AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY

1. SUBJECT CLASSIFICATION

A. PRIMARY
ECONOMICS

B. SECONDARY
AGRICULTURAL ECONOMICS

2. TITLE AND SUBTITLE
TENDENCIES IN RELATIVE ECONOMIC EFFICIENCY AND THEIR CONSEQUENCES

3. AUTHOR(S)
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4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
SEPTEMBER 1973	11 PAGES	ARC IN-338.1-C953

7. REFERENCE ORGANIZATION NAME AND ADDRESS
IOWA STATE UNIVERSITY
DEPT. OF AGRICULTURAL ECONOMICS
AMES, IOWA 50010

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

PUBLISHED IN INDIAN JOURNAL AGRIC. ECONOMICS-VOL. 28-NO.3

9. ABSTRACT

This analysis will show that, in the three districts of India resurveyed as part of the recent Studies in the Economics of Farm Management (Ferozepur in Punjab, Muzaffarnagar in Uttar Pradesh, and Thanjavur in Tamil Nadu), (a) the economic efficiency of all classes of farms has increased and (b) that the rates of increase for farms in different acreage classes have varied significantly within and between districts. Thus, whatever the truth about the relative efficiency of the small versus large farms in 1955-57 and earlier, this analysis will show that the truth has been modified over time through the dynamics of ongoing agriculture. Further, the analysis suggests that it is at least possible for the "true" relationships of the past to have been reversed over time.

With these indications it will be argued that the dual targets of equity in the distribution of wealth and income and growth in the amount of real income available for distribution may not be simultaneously attained through instruments such as the confiscation and redistribution of land. Indications are, rather, that the tendencies in relative efficiency have or soon will mean that drastic reduction in farm size will have a positive opportunity cost in terms of efficiency and, thus, potential output. With the results of this study, current and proposed land ceilings can be appraised in terms of efficiency loss for equity's sake.

10. CONTROL NUMBER	11. PRICE OF DOCUMENT
PN-AAA-980	

12. DESCRIPTORS

INDIA, FARM MANAGEMENT, SMALL FARMS, ECONOMIC EFFICIENCY, LARGE FARMS, ANALYSIS, DISTRIBUTION OF WEALTH, INCOME GROWTH

13. PROJECT NUMBER	14. CONTRACT NUMBER	15. TYPE OF DOCUMENT
931-11-140-124	AID/CSD-2824	RESEARCH BULLETIN

AID 590-1 (4-74)

Reprinted from Indian Journal of Agricultural Economics Vol. XXVIII No. 3 July-September 1973.

TENDENCIES IN RELATIVE ECONOMIC EFFICIENCY AND THEIR CONSEQUENCES*

Robert W. Crown and Vishnuprasad Nagadevara‡

In spite of an argument that spanned the decade of the 'sixties, the question of which farmers in India's agricultural economy are the more efficient has yet to be satisfactorily resolved. But an answer is all the more needed now considering the current and planned rounds of land reforms, the changes in rice and wheat production technology that appear to favour the use of land with labour-intensive techniques [16],† and the pressing political needs to attain a significant measure of equity in the distribution of the gains of "progress" simultaneously with growth. (See Frankel [3] for a more recent exposition of these conflicts.)

Early argument revolved around whether it was the large or the small farm operators who exhibited greater productivity per hectare (the implication being that whoever was more productive was also more efficient, that is, they showed greater technical efficiency). The empirical evidence of the day showed that there was an inverse relationship between per hectare productivity and farm size [1]. Coupled with other evidence that farmers were, in general, efficient allocators of scarce resources given marginal costs, marginal returns, and the constraints imposed by their own objectives [5] (that is, all farmers showed allocative efficiency), the conclusion was generally drawn and accepted that the small farm operators were relatively more efficient when allocative and technical efficiency were both considered (that is, they showed superior economic efficiency).

Recent studies have built elaborate means for testing the hypothesis that the farm operators exhibit *equal* economic efficiency regardless of farm size. Using a new model and 1955-57 data, Lau and Yotopoulos [17] rejected the equal efficiency hypothesis, agreeing with the contention that the small farm operators showed relatively more efficiency in the overall economic sense. They demonstrated later [18] that the small farm operators have greater economic efficiency by virtue of their using methods of greatest technical efficiency. (The argument thus appears to have come full circle, considering the initial efforts to determine the truth about efficiency in agriculture and the reasons for it.)

Why then, with this weight of evidence, does the question still seem to be open? First, the basic data most commonly employed in empirical analysis to date were collected under the auspices of the Government of India

* Journal Paper J-7231 of the Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa. Project Number 1558. The comments of Keith D. Rogers, Chandi C. Maji and Neil A. Patrick are acknowledged.

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† Figures in parentheses refer to the bibliography given at the end.

as part of the Studies in the Economics of Farm Management [6, 7, 8] in the years 1954-62, fully five years before the advent of the "green revolution" and before the efforts of the Intensive Agricultural District Programme commenced; secondly, any choice of a demarcation line between "large" and "small" for the nation will always be arbitrary,[1] since what constitutes "large" depends on regions, major crops, and technologies used, and is subject to change any time; thirdly, recent evidence suggests that the traditional view of the inverse relationship between productivity and farm size (which accounted for much of the small farm operators' greater economic efficiency) is no longer believable.[2]

Essentially, the debate has not been convincing because it has failed to account for dynamics in the agricultural sector and the significance of tendencies for change in efficiency for future public policy.

Purpose of this Analysis

This analysis will show that, in the three districts of India resurveyed as part of the recent Studies in the Economics of Farm Management (Ferozepur in Punjab, Muzaffarnagar in Uttar Pradesh, and Thanjavur in Tamil Nadu),[3] (*a*) the economic efficiency of all classes of farms has increased and (*b*) that the rates of increase for farms in different acreage classes have varied significantly within and between districts. Thus, whatever the truth about the relative efficiency of the small *versus* large farms in 1955-57 and earlier, this analysis will show that the truth has been modified over time through the dynamics of ongoing agriculture. Further, the analysis suggests that it is at least possible for the "true" relationships of the past to have been reversed over time.

With these indications it will be argued that the dual targets of equity in the distribution of wealth and income and growth in the amount of real income available for distribution may not be simultaneously attained through instruments such as the confiscation and redistribution of land. Indications are, rather, that the tendencies in relative efficiency have or soon will mean that drastic reduction in farm sizes will have a positive opportunity cost in terms of efficiency and, thus, potential output. With the results of this study,

1. Lau and Yotopoulos [17, 18], for example, select 10 acres (4·04 hectares) as the demarcation line. But in the Indian economy of 1954-57, 63·1 per cent of the farms surveyed in the Studies in the Economics of Farm Management were smaller than 10 acres, with more than a third (37·7 per cent) under 5 acres.

2. Comparing average value of output per hectare for farms in different size-classes, as shown in the Studies in the Economics of Farm Management for 1954-57 [8], with the averages in 1968-69, the Studies in the Economics of Farm Management [11] for Uttar Pradesh alone, reveals a rise in productivity of farms with over five acres (2·02 hectares) of the order of 10-12 times (without deflating for price rises). This is considerably greater than the eight-fold increase experienced for farms of under five acres, over the same time period; so that even if the larger farms are still inefficient, this could change in the future.

3. The 1955-57 Studies in the Economics of Farm Management in Madras [6] was for the districts of Salem and Coimbatore. Our results, therefore, will reflect the extent that Thanjavur was different from the two districts at that time.

current and proposed land ceilings can be appraised in terms of efficiency loss for equity's sake.

The Model

Some of the dynamics of the agricultural sector that suggest that the farm operators will show changing efficiency can be briefly and verbally described. The farm operators' available investment funds at any point in time (both their own "cash on hand" and credit availability) would depend on their past incomes and accumulated capital stocks to date. An individual's acquisition of new assets would depend on the size of this investment fund, the degree to which assets are divisible, and the net price per purchasable unit. By acquiring new assets, the farm operators would be able to employ the new technologies embodied in the capital involved and also partially to adjust for any past errors in resource allocation that had come to their attention (in a learn-by-doing process). Changes in the pattern of production, with respect to enterprise type, input type and mix, and technique would thus occur, with the likelihood of greater allocative and technical efficiency.

Over time, a population of farm operators, differentiated by initial farm size, would exhibit differentiated behaviour with respect to their asset acquisitions, enterprise changes, and changes in production technique and input mix. Exhibited differences would reflect, among other things, differences in market bargaining power on both input and output sides (so that it would be different absolute, but similarly moving prices that each adjust for), differences in the per unit prices of inputs with different degrees of divisibility, and differences in constraints imposed by an initial distribution of the resource base.[4] By selecting an arbitrary "starting" and "end" point in time and comparing the economic efficiency of a class of producers at these time points in a comparative static way, one could develop a statistical measure of that class' tendency towards greater efficiency.

A statistical model is available to test whether the operators in a given farm size class have undergone changed economic efficiency relative to operators in the same farm size class of an earlier time. The test was originally developed to determine which operators were relatively more efficient at a point in time [17]. The test equation (Equation 1) takes its shape because the Cobb-Douglas form is assumed to depict a farm's aggregate production function. The equation is the reduced form of a model containing the assumed production function, the technical relationship selected because it fits data best [17, p. 101] and the first-order conditions for profit maximization given input and output prices, and the possibility that the individual might systematically err in his perception of prices and marginal productivity [17, pp. 98-103].

4. Gotsch [4] presents an informative model of the interaction of the initial state of economic and social variables, with the dynamics of socio-political and economic change and with technologies of different characteristics (like divisibility of capital involved, differing capital-labour ratios, and so on), to qualitatively predict the potential impacts of technical changes in allocative and technical efficiency behind income determination.

In the equation, the variable C is, in essence, the "reduced form" parameter representing the entire set of economic dynamics leading to change efficiency described above. It assumes values of zero when data for the starting point are considered and one when data for the end point are considered. The coefficient of C, (γ), indicates whether the operators are more efficient today relative to the past, as efficient today as in the past, or less efficient today compared with the past; by virtue of its being, respectively, statistically significant and positive, statistically not different from zero, or statistically significant and negative. In testing, the null hypothesis is that the operators are as efficient today as in the past or less efficient.

In Equation 1, the value of γ is a measure of the extent of the change in a group's inter-temporal efficiency change. Assuming that it is possible to talk about a measure of economic efficiency as if it were single magnitude without actually quantifying it, γ estimates the natural logarithm of the ratio of economic efficiency after change to the measure before change.[5]

Considering two groups in a given district when each group has had an opportunity to change its state of economic efficiency, a simple "t" test is applied to determine whether there is a significant difference between respective values of γ between groups (Equation 2). The results are a basis for inferring whether a group has altered economic efficiency to a greater or lesser degree, relative to other groups.

$$(1)\quad \ln\pi = \alpha_0 + \gamma C + \delta D + \alpha_1 \ln w + \alpha_2 \ln S + \alpha_3 \ln F + \beta_1 \ln T + \beta_2 \ln K$$

where $\pi = V - TVC$,

$TVC = W + E$,

$w = W/L$,

W = wages actually paid out or imputed,

L = per holding average number of labour days worked, adjusted for the varying contribution of male, female, and child workers, and cropping intensity,

V = value of crops produced per holding annually, imputed and actually received,

S = value of seed per acre, per holding,

5. Equation 1 can be rewritten as
$\pi = (\text{anti-log } \alpha_0)\ (\text{anti-log } \gamma)^C\ (\text{anti-log } \delta)^D\ w^{\alpha_1}\ {}_S{}^{\alpha_2}\ {}_F{}^{\alpha_3}\ {}_T{}^{\beta_1}\ {}_K{}^{\beta_2}$
when anti-log $\gamma = A_1/A_0$.
Let A_1 be the efficiency measure in current time and A_0 be the efficiency measure in past time. The null hypothesis in the test is that $A_1/A_0 \leq 1$. The creation of "data" for the regression in the form of the dummy variable C permits the estimation of the magnitude of the ratio, in fashion that is analogous with the estimation of the log of the intercept (where ones are inserted as "data").

F = value of fertilizer per acre, per holding,

T = number of acres per holding (operational size),

K = per holding capital input (estimated at 3 per cent of per holding owned non-land assets),

C = a dummy variable, assuming values of zero in 1955-57 and one in 1967-69,

E = all other variable costs actually paid or imputed (not including rent, capital charges, or wages),

D = dummy variable used to pool observations in 1955-56 with those in 1956-57 in Uttar Pradesh, and those in 1967-68 with those in 1968-69 in all States.

QUANTIFICATION AND STATISTICAL RESULTS

Two sets of data are used in the analysis. The initial or "before-change" data are drawn from unpublished farm-by-farm accounts that were compiled into the Studies in the Economics of Farm Management [6, 7, 8]. The "after-change" data are taken from the farm-by-farm accounts compiled as part of recent re-surveys and Studies in the Economics of Farm Management [9, 10, 11]. These latter data were unpublished. All data were collected on a cost accounting basis.

The following price indexes were used to deflate the 1968-69 observations to make them comparable in real terms with the 1955-57 observations : the value of crops by the change in price of the major crop in a central market place in the region (wheat in Abohar, Punjab; and Hapur, Uttar Pradesh; rice in Madras, Tamil Nadu) [13, p. 125]; wages paid out, by the index of money wages paid in the respective regions [12, p. 114] ; value of fertilizer by the nation-wide index of prices for fertilizer [14, p. 153 adjusted by price index p. 143]; and capital inputs by the nation-wide index of price for machinery [15, p. 124]. Obviously, other indices could have been employed to deflate seed and other variable costs, but reliable indices were not available at the time of the study (in truth, the "error" that this omission creates in the analysis is likely to be small, owing to the small proportion of total expenses accounted for by seed and "other variable costs").

The farm operator sample in each State in 1967-69 is, simply, divided into five equal classes. This permits one to discuss the tendencies for change shown by the currently largest or smallest (or intermediate) 20 per cent of the farms with respect to other similar classes without defining "large" or "small." The farm-size-class-marks that define the equal fifths in 1967-69 are used to subdivide the specific State's farm operator sample of the 1955-57 Studies in the Economics of Farm Management. Table I contains the class-marks and the number of farms included in each class.

TABLE I—FARM OPERATOR SAMPLE, 1967-69 AND 1955-57, BY ANALYTIC CLASS

Analytic class	Tamil Nadu			Punjab			Uttar Pradesh		
	1967-69 Number	Class-marks (acres)	1955-57 Number	1967-69 Number	Class-marks (acres)	1955-57 Number	1967-69 Number	Class-marks (acres)	1955-57 Number
1	60	under 2·67	43	60	under 14·0	106	60	under 2·3	130
2	60	2·67—4·45	36	60	14·0—21·8	41	60	2·3—11·5	92
3	60	4·45—6·53	31	60	21·8—31·0	30	60	11·5—17·2	41
4	60	3·53—10·95	30	60	31·0—44·5	19	60	17·2—24·1	19
5	60	over 10·95	34	60	over 44·6	3	60	over 24·1	12

Sources: 1955-57 : Studies in the Economics of Farm Management [6, 7, 8].
1967-69 : Studies in the Economics of Farm Management [9, 10, 11].

These deflated and grouped data are used to estimate the coefficients in test Equation 1; one test equation is run for each analytic class in each State, making 15 iterations of the test in all. The estimated coefficients, the standard errors of the estimates, and the estimated R^2s are listed in Tables IIA, IIB, and IIC.

TABLE IIA—ESTIMATES OF COEFFICIENTS OF TEST EQUATION, BY ANALYTIC CLASS—TAMIL NADU

Analytic class[a]	Coefficient estimated[b]								
	α_0	β_1	α_1	α_2	α_3	β_2	δ	γ	R^2
1 (95)	8·0286	·0567* (·0306)	--	+	—	+	+	·2163‡ (·0565)	0·4974
2 (88)	7·1413	1·0572 (·6212)	—	+	+	—	—	—·1909 (·0457)	0·0420
3 (83)	7·3359	·3454‡ (·1280)	—	·0699‡ (·0262)	—	—	·1306‡ (·0377)	·5207‡ (·0893)	0·7748
4 (82)	6·8887	·3742‡ (·1386)	—·0277† (·0114)	·0833† (·0363)	—	·0396* (·0209)	·1171‡ (·0545)	·6567‡ (·1768)	0·7742
5 (80)	6·7948	·3098 (·0086)	+	·1175† (·0491)	—	+	·3112‡ (·0709)	·6389‡ (·2481)	0·7837

a Parentheses contain number of degrees of freedom.
b Parentheses contain estimated standard errors. Non-significant estimates are excluded for use of reading. Signs of these coefficients are presented.
‡ = significant at ·005 level, one tail-test.
† = significant at ·025 level, one tail-test.
* = significant at ·05 level, one tail-test.

TABLE IIB—ESTIMATES OF COEFFICIENTS OF TEST EQUATION, BY ANALYTIC CLASS—PUNJAB

Analytic class[a]	Coefficient estimated[b]								
	α_0	β_1	α_1	α_2	α_3	β_2	δ	γ	R^2
1 (158)	7·8781	+	—	—	—	—	·5020‡ (·1894)	1·0783‡ (·2615)	0·1365
2 (93)	7·4129	—	+	·0005* (·0579)	+	+	·4797‡ (·1076)	·6147‡ (·1526)	0·5807
3 (82)	10·2131	—	·5763* (·3802)	—·4329* (·2553)	+	+	·7916‡ (·3884)	·9896* (·5433)	0·2404
4 (71)	7·0593	+	—1·4849† (·6966)	—	+	+	1·2101† (·5899)	1·8060† (·8311)	0·2227
5 (55)	2·8732	1·0743‡ (·1823)	+	+	·1478† (·0738)	·1405† (·0783)	+	·8467† (·3552)	0·0871

a See footnotes, Table IIA.
b See footnotes, Table IIA.

TABLE IIC—ESTIMATES OF COEFFICIENTS OF TEST EQUATION, BY ANALYTIC CLASS—UTTAR PRADESH

Analytic class[a]	Coefficient estimated[b]								
	α_0	β_1	α_1	α_2	α_3	β_2	δ	γ	R^2
1 (182)	7·9029	·1028‡ (·0280)	—	+	—	+	+	·5555‡ (·0603)	0·6905
2 (144)	6·8833	·3745‡ (·0968)	·3750† (·1522)	·7851† (·0321)	—	·0571† (·0224)	+	·6002‡ (·0822)	0·8804
3 (93)	5·9620	·4605‡ (·1379)	·3774* (·2402)	·1846‡ (·0441)	—·0107† (·0053)	·1064‡ (·0307)	·0849† (·0558)	·6186‡ (·1088)	0·9318
4 (71)	4·9132	1·0168‡ (·3184)	·3527* (·2000)	·1043‡ (·0534)	—	·2232‡ (·0677)	·2272‡ (·0677)	1·0640‡ (·1200)	0·8730
5 (64)	5·2251	·7016‡ (·1034)	·6541† (·2541)	·1512† (·0598)	+	·0743* (·0359)	·1821‡ (·0538)	·9056‡ (·1348)	0·9300

a See footnotes, Table IIA.
b See footnotes, Table IIA.

A separate analysis is conducted to determine whether the estimates of γ for each analytic class within a given district are statistically different. The null hypothesis is that the values of γ for all classes in a State are equal, so that the difference between them is zero. The test employed [20] permits one to reject the null hypothesis when an estimated value of "t" (see Equation 2) is different from zero (hence, conclude that the estimated γ's are different).

Ten iterations of the test are required to test each value of γ against all other values within a given district. The estimated values of the test "t", are given in Table III.

TABLE III—TEST VALUES OF "t" IN DETERMINATION OF WHETHER $\gamma i = \gamma j$, $(i \neq j)$, BY DISTRICT

Analytic class "i"	Analytic class "j"			
	2	3	4	5
		TAMIL NADU		
1	·4072	—·3044‡	—·4404‡	·4226†
2		—·7116*	—·8476*	—·8298*
3			·1360	·1182
4				·0178
		PUNJAB		
1	·4636†	·0887	—·7277*	·2316
2		—·3749*	—1·1013†	—·2320
3			—·8164	·1429
4				·9593*
		UTTAR PRADESH		
1	—·0447	—·0631	—·5085‡	—·3501‡
2		—·0184	—·4638‡	—·3054‡
3			—·4454‡	—·2870†
4				·1584

‡ t value sufficient to reject null hypothesis ($\gamma i = \gamma j$) at 99 per cent level.

† t value sufficient to reject null hypothesis ($\gamma i = \gamma j$) at 95 per cent level.

* t value sufficient to reject null hypothesis ($\gamma i = \gamma j$) at 90 per cent level.

Negative sign indicates that $\gamma j > \gamma i$; that is, the efficiency tendency is greater in jth analytic class.

$$(2)\quad t = \frac{\gamma_i \quad \gamma_j}{\sqrt{s_p}} \qquad i \neq j \qquad \begin{matrix}(i = 1, 2, 3, 4, 5)\\ (j = 1, 2, 3, 4, 5)\end{matrix}$$

$$\text{where } s_p^2 = \frac{(n_i - k_i)\, s_i^2 + (n_j - k_j)\, s_j^2}{(n_i - k_i) + (n_j - k_j)} \qquad i \neq j$$

s_i^2 = variance of estimated γ_i for ith analytic class.

$(n_i - k_i)$ = degree of freedom in the analyses $(k_i = k = 8)$.

THE RESULTS CONSIDERED

Even though some of the equations do not explain as much of the variation in "profit" (π) as might be desirable in an equation used for prediction, the γ's (the coefficients of C, the inter-temporal efficiency dummy variable) generally are significantly greater than zero (recall that the null hypothesis was that γ would be equal to, or less than, zero). This indicates that except for one or two groups, the operators in analytic classes demonstrate measureable increases in efficiency over time. The increases have been considerable among some Punjab farmers, good in Uttar Pradesh, and modest in Tamil Nadu (see Table IV).

TABLE IV—ESTIMATED MULTIPLE GAIN IN ECONOMIC EFFICIENCY,* BY ANALYTIC GROUP: 1955-57 TO 1967-69

Analytic group	Tamil Nadu	Punjab	Uttar Pradesh
1	1·24	2·94	1·75
2	0·98	1·85	1·83
3	1·69	2·69	1·86
4	1·03	6·09	2·90
5	1·89	2·33	2·47

* Estimated by taking the natural anti-log of the estimated values of γ as reported in Tables IIA, IIB, and IIC.

The question remains, however, as to whether it has been the relatively larger or smaller farm operators who have gained faster. If the smaller farm operators have gained most rapidly, then, assuming that they were initially more efficient, there would be every reason to agree with the traditional wisdom supporting land reform with any ceiling on holding size (*i.e.*, this instrument

of public policy could yield *both* better use of scarce agricultural resources from the viewpoint of realizing growth potential *and* better distribution of resources viewed from the standpoint of equitable distribution of wealth and income). The small farm operators would be, now, even more efficient relatively to the large-farm operators than in the past.

But if it is the relatively larger farm operators who have gained economic efficiency more rapidly, the traditional wisdom no longer automatically holds. Assuming that the relatively larger farm operators began the 'sixties in a relatively less efficient position, would not exclude the possibility of their having closed whatever efficiency gap there may have been. Indeed, they could have become *as efficient as* the small farm operators, or (what is possibly more likely) surpassed the smaller farm operator to become relatively *more* efficient over the decade.[6] In these circumstances, policies like land reform would no longer attain the targets of equity and growth as if they were complementary, but would bring greater equity only at the cost of efficiency. The magnitude of the efficiency cost would, moreover, depend on the level of the ceiling.

The results of the second test (generated in Equation 2, and tabulated in Table III) show that in spite of there being sizable cross-district variation in efficiency growth, the main beneficiaries of change over the decade have been the farms that comprise the top 40-60 per cent of farms by current holding size. Indeed, in all districts, it has been the second-to-the-largest-farm size two-decile class that has gained most rapidly. This is particularly evident in Punjab and Uttar Pradesh, but also true in Tamil Nadu where the largest and third largest two-decile classes appear, at most, to have gained efficiency as fast as the second largest two-decile class.[7]

There is, therefore, in all of the three districts analysed, a very real possibility of efficiency loss (with the resultant loss in real income growth) if the ceilings on operational holding size are too low. What this critical level is, and whether or not the possibility will become a reality, depends on the ceiling chosen in each State.

Our results suggest that land ceilings *below* 4.5 acres in Tamil Nadu, 31 acres in Punjab, and 17 acres in Uttar Pradesh would create an oppor-

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6. If the large farm operators had not already surpassed the smaller farm operators, one faces the problem of predicting when they would, or indeed, if they would. Also, there is a problem of predicting whether the small farm operators would spurt ahead in the future, regaining equal efficiency status with the larger farm operators. The latter event would not likely to arise, however, since it would be highly unlikely that a lagging individual who was initially constrained from becoming more efficient would suddenly find these constraints removed without specific government programmes for him. We comment on this further, later.

7. Parenthetically, it should be pointed out that the gain in efficiency experienced by the small farm operators in the Punjab *supports* the view that the efficiencies have tended to be gained by the *larger* farm operations. Frankel has observed [3, p. 36] that there is a reasonably large incidence of small landowners "renting out" their land (but still working it) under share arrangements with already larger landowners, in order to overcome the land and capital constraints that prevents their independent realization of greater efficiencies (technically speaking in this case). It is indeed possible that the revealed increase in small farm efficiency would not be there if there *had* been limits on the size of operational holdings.

tunity cost in efficiency. But fortunately for the cause of efficiency and growth, proposals are for ceilings that are above these critical levels. The directive of the Central Agriculture Ministry (for the Central Land Reforms Committee) is that 'the ceiling for a family of 5 members may be fixed within the range of 10 to 18 acres of perennially irrigated acres, or land under assured irrigation from government sources capable of growing two crops."[8] With allowances for the administrative conversion of unirrigated to irrigated acres the recommendation seem to exceed the critical levels in Tamil Nadu and Uttar Pradesh.

When considering the proposals of State Governments, the picture appears even brighter for efficiency. In Tamil Nadu the proposed ceiling is 15 "standard acres" (combined irrigated and unirrigated acres);[9] the Uttar Pradesh proposal calls for about 18 irrigated acres with an unirrigated acre counted as two-thirds of an irrigated acre;[10] and the Punjab cabinet has already approved a ceiling of 17.5 acres irrigated with two crops (effectively 35 acres by the measure of operational holding used in this study) or 27 acres irrigated with one crop.[11] All of these proposals include a family size variable and other provisions that will alter the allowable size of farm for any given family.

SIGNIFICANCE AND CONSEQUENCES OF THE TRENDS

With the added assumption that, given prices, all producers are efficient resource allocators, the results of the preceding analysis can be interpreted as indicating the growing possibilities of technical economies of scale in Indian agriculture, for wheat as well as rice production. Whether these possibilities have yet been fully exploited or not is not proved in this study. But the consequences of these emerging possibilities for land reform and other programmes are clear.

For example, a land reform programme that redistributed the title to land, but not the use of it, could conceivably serve to remove some of the inequalities in the distribution of income (to the extent that rent is a significant part of total income). The transfer of title to land away from a large landowner might thus be viewed as a once-and-for-all tax on the life-time income stream of the large landowner, and a once-for-all transfer payment to the recipient. These policy gains would not automatically lead to reduced productivity as long as the attitudes of those losing title were not turned away from profit maximization. On the other hand, if the land reform programme limited land *use*, then a ceiling that was too low would be sufficient to create opportunity costs in efficiency and growth for the sake of equity.

8. *Economic and Political Weekly*, Vol. VII, No. 10, May 6, 1972, p. 915.
9. *The Times of India*, August 13, 1972.
10. *Economic and Political Weekly*, Vol. VII, No. 29. July 15, 1972, p. 1347.
11. *The Times of India*, September 27, 1972.

Evidently, to the extent that our definition of farm size and that used in the recommendations of the State Governments for land ceilings are consistent, the State planners and policy-makers have, at least implicitly, taken considerations of emerging economies of scale into account in their decisions. Indeed, one might congratulate them for performing the near-perfect feat of satisfying the people's demands for a land reform programme (a programme that would be unworkable at *any* ceiling owing to the scarcity of land in the first place [2, p. 108]) while making the programme economically harmless. Of course, this manoeuvre still leaves the serious problems of the inequitable distribution of income unsolved.

Of additional interest and consequence is the indicated similarity in the results of analyses (at least quantitatively) that it is the larger farm operators who have gained efficiency more rapidly in Tamil Nadu, as well as in Punjab and Uttar Pradesh. But with Thanjavur being under the Intensive Agricultural Development Programme for the past decade, one would have expected the rates of efficiency growth to be equal (statistically) for all farm sizes (since this condition would be necessary if income disparities are not to grow and, to a large degree, IADP represents an attempt to programme an equity policy). It is apparent in the analysis, however, that this agricultural development strategy (the Package Programme) has not yielded qualitatively different results than the development strategy to simply promote output increases without regard for the possible inequity in the distribution of the gains (as has been the seed-fertilizer-water strategy for wheat production). A possible explanation of this is that the methods of distribution of resources under the package programme essentially treat each area as if it were in the same initial condition and regardless of what sized farm includes it. uBt, it should be clear that the acres on the small farms would need extra "help" in order to overcome their initial production disadvantage compared with the acres on the large farms that produce with some scale economies. Thus, for a package programme to attain an equity goal, it should give special treatment to the small or lagging farm operators.

The most significant consequence of the differentiated tendencies in efficiency, however, is that they indicate that pressure will continue to exert itself to perpetuate an already inequitable distribution of personal or family income. The pressure is intensified as the inequitably distributed resource base becomes even less equitably distributed over time (under the influence of differentiated resource-buying behaviour) without a compensating shift in relative efficiency (that is, a shift favouring the small farm operators). Even expanding markets will not allow the initially lagging producers to gain income relative to the initial leaders, since the leaders will always gain at least a larger absolute share of markets (if not larger relative share) (see a proof in [19]). While the transfer of land under the current proposed land reform programmes will probably not lead to sacrificed growth potential (although lower ceilings than those proposed clearly would), the policy itself

will only improve equity if there is enough land to redistribute and if other resources are also redistributed (like seeds, fertilizer, water rights, and capital).

In the light of these difficulties, it pressses on the policy planners to investigate other means of attaining equity, through tax-transfer schemes, support for public services and so on. In effect, the need seems to be to develop distribution systems that are somewhat divorced from production systems if both maximum growth and desired equity are to be simultaneously attained.

REFERENCES

1. Jagdish N. Bhagwati and Sukhamoy Chakravarty, "Contributions to Indian Economic Analysis: A Survey," *The American Economic Review*, Vol. LIX, No. 4, Part 2, Supplement, September, 1969, pp. 2-73.
2. V. M. Dandekar and Nilakantha Rath: Poverty in India, Ford Foundation, New Delhi, December, 1970.
3. F. R. Frankel: India's Green Revolution: Economic Gains and Political Costs, Princeton University Press, Princeton, 1971.
4. C. H. Gotsch, "Technical Change and the Distribution of Income in Rural Areas," *American Journal of Agricultural Economics*, Vol. 54, No. 2, May, 1972, pp. 326-341.
5. W. D. Hopper, "Allocative Efficiency in a Traditional Indian Agriculture," *Journal of Farm Economics*, Vol. 47, No. 3, August, 1965, pp. 611-624.
6. India, Government of: Studies in the Economics of Farm Management, Madras, 1956-57, Directorate of Economics and Statistics, Ministry of Food and Agriculture, New Delhi, 1958.
7. India, Government of: Studies in the Economics of Farm Management, Punjab, 1956-57, New Delhi, 1957, 1958.
8. India, Government of: Studies in the Economics of Farm Management, Uttar Pradesh, 1955-56, 1956-57, New Delhi, 1957, 1958.
9. India, Government of: Studies in the Economics of Farm Management, Punjab, 1967-68, 1968-69, Part II Tables, New Delhi, 1971.
10. India, Government of: Studies in the Economics of Farm Management, Tamil Nadu, 1967-68, 1968-69, Part II Tables, New Delhi, 1971 (typewritten).
11. India, Government of: Studies in the Economics of Farm Management, Uttar Pradesh, 1967-68, 1968-69, Part II Tables, New Delhi, 1971 (typewritten).
12. India, Government of : Modernizing Indian Agriculture, Volume I, New Delhi, 1969.
13. India, Government of : Indian Agriculture in Brief, Tenth Edition, New Delhi, 1970.
14. India, Government of : Economic Survey of Indian Agriculture 1967-68, New Delhi, 1970.
15. India, Government of: Economic Survey 1970-71, Cabinet Secretariat, New Delhi, 1971.
16. Bruce F. Johnston and John Cownie, "The Seed-Fertilizer Revolution and Labour Force Absorption," *The American Economic Review*, Vol. LIX, No. 4, September, 1969, pp. 569-582.
17. Lawrence J. Lau, and Pan A. Yotopoulos, "A Test for Relative Efficiency and Application to Indian Agriculture," *The American Economic Review*, Vol. LIX, No. 1, March, 1971, pp. 94-108.
18. Lawrence J. Lau and Pan A. Yotopoulos: A Simultaneous Equation Approach to Relative Efficiency, Memorandum 104, Research Center in Economic Growth, Stanford University, Stanford, 1970.
19. U. K. Srivastava, R. W. Crown and E. O. Heady, "Green Revolution and Farm Income Distribution," *Economic and Political Weekly*, Vol. VI, No. 52 (Review of Agriculture), December 25, 1971, pp. A-163—A-172.
20. Helen M. Walker and Joseph Lev : Elementary Statistical Methods, Third Edition, Holt, Rinehart, and Winston, Inc., New York, 1969.