LABOR INTENSITY AND RELATIVE EFFICIENCY IN INDIAN AGRICULTURE

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The bountiful data produced by the ambitious, meticulous, and voluminous *Farm Management Studies* of the Indian Ministry of Food and Agriculture have been a valuable source for the analysis of Indian agriculture as well as an empirical testing ground for economic theory. A number of writers have approached the *Studies* with an eye on implications about the efficiency of Indian agriculture. R. L. Bennett and M. Paglin have utilized data provided by the *Studies* to analyze the effect of farm size on agricultural productivity (*1*; *6*). G. S. Sahota besides the size question considers also the crop-mix effect and the regional effect by appropriately fitting Cobb-Douglas production functions (*8*). A. K. Sen compares the behavior of two groups of farms, capitalist and peasant, and he concludes that their respective output-input utilization is consistent with the hypothesis that the former maximize profits while the latter maximize utility (*9*).

Some of the most celebrated findings of the *Studies* suggest that there exist significant differences in factor intensities and in input-output ratios between different size classes of farms. More specifically it has been observed that: (1) output per acre is inversely related to farm size as measured by area; (2) input per acre (in terms of a "cost" concept which includes, among other things, both hired and family labor) is inversely related to farm size; (3) output (in value terms) per acre is directly related to input per acre.

These relationships are open to a wide range of interpretations and economic (as well as noneconomic) rationalizations. Sen, for example, suggests that the observed higher output per unit of land and lower costs per unit of output for small farms may be entirely consistent with economic theory (*9*). A plausible explanation is that small farms are inherently more fertile than large farms and also that they face lower wage rates than large farms.[1] On the other hand, Sen shies away from comparison of relative efficiency of small and large farms. He assumes that small and large farms in India operate under different institutional arrangements and indeed may be considered to have different objective functions

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[1] The former explanation was formulated as a hypothesis, tested and rejected (*5*). The latter is borne out by the data.

—e.g., one group may be maximizing profits from agriculture while another may be maximizing prestige from ownership of the land or security from expropriation. If the objective functions differ, comparison of intergroup efficiency is not possible.[2]

Paglin asserts that the large farms (i.e., above ten acres) "are markedly underutilized in terms of *economically feasible* [italics added] levels of intensity of cultivation" and that the farmer with a large holding "seems to prefer the low-effort, low-risk, low-output package to the higher-risk, higher-profit, higher-output combination" (6, pp. 816, 828). In other words, the large farms are less efficient allocatively than the small farms. However, no satisfactory evidence is presented to support this assertion.

Sahota, on the other hand, finds that in general one cannot reject the hypothesis that the values of the marginal products are not substantially different from the opportunity costs (8). In addition, there appears to be no substantial difference of technical efficiency amongst different land size classes except in the case of a few specific crops.

This paper employs the framework of the theory of production to analyze the differences in input intensities and in input-output ratios that are observed between large and small farms. This approach incorporates both the technological factors that may account for such differences (i.e., the factors that are usually reflected in the coefficients of the production function) and the economic considerations that may arise because of differences in endowments between large and small farms (i.e., the differences that are usually reflected in the relative factor prices). In this sense, we consider in this paper questions of differences in technical and price efficiency between the two groups of farms.

THE ANALYSIS OF PRODUCTION APPROACH

Let us define the technology of production in terms of the coefficients of the production function. If small and large farms have identical production functions (i.e., if there exists one explicit functional relationship that describes both) they still may differ in factor utilization and in output-input ratios. Such differences can arise in several ways:

(1) The production function may not be homothetic, that is, the marginal product of land may be low when other inputs per unit of land are low, and high when they are high.

(2) There may be differences in technical efficiency between small and large farms. Technical efficiency, in its simplest formulation, implies that, given the same production function and the same quantity of measured inputs, one firm is producing a greater quantity of output than another firm. Technical efficiency is thus represented by the intercept term and/or by the residual factor in a production function.

[2] Of course, the hypothesis that the objective function of some farms is not profit maximization is a testable hypothesis as Wise and Yotopoulos have demonstrated (*10*). Lau and Yotopoulos submitted this hypothesis to a test in connection with Indian agriculture and they found that the observable behavior in the sample conforms to the profit maximization rule and furthermore that the behavior of the two groups is not significantly different from the point of view of profit maximization (*5*).

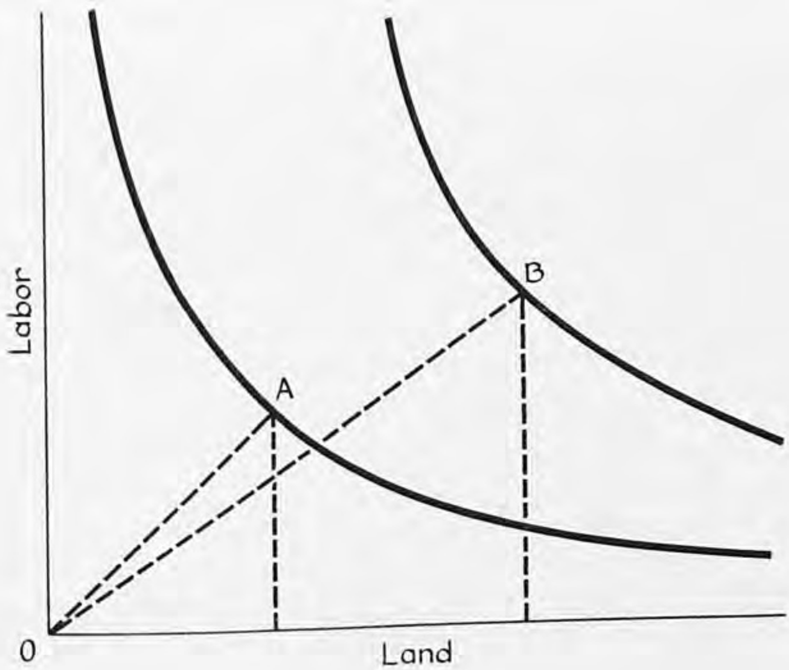
(3) There may exist differences in allocative efficiency, in the sense that either the small or the large farms or both operate at a point where the values of the marginal productivities are not equal to the marginal factor costs.

(4) Small and large farms may face different market conditions.

Diagrammatically, nonhomotheticity in production can be represented by an isoquant map such as in Chart 1. Observe that although the slopes of the isoquants are the same at the points indicated, the optimal labor-land ratio is higher for the farm producing the smaller output. This implies that even if small and large farms face the same market conditions with respect to the factor inputs, it is still possible for them to have different factor intensities. Although analytically clear, nonhomotheticity is empirically indistinguishable from other differences in the production functions. A situation as depicted in Chart 1, for example, may involve differences in technical efficiency, differences in the elasticity of substitution and differences in the elasticity coefficients of the production functions of small and large farms.

Suppose that there exist technological differences between small and large farms in the sense that their respective production functions are different. In this situation two questions are relevant: (1) Is one of these production functions technically more efficient over the entire range of production, in the sense that less of some or all inputs are required to produce the same output? (2) Which group of farms is economically more efficient, in the sense of having lower total variable cost per unit of output?

CHART 1.—ISOQUANTS OF A NON-HOMOGENEOUS PRODUCTION FUNCTION



THE DATA AND THE FUNCTIONAL FORM

Before we proceed to the specification of the functional form for our analysis we may briefly describe the data. Such description will serve to caution the reader against undue confidence in the results, entirely independently of any conceptual problems that may be inherent in the formulation of the problem.

The *Studies* report the data collected over a three-year period (1955–57) from cost-accounting records of 2,962 holdings in the six main agricultural regions of India.[3] All the data are reported in terms of averages of farms of a given size. This is certainly a considerable disadvantage for rigorous analysis. Within this restricted framework, the data utilized in our analysis refer to average output per farm in rupees, average farm size in acres, and average cost of other inputs which may include, besides variable costs such as seeds and fertilizer, a cost concept of fixed capital (e.g., depreciation on the capital stock) and imputed cost of family labor. In some cases we separate labor costs from other costs. We also utilize in our analysis the average (i.e., for each land-size cell) rent per acre and wage per day. More complete specification of the data will be provided in the tables below.

We now turn to the question of the appropriate functional form for the analysis of production. One can use any of a number of traditional production functions or any other less orthodox form relating inputs to output. The adequacy of these forms in explaining the phenomena under consideration is then judged on the basis of a priori economic notions as well as on the basis of purely statistical criteria. Paglin, for example, relates output per acre to input per acre and fits for the sample of Indian farms

$$(1) \qquad \frac{Q}{L} = a + b \log \frac{C}{L}$$

where Q is (average) output per farm in rupees, L is (average) farm size in acres and C is (average) cost of other inputs per farm in rupees (such as cash outlays for hired labor, seeds), plus imputed value of family labor and depreciation of equipment—"cost A" according to the terminology of the *Studies* (*6*). The values of the parameters of (1), estimated from the 34 observations of different land-size cells of farms for the five states (Madras, Uttar Pradesh, Madhya Pradesh, West Bengal, and Punjab), are given in (2) with the standard errors appearing in parentheses.[4] Chow tests indicate that when the sample is split into two subsets for small and large farms (i.e., size classes below and above 10 acres, respectively), the tested functional forms are not significantly different (*3*).

$$(2) \qquad \frac{Q}{L} = \underset{(30.2)}{-24.97} + \underset{(6.6)}{89.5}\; ln \frac{Q}{L}$$

$$\bar{R}^2 = 0.8453$$

$$F_{1,32} > 99.9$$

[3] For this analysis we utilize data from the following states and years: West Bengal, Madras, Uttar Pradesh, Punjab, 1955–56; and Madhya Pradesh, 1956–57. The last is chosen because the 1955–56 report of the *Farm Management Studies* for Madhya Pradesh does not contain as comparable information as the others.

[4] The differences between our estimates and Paglin's are due to the fact that we use natural logs and that we have corrected the data for the sake of consistency.

An interesting characteristic of (1) is that it implies linear homogeneity in the relationship between $Q, C,$ and L but also, unlike the Cobb-Douglas, it is not constrained to have unitary (or even constant) elasticity of substitution between C and L. The elasticity of substitution for a homogeneous production function is given by

$$(3) \qquad \sigma = \frac{\frac{\partial Q}{\partial L}\frac{\partial Q}{\partial C}}{\frac{\partial^2 Q}{\partial L \partial C}} .$$

It is easily verified that for Paglin's function

$$\frac{\partial Q}{\partial L} = a + b\, ln\, C - b(ln\, L + 1); \; \frac{\partial Q}{\partial C} = \frac{bL}{C}; \text{ and } \frac{\partial^2 Q}{\partial L \partial C} = \frac{b}{C} .$$

Hence

$$(4) \qquad \sigma = \frac{Q - bL}{Q} = 1 - \frac{b}{Q/L} .$$

Although b is a constant parameter, the elasticity of substitution of Paglin's production function varies with the average productivity of land. By substituting for b its estimator in (2) and for Q/L the mean output per unit of land for the overall sample—154.78 rupees—we find that the average elasticity of substitution between other inputs and land is 0.423.[5]

This specification may be compared with the result of a CES specification. We have fitted a CES production function to the data in the form of

$$(5) \qquad Q = \gamma[\delta C^{-\rho} + (1 - \delta)L^{-\rho}]^{-1/\rho} .$$

The results are reported in Table 1. One observes that for the sample of all farms the value of the elasticity of substitution is equal to 0.295. This is relatively close to the value estimated indirectly from Paglin's function.

However, when the same specification is fitted on two subsamples for large and small farms the results change substantially and raise doubts about the reliability of these nonlinear estimates. As can be seen from Table 1, ρ is no longer significantly different from zero.

These results, together with the implausibility of so small an elasticity of substitution in agriculture, have led us to resort to further analysis in terms of the empirically more weatherproof Cobb-Douglas functions. Table 2 (and Chart 2 which will be discussed below) presents the results for the overall sample of farms as well as for the small and large farms separately.

Table 3 (and Chart 3 also to be discussed below) presents the results of fitting a Cobb-Douglas function with a slightly different specification of variables. It has been suggested that the utilization of resources on large farms may reflect the fact that large farms derive a significant part of their income not by cultivating but by renting land (*9*). We correct for this misspecification of the land input in the second set of regressions by defining L as land cultivated per farm

[5] For the extreme values of Q/L observed in the sample, the elasticity of substitution ranges from −0.322 (i.e., L and C are complements) to 0.687.

TABLE 1.—CONSTANT ELASTICITY OF SUBSTITUTION (CES) PRODUCTION FUNCTION COEFFICIENTS AND RELATED STATISTICS, SAMPLE OF INDIAN FARMS*

Coefficients	All farms n = 34	Large farms n = 18	Small farms n = 16
γ	2.382 (0.209)	2.331 (0.231)	53.873 (95.271)
δ	0.00001 (0.00008)	0.000003 (0.000002)	0.094 (0.032)
ρ	2.395 (1.071)	2.772 (1.633)	0.062 (1.196)
σ	0.295	0.265	0.942
$\bar{R}^2$	0.981	0.974	0.959

* The estimating equation is

$$Q = \gamma \{\delta C^{-\rho} + (1-\delta)L^{-\rho}\}^{-1/\rho}$$

where

Q is output in rupees per farm,
L is average farm size in acres,
C is all other costs excluding rent but including imputed family labor in rupees.

Figures in parentheses are standard errors.

Basic data are from India, Ministry of Food and Agriculture, *Studies in the Economics of Farm Management* (4).

rather than land owned. Other inputs are broken down into labor (N) and capital (X) components.

The fits reported in Tables 2 and 3 are remarkably satisfactory. The coefficients are statistically significant and consistent with a priori notions from economic theory. We proceed to utilize these relationships in order to draw inferences about the relative efficiency of resource utilization.

INTER-GROUP DIFFERENCES IN EFFICIENCY

A comparison of the two sets of regressions reveals consistently the following results: (1) the small farms have a significantly higher intercept than the large farms; (2) the land coefficient is higher (but not significantly) for small farms; (3) the labor or other inputs coefficient is lower for the small farms; and (4) the marginal products of land, other inputs and/or labor are significantly different from zero on both small and large farms.

How meaningful are these differences in coefficients between large and small farms? Chow tests indicate that the regressions for the two subsamples do not differ significantly from the pooled regression in the results of Table 2 but there is significant difference for the results of Table 3 (*3*). This finding recommends that a further attempt be made to locate the source of differences between small and large farms on the basis of the data utilized in Table 3. For this purpose we fit a new regression on the pooled data with a dummy variable for small farms. The following results are reported:

$$\begin{aligned} ln\,Q &= \underset{(0.094)}{2.064} + \underset{(0.094)}{0.179}\,\text{Dummy} + \underset{(0.066)}{0.465}\,ln\,L + \underset{(0.069)}{0.596}\,ln\,C \\ \bar{R}^2 &= 0.9723\,. \end{aligned}$$

TABLE 2.—COBB-DOUGLAS PRODUCTION COEFFICIENTS AND RELATED STATISTICS, SAMPLE OF INDIAN FARMS[*]

	All farms n=34	Large farms n=18	Small farms n=16
Coefficients[a]			
Intercept	2.249	1.470	2.925
	(0.377)	(0.593)	(0.361)
L, coefficient	0.393	0.461	0.512
	(0.057)	(0.104)	(0.070)
C, coefficient	0.605	0.678	0.475
	(0.071)	(0.104)	(0.070)
Sum of elasticities	0.999[b]	1.138[b]	0.987
$\bar{R}^2$	0.9699	0.9223	0.9771
Marginal products[c] (rupees)			
L	56.600	54.908	94.684
	(8.209)	(12.387)	(12.205)
C	0.949	1.117	0.708
	(0.157)	(0.171)	(0.050)

[*] Variables are defined as in Table 1, and basic data are from the source cited there. Figures in parentheses are standard errors.

[a] All coefficients are significantly different from zero at a probability level = 95%.

[b] Discrepancy due to rounding.

[c] Marginal products are computed at the geometric means. Use of the Carter-Hartley modification (2) yields substantially the same results.

The coefficient corresponding to the dummy variable is significant, indicating that small farms are probably technically more efficient than the large farms.

Although there is no clear-cut answer to whether the production functions of the small and large farms differ in a statistically significant manner, their marginal products, especially that of labor, do differ significantly. Whether or not the underlying production function is identical, the discrepancy in the marginal products implies that either the two groups of farms face different market conditions, or one group is less efficient allocatively, or both.

There exists some evidence to suggest that the two groups of farms indeed face different market conditions. Bennett has indicated that rent per acre is uniformly lower for large farms than for small farms (*1*).[6] We present the average rent (plus land revenue) per acre and the average wage rate per day for the small and large farms separately in Table 4. Consistent with the rent figures—and as one would have expected from economic theory—the marginal product of land is also lower for the large farms in both sets of regressions in Tables 2 and 3.

With respect to labor costs, as Paglin has pointed out, the large farms have to resort to hiring labor at the market wage rate; small farms employ mainly family labor whose opportunity cost, especially during the slack seasons of agricultural employment, may be less than the market wage rate (*6*). Table 4 does confirm the fact that the large farms face higher wage rates. Thus likewise, one expects

[6] The question of whether this rent differential reflects primarily land quality is immaterial for the issue under consideration.

TABLE 3.—ALTERNATIVE COBB-DOUGLAS PRODUCTION COEFFICIENTS AND RELATED STATISTICS, SAMPLE OF INDIAN FARMS*

	All farms n = 34	Large farms n = 18	Small farms n = 16
Coefficients[a]			
Intercept	2.329	1.915	2.984
	(0.268)	(0.338)	(0.370)
L	0.330	0.369	0.477
	(0.047)	(0.071)	(0.071)
N	0.460	0.552	0.308
	(0.052)	(0.070)	(0.067)
X	0.237	0.188	0.235
	(0.040)	(0.063)	(0.042)
Sum of elasticities	1.027	1.109	1.020
$\bar{R}^2$	0.9813	0.9665	0.9765
Marginal products[b] (rupees)			
L	47.529	43.950	88.212
	(6.769)	(8.457)	(13.130)
N	2.925	2.353	1.096
	(0.331)	(0.298)	(0.239)
X	0.677	0.565	0.671
	(0.114)	(0.189)	(0.120)

* Variables are defined as follows:
L is land cultivated per farm in acres,
N is family plus hired labor per farm in rupees,
X is other inputs per farm in rupees.
Figures in parentheses are standard errors.
Basic data are from India, Ministry of Food and Agriculture, *Studies in the Economics of Farm Management* (4).
[a] All coefficients are significantly different from zero at a probability level = 95%.
[b] Marginal products are computed at the geometric means.

the marginal product of labor to be higher on the large farms—which is again confirmed in Table 3. All the above observations are trivial implications of an imperfect market and say nothing about the relative degree of allocative efficiency between the small and the large farms. By comparing the estimated marginal products of land and labor for both small and large farms with land rentals and wage rates, one cannot conclude that the small farms are *allocatively* more efficient.

Another possible reason for the apparent discrepancy is that by expressing labor in terms of the imputed market wage rate for both family and hired workers, the actual labor inputs have been overestimated for small farms and underestimated for large farms. This is likely in view of the seasonal characteristics of agricultural market employment. During the slack seasons of agricultural activities, the opportunity cost of family labor in small farms is zero (7, p. 202). Evaluating this labor at the market wage rate leads to an overestimate of the labor input. On the other hand, there is evidence that during the peak-season agricultural activities there is shortage of labor in Indian agriculture (6, pp. 826–27).[7]

[7] The days of monthly employment per adult male working during the peak period of the year range from 26 (in Uttar Pradesh) to 33.2 (in Punjab) eight-hour units. Since these are state averages, individual villages within the states may have even higher employment rates during the peak months.

TABLE 4.—RENTAL AND WAGE RATES FOR FIVE STATES OF INDIA*

Farm size	West Bengal	Madras	Madhya Pradesh	Uttar Pradesh	Punjab
	Rent, or Land Revenue, per Acre (*rupees per year*)				
Large	13.8700	21.3750	32.1966	9.5733	56.1900
Small	41.0166	43.3000	32.4650	5.9950	66.8950
	Wage Rates (*rupees per day*)				
Large	1.5824	0.5723	1.0873	1.0484	1.6059
Small	1.5364	0.5699	1.0052	1.0011	1.3690

* Data from India, Ministry of Food and Agriculture, *Studies in the Economics of Farm Management* (4).

In these cases, nonmarket rationing would also be resorted to for the allocation of labor. Evaluating labor inputs during the peak seasons on the basis of the market wage rate alone would then underestimate the opportunity cost of labor of the farms that have a high ratio of hired to family labor—i.e., the large farms.

INTER-GROUP DIFFERENCES IN UNIT OUTPUT COSTS

We may now focus on the possibility of different production functions for small and large farms. For purposes of comparison in this case we have to cast our data in terms of the unit output isoquant for small and large farms, respectively. Unit output isoquants based on the data of Table 2 and Table 3 appear in Chart 2 and Chart 3, respectively.

It is evident from an examination of Charts 2 and 3 that the small farms are technically more efficient at one set of factor price ratios and the large farms are efficient at another set of factor price ratios. If they face different factor price ratios because of market conditions, it is possible for both technologies (and therefore for different factor intensities) to exist side by side. Production function analysis, therefore, is inconclusive in discussing questions of economic efficiency when the underlying production function is different for the two groups of farms.

Especially in such cases it is usual to cast the comparisons of economic efficiency in terms of costs per unit of output. Total costs and variable costs per unit of output are considered good indicators of economic efficiency as they measure the cost of production per unit using the cost-minimizing input combinations when all inputs are variable and when some inputs (e.g., land or entrepreneurship) are fixed, respectively.[8] These average costs have been computed for each size category and for each of the five states and are summarized in Table 5.[9] On this count then, one must consider the large farms as more efficient producers than the small farms.

[8] The omission of capital improvements on both the output and the input accounts actually biases the average cost in favor of the small farms. Presumably the average cost of these improvements is one. Hence, their inclusion will raise the average cost for West Bengal, Madhya Pradesh and Uttar Pradesh. In any case, it will not lower the average cost on the small farms to less than one in Madras and Punjab.

[9] Only the figures for the two groups are presented. The complete breakdown by size of farms reveals essentially identical results.

Chart 2.—Unit Output Isoquant for Small and Large Farms Based on Cobb-Douglas Relationship (Table 2)

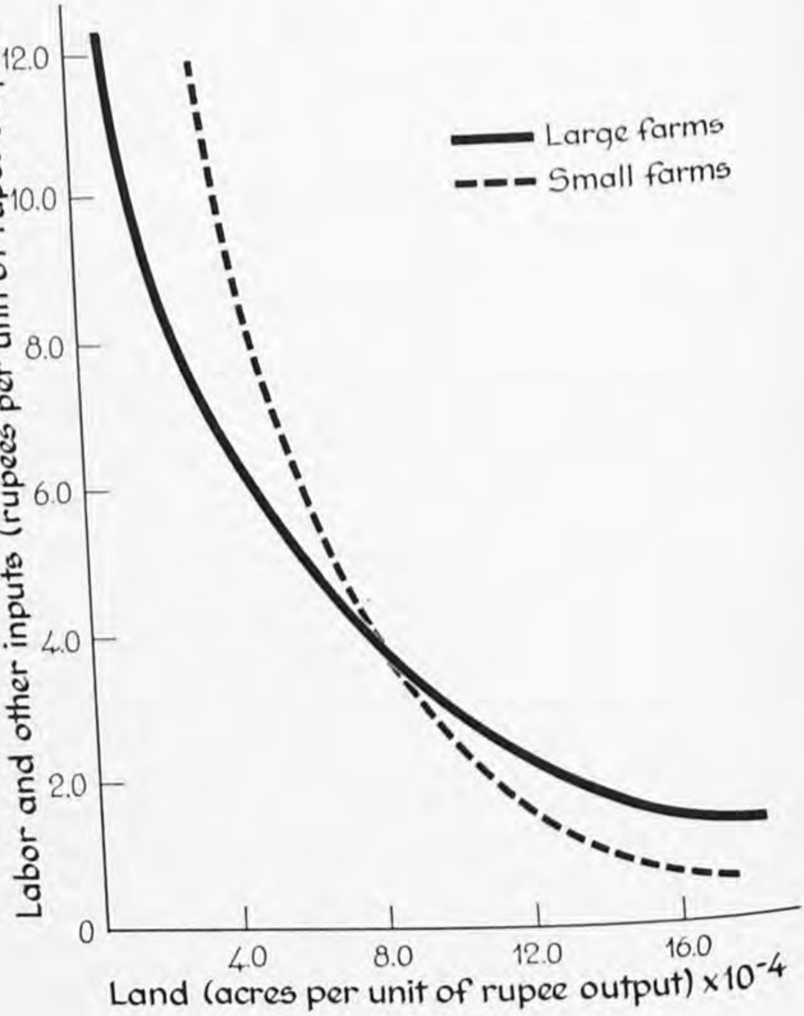


Table 5.—Total and Variable Costs per Unit of Output in Five States of India*

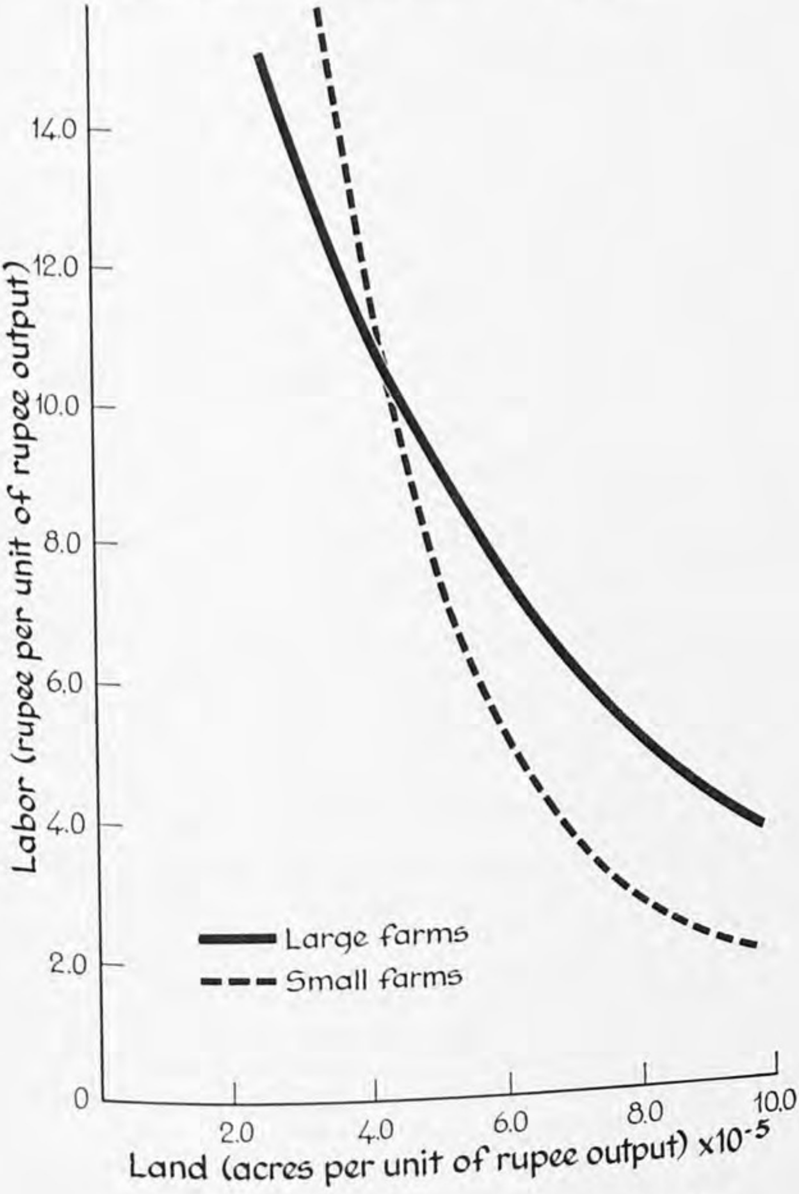
(Rupees of cost per rupee of output)

Farm size	All five states	West Bengal	Madras	Madhya Pradesh	Uttar Pradesh	Punjab
Total costs						
Large farms	0.8704	0.7503	0.9148	0.7401	0.7965	0.8808
Small farms	0.9124	0.8392	0.9782	0.7410	0.8768	1.1275
Variable costs						
Large farms	0.5492	0.5976	0.5842	0.4270	0.7223	0.5282
Small farms	0.6525	0.5633	0.6531	0.4684	0.8135	0.7428

* The cost per unit of output for each size class is computed as an unweighted average of t[he] costs per unit of output for each subclass of farms within the same size class.

Basic data are from India, Ministry of Food and Agriculture, *Studies in the Economics of Far[m] Management* (4).

CHART 3.—UNIT OUTPUT ISOQUANT FOR SMALL AND LARGE FARMS BASED ON COBB-DOUGLAS RELATIONSHIP (TABLE 3)



REFLECTIONS ON THE FUTILITY OF THE ATTEMPT TO MEASURE RELATIVE EFFICIENCY

Aside from any reservations about the data (that we would consider entirely legitimate) the results of the analysis of relative efficiency of small and large Indian farms are rather inconclusive and they should be taken with several grains of salt. If we constrain our analysis by the assumption that small and large farms face the same production function (i.e., they have the same elasticities of production) we find some evidence that small farms have a higher intercept. This suggests that the small farms are more efficient than the large farms in the sense that for a given quantity of factors of production the former will produce a greater quantity of output. There is no evidence, on the other hand, that small farms are more efficient in allocating their resources than large farms. The indication is that the small farms face higher land rentals and lower wage rates than the large farms, and the discrepancies in the marginal products of land and labor on the small and large farms reflect the price differentials in the expected direction.

At least in one case, Table 3, it appears that the assumption of the same production function is not warranted. If we allow for differences in the production function, comparison of relative technical efficiency is entirely inconclusive as shown in Charts 2 and 3. It is entirely possible, and the graphs of the data seem to bear out, that one group of farms is more efficient at one set of prices, while the other is more efficient at another set of prices. The prices of inputs, therefore, should also enter the analysis of efficiency directly. We attempt this by computing cost per unit of output for each group of farms. On this count the large farms seem to be economically more efficient in at least four out of the five states.

At this point we should confess that the search for relative efficiency in Indian agriculture has been rather futile. This inspires the pessimism of "hunting the Heffalump" of the children's fairy-lore—the animal that nobody has seen yet everybody is convinced exists and is constantly modifying the traps in an attempt to capture it![10] We submit that the production function is the wrong trap for the purpose of capturing relative efficiency. We can summarize this argument around the rigid assumptions that are implicit in the estimation of production functions.

It is well known that all firms would have the same quantities of inputs and outputs (and as a result only one point on the production surface would be observable) if:

(1) all firms had the same production function, i.e., the same technical knowledge and identical fixed factors;

(2) all firms faced the same prices in the product and factor markets; and

(3) all firms maximized profits perfectly and instantaneously.

Nevertheless we observe in the world firms that produce (roughly) homogeneous outputs having different factor intensities and varying average factor productivities. It is, of course, sufficient to explain the world if we assume that firms behave randomly. They are ignorant of their production, cost, and return functions and, no matter what prices they have to take as given, they do not behave as if they maximized profits. If this is the case, any attempt to measure relative economic efficiency could as well be abandoned.

On the other hand, suppose we establish that firms behave according to a certain decision rule which we can conveniently call profit maximization with respect to a set of exogenous variables, such as prices and fixed factor of production. Then the observed interfirm differences in factor intensities and productivities still need explaining. The two possible explanations are that (1) firms use different input mixes because they face different prices; and/or (2) firms use different input mixes because they have different endowments of fixed factors of production, i.e., they have neutral differences in technical efficiency.

[10] We owe this excursion into fairyland to our colleague Peter Kilby and his "Quest of the Heffalump" in connection with entrepreneurship.

A conclusive test of economic efficiency should, therefore, include two parts. First, given different regimes of prices of the variable factors of production and of quantities of fixed factors of production, it should determine if firms behave according to a decision rule such as profit maximization. Second, if and only if a decision rule appears to be generally applicable, then the question arises whether a set of firms is more economically efficient than another because it is more successful in responding to the set of prices it faces (price efficiency) and/or because it has higher quantities of fixed factors of production, including entrepreneurship (i.e., it is technically more efficient). The first part is formalized and tested for by the Wise-Yotopoulos test of economic rationality (*10*). In an attempt to make the second part also operational, Lau and Yotopoulos have devised a new test of relative efficiency (*5*). Since firms that are more price efficient and/or more technically efficient should be expected to have higher profits, the Lau-Yotopoulos test is constructed in the framework of the profit function.

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