0$	
	and : $\alpha_i^m = \alpha_i^s$	$i = 1 \dots 5$
(4) <i>Absolute price efficiency</i>	Ho : $\alpha_i^s = \alpha_i$	(Small farms)
	Ho : $\alpha_i^m = \alpha_i$	(Medium farms) $i = 1 \dots 5$
(5) <i>Constant returns to scale</i>	Ho : $\beta_1^* + \beta_2^* + \beta_3^* = 1$	

---



---

We may now test if either farm group achieves perfect profit maximisation. Considering first the Small Group, the hypothesis of *absolute price efficiency* is rejected at a 10 per cent significance level for the feed, fertiliser and livestock maintenance variables, but cannot be rejected for the statistically insignificant seed and transport variables. In accordance with the acceptance of hypothesis (2), a similar test for the Medium Group gives the same result. Thus, both farm groups are not achieving perfect price efficiency in the three principal variable inputs. Increases in profit are, therefore, available if resources are reallocated in the optimal direction.

The final test is that of *constant returns to scale* in the fixed inputs of production. An F test cannot reject this hypothesis at the 5 per cent level of significance. Thus the degree of homogeneity is not different for the two groups. This result has important implications for the idea of co-operative farming.

#### IV IMPLICATIONS AND CONCLUSIONS

Given the production function and the average output and variable input prices, the econometric results show that both farm groups experience constant returns to scale in the fixed factors of production. Economies of



scale are, therefore, rejected as an argument for the consolidation of small farms. Land reform policies, in so far as they are implemented, can be expected to have little effect on the growth rate of agricultural output.

The results also show equal price efficiency between farm groups – that is, an equal ability to equate marginal product to its price. This indicates an habitual element in deciding on input purchases. However, as the fourth hypothesis showed, these input levels are not the optimal levels. Both farm groups failed to perfectly maximise profits in the feed, fertiliser and live-stock maintenance variables. Thus, allocative errors are being made and this reflects the degree of complexity in these markets. However, this situation is not surprising in view of the instability in prices over the past few years. The average price of feed, for example, rose 20.1 per cent in 1975, increased by 29.6 per cent in 1976 and rose by 2.0 per cent in 1977. Similarly, average fertiliser prices rose 2.8 per cent in 1975, increased by 9.3 per cent in 1976 and, subsequently rose by 6.0 per cent in 1977. Average output prices showed a decreasing rate of change from 25.7 per cent in 1975 to 13.0 per cent in 1977.<sup>2</sup>

Given these price variations, attempts to assess the profitability of purchasing additional inputs will have to be a continuous calculation with little prospect of achieving an optimal solution. Price stability would appear to be necessary if allocative efficiency is to be improved.

The fixed exchange rate system and the ending of the transition period between Irish and Community food prices will have a stabilising effect on output prices. However, exogenous shocks such as oil price changes will destabilise input prices and the output/input price ratio is likely to continue to fluctuate. Since the farming sector is a price-taker in an open economy, the scope for removing these oscillations is limited and, as a consequence, improvements in price efficiency will be difficult to achieve.

Finally, the results show the Medium Group to be more profitable (i.e., efficient) due to its superior technical efficiency. Why this is the case is difficult to substantiate as most of the determining factors are not amenable to measurement. However, factors such as access to markets and services can largely be discounted because of the similarities between the groups in terms of farm size and location. Differing technical efficiency would, therefore seem to be largely related to the farmer's ability, as well as his incentive, to innovate and be efficient. The government's training, advisory and educational services, coupled with the disease eradication and livestock breeding programmes, should considerably improve the "ability" aspect. Similarly, the "incentive" element will improve as older people leaving agriculture are replaced by skilled young people. Improvements could, however, be made in

2. Source: *Irish Statistical Bulletin*, Central Statistics Office, March 1979.

both areas. A revision of the inheritance tax rates and a compulsory farm accounts system are frequently cited suggestions. Improving technical efficiency is, however, a lengthy process and it may be some years before the results are translated into increases in agricultural output.

Summarising, the results identify price stability and entrepreneurship as principal areas of concern if the growth rate of agricultural output is to be increased. The present government policies should improve growth rates significantly, but stability in output and input prices appears to be necessary if the best results are to be achieved.

#### REFERENCES

- LAU, L. J. and P. A. YOTOPOULOS, 1971. "A Test for Relative Economic Efficiency and Application to Indian Agriculture", *American Economic Review*, March, Vol. 61, pp. 94-109.
- LAU, L. J. and P. A. YOTOPOULOS, 1973. "A Test for Relative Economic Efficiency, Some Further Results", *American Economic Review*, Mar, Vol. 63, pp. 214-223.
- JORGENSON, D. W. and L. J. LAU, 1974. "The Duality of Technology and Economic Behaviour", *Review of Economic Studies*, April, pp. 181-200.