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## INTERNATIONAL AGRICULTURAL TRADE AND DEVELOPMENT CENTER

A COMPARISON OF THE EFFICIENCY OF PRODUCERS  
UNDER COLLECTIVE AND INDIVIDUAL  
MODES OF ORGANIZATION

By

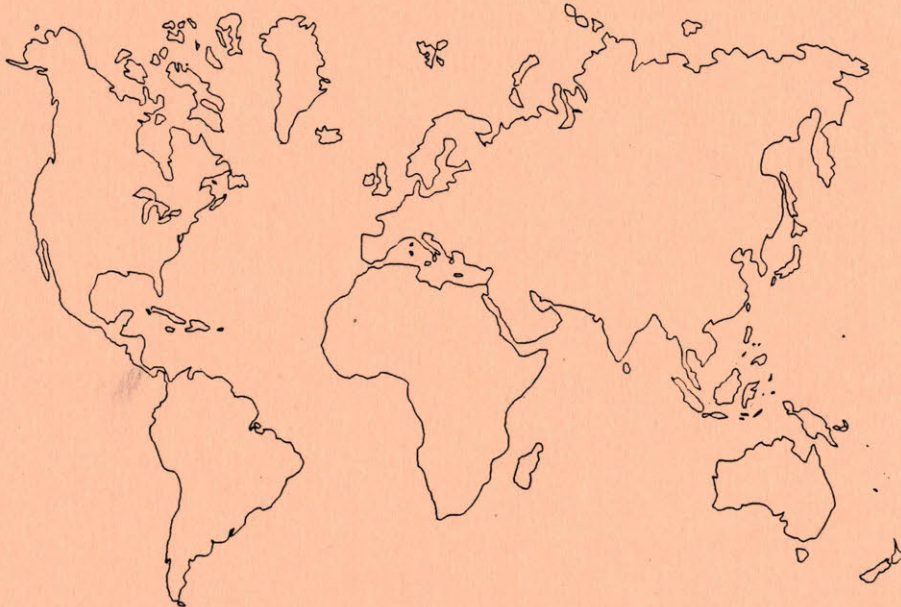
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**MISSION AND OBJECTIVE  
OF THE  
INTERNATIONAL AGRICULTURAL TRADE  
AND DEVELOPMENT CENTER**

**MISSION:**

To enhance understanding of the vital role that international agricultural trade plays in the economic development of Florida, and to provide an institutional base for interaction on agricultural trade issues and problems.

**OBJECTIVE:**

The Center's objective is to initiate and enhance teaching, research, and extension programs focused on international agricultural trade and development issues. It does so by:

1. Serving as a focal point and resource base for research on international agricultural trade, related development, and policy issues.
2. Coordinating and facilitating formal and informal educational opportunities for students, faculty, and Floridians in general, on agricultural trade issues and their implications.
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4. Encouraging interaction between the University community and business and industry groups, state and federal agencies and policy makers, and other trade centers in the examination and discussion of agricultural trade policy questions.

# **A Comparison of the Efficiency of Producers Under Collective and Individual Modes of Organization**

by  
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JEL classification code: P13 Cooperative Enterprises

**Keywords:** Cooperative, Technical and Allocative Efficiencies, Stochastic Production Frontier, Individual Versus Collective Production

**Abstract:** This paper compares the technical and allocative efficiencies of collective and individual production systems. The producers under study are members of Honduran agrarian reform cooperatives who engage in collective and/or individual production of maize. Debreu-Farrell technical efficiencies are calculated relative to a stochastic production frontier. Allocative efficiencies are obtained from an analytically derived cost frontier. Results indicate that collective systems are slightly more efficient than individual production systems.

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# **A Comparison of the Efficiency of Producers Under Collective and Individual Modes of Organization**

## **Introduction**

The cooperative mode of production has long held theoretical benefits that are appealing to socialist and developing countries. Cooperatives have been promoted to achieve economies of scale and introduce new technologies beyond the reach of small, independent producers. They have also been favored as a means of organizing and integrating low-income and geographically dispersed rural people into modern forms of social and economic interaction.

Unfortunately, the theoretical potential of cooperatives has been superseded by the dismal level of their failures. Indeed, the term "collective" is rarely heard in the popular and business media without pejorative antecedents: "inefficient," "lethargic," "bureaucratic-heavy," etc.. Many of the economic problems of formerly communist countries, and of poorly performing developing countries, are attributed to the waste incurred by collective organizations.

Inefficiency obviously exists in cooperatives, but its precise origins are unclear. Furubotn and Pejovich (1970) predicted that cooperatives would degenerate in a capitalist environment as worker/owners have relatively less incentive to make long-run capital investments. However, cooperatives in East Asia, France, Italy, and the former Yugoslavia have notable success records. And recent studies from Northern Italy (Bartlett, et al. 1992), and the former Yugoslavia (Boyd, 1987; and Piesse, et al., 1996) suggest that cooperatives may, in fact, be more efficient than private enterprises.

Conventional wisdom has attributed the inefficiencies of collectives to "shirking," or the abdication of personal work responsibilities. However, it is not clear whether shirking is most

detrimental at the worker or management level. Alchian and Demsetz (1972) conjectured that individuals in a collective enterprise lack adequate incentive to monitor coworkers because they do not receive the residual claim awarded to managers of private firms. Even if one member is appointed the task of monitoring, they argue, the monitor/manager has no authority to hire and fire, and has no incentive to efficiently utilize and maintain capital investment because the individual portion of capital returns is less than the personal trade-off between labor and leisure. Jensen and Meckling (1979) argue shirking inefficiencies are most problematic at the level of management. They consider it "naive" to believe that managers of collectives would take the same pains to "seek out high pay-off new projects, to weed out projects which have negative pay-offs, to control waste and shirking, etc." without an additional claim on returns.

The distinction between worker shirking and management shirking is important.

Widespread shirking by workers may be an exogenous social characteristic unresolvable by policy modifications because it involves substantial monitoring costs. The successes of the Israeli Kibbutz, for example, as well as Amish and Hutterite communities in the United States, are often attributed to pre-existing religious bonds that significantly reduce monitoring costs. Management inefficiencies, on the other hand, may be overcome through restructuring and incentive realignments.

Different sources of shirking generate characteristically different inefficiencies. If shirking is so extensive at the worker level that it over-rides gains achieved from economies of size procured through collectivization, technical efficiencies will be lower on collective systems than individual systems. In other words, laborers systematically relinquish work to other members of the collective to the extent that the level of output obtainable from a given set of

inputs will be less under the collective system than the individual. Scale efficiencies become immaterial.

Allocative efficiency, on the other hand, depends on the optimal selection of input combinations. Input selection is primarily a function of management decisions and input markets. Allocative efficiency can be diminished by poor management or by friction in input distribution systems, which are notably inefficient in developing countries. Labor shirking is less likely to surface in allocative efficiency measures because input selection must occur prior to input utilization. By the same token, nothing precludes any set of inputs from being used in a technically efficient manner.

One could argue that if labor resources are missallocated so that the training skills within people are mismatched with assigned tasks, allocative inefficiency could be incorrectly attributed to the technical side. The prospect of such missallocation increases as production systems become more complex and labor is divided into a greater number of specific tasks that require training. Fortunately, this study analyzes basic maize production in Honduras, a system which has not changed dramatically from traditional practices and in which exists few divisions of labor.

Most research on issues related to collective versus individual production has been based on heuristic insights or theoretical models.<sup>2</sup> Empirical studies are rare because data sets on both forms of organization are difficult to acquire. Moreover, all previous empirical studies examined cooperatives that were comprised of individuals who did not own the private enterprises against

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<sup>2</sup>See Prychitko and Vanek, 1996, for a thorough review of cooperatives and labor managed firms.

which the cooperatives were compared. Collectives were compared to individual enterprises in industries whose managers and workers were confined to one of the two organizational modes. Comparing organizational modes within specific regions eliminates cultural and institutional differences which muddle cross-regional comparisons. However, they do not account for human capital differences which are fundamental to cooperative undertakings. Differences in education, training, familial background, and socio-political orientation can affect the performance of economic enterprises and may constitute the basis for forming a particular organizational structure.

This paper compares the technical and allocative efficiencies of the same producers working in alternative modes of production, collective and individual. The study examines production plots in Honduran agrarian reform cooperatives. Some basic grain coops in Honduras produce on exclusively individual or collective bases. However, the majority operate under both modes of production.

Technical efficiency comparisons enable the testing of Alchian and Demsetz's hypothesis that collective modes of worker organization induce shirking at the level of the laborer. If widespread labor shirking occurs, which is often conjectured about Honduran basic grain cooperatives, it will dampen the technical efficiency of collective parcels vis à vis individual parcels. On the other hand, if technical efficiencies are not greater on individual parcels, it will suggest that collective production is a viable mode of worker organization and that cooperative failures are more attributable to mismanagement, a shortcoming that may be overcome by the reorganization of management responsibilities.

The next section describes the methodology of estimating a stochastic frontier production



function and in deriving Debreu-Farrell technical and allocative efficiencies. The third section presents the specific form and data used to estimate the production function. The fourth section presents and discusses the results. The final section summarizes the findings and their implications.

### **Technical and Allocative Efficiency**

The most widely used efficiency measures are rooted in the writings of Debreu (1951) and Farrell (1957). The Debreu-Farrell measure of technical efficiency (TE) is defined as the equiproportionate reduction of all inputs that produces a demonstrated optimal level of outputs. Conventionally, it is measured as the ratio of observed output to optimal output for a given set of inputs.

$$TE = \frac{q(x)}{q^*(x)} \quad (1)$$

where  $x$  are inputs,  $q(x)$  is the actual level of output and  $q^*(x)$  is the optimal level of output. A value of unity represents 100 percent efficiency and values less than one indicate the level of inefficiency.

Following the approach proposed by Farrell (1957), the optimum level of output for a given level of inputs,  $q^*(x)$ , is determined by estimating the "best practice" or frontier production function<sup>3</sup>. Prior to the emergence of frontier functions, the conventional production function model that was estimated took the form

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<sup>3</sup>For an excellent review of the theoretical and empirical aspects of technical and allocative efficiencies, as well as the frontier production functions upon which they are based, see Fried, Lovell and Schmidt (1993).

$$q = q(\mathbf{x}) + e \quad (2)$$

where  $\mathbf{x}$  is a vector of inputs and  $e$  is the random error. OLS necessarily assumes the expected value of the disturbance term,  $e$ , is zero because it estimates parameters by minimizing the sum of the squared errors. However, neo-classical production theory defines the production function as the *maximum* output obtainable from a given set of inputs. In the absence of random error, observed levels of output cannot exceed the theoretical maximum. Farrell's initial approach, and subsequent "full" frontier estimations of  $q^*(\mathbf{x})$  constrain  $e$  to be non-negative, attributing all deviations from the production frontier to inefficiency, precluding random events.

The "stochastic frontier" (Aigner, Lovell and Schmidt, 1977; Battese and Corra, 1977; and Meeusen and van den Broeck, 1977) accounts for random error and has been used extensively in examining production efficiency.<sup>4</sup> Unlike full frontier estimations, the stochastic frontier allows for random deviation from the frontier owed to measurement error or events beyond the control of the producer. The error term of the production function in the stochastic frontier is comprised of two components:

$$e = v - u \quad (3)$$

where  $v$  has a symmetric distribution which captures random effects and exogenous shocks across firms; and the one-sided error,  $u \geq 0$ , captures technical efficiency of a firm relative to the stochastic frontier. Thus, the estimated frontier accounts for stochastic characteristics likely to

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<sup>4</sup>Stochastic frontiers have been used in LDC's to measure the effectiveness of credit programs (Ekanayake, 1987; and Taylor, Drummond and Gomez, 1986). Several studies examined extension programs (Kalirajan and Shand, 1985; Kalirajan, 1984; Kalirajan and Finn, 1983; and Bravo-Ureta and Evenson, 1994) and education (Kalirajan, 1990; and Pinheiro, 1992). The stochastic frontier has also been used to identify firm and managerial characteristics that influence efficiency (Seale, 1990).

affect any production system, isolating systematic effects in the measurement of technical inefficiency.

Although Aigner et al. (1977) distinguished the variances of  $u$  and  $v$  within the residual  $e$  for the entire data sample, they were not able to decompose the residual into its individual components for *each observation*. Efficiency scores were calculated as averages for the entire sample. Decomposition of the variances for each observation, a distinguishing attribute of mathematical programming techniques, remained beyond the scope of statistically estimated frontiers until Jondrow et al. (1982) derived the conditional distribution  $(u_i|e_i)$ . By specifying a functional form for the distribution of  $u$  given the composed error term  $e$ , Jondrow et al. demonstrated that point estimates of efficiency are obtainable for each observation. These indirect estimates of  $u$  can be shown to be unbiased. However, they are not consistent because with a mean truncated at zero the variance of the coefficients can never be zero.

Analogous to technical efficiency, a measure of "economic efficiency" (EE) is obtained from the ratios of minimum observed total cost to actual total cost

$$EE = \frac{c^*(q^*, w)}{c(q, w)} = TE * AE \quad (4)$$

where  $c(q, w)$  is actual cost incurred to produce  $q$  at input prices  $w$ , and  $c^*(q^*, w)$  is the minimum level of cost incurred to produce  $q^*(x)$ . Values less than one denote the level of economic inefficiency. Economic efficiency is the product of technical and allocative efficiency (AE), as it requires both the optimum level of physical output for a given set of inputs and the optimum

input mix given input prices. A measure of allocative efficiency is thus obtainable from technical and economic efficiencies:

$$AE = \frac{EE}{TE} \quad (5)$$

In the case of the Cobb-Douglas functional form, it is not necessary to statistically estimate the dual cost frontier,  $c^*(q^*, w)$ , as it can be analytically derived from the production function. The cost function is a dual representation of the production technology (Shepard, 1970), thus coefficients from the frontier production function can be incorporated into the frontier cost function,  $c^*(q^*, w)$  (Kopp and Diewert, 1982).<sup>5</sup>

### Empirical Model and Data

The Cobb-Douglas model was selected as the functional form for the empirical analysis. Although considered restrictive in some instances, the Cobb-Douglas has been used extensively in agriculture in both developed and developing countries. As interest is centered on efficiency measurement rather than specific relationships concerning the structure of production, this choice is appropriate. Moreover, functional form has been shown to have minimal impact on efficiency

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<sup>5</sup>In the case of the Cobb-Douglas production function:

$$q(x) = Ax_i^{\beta_i}$$

the dual cost frontier is:

$$c^*(q, w) = kw_i^{\alpha_i} q^m.$$

where  $w$  is the vector of input prices. The cost function parameters  $\alpha$  and  $m$ , are analytically derived directly from the estimated parameters of the production function where:

$$\alpha_i = m\beta_i, \quad m = (\sum_i \beta_i)^{-1}, \quad \text{and} \quad k = \frac{1}{m} [\hat{A} \prod_i \beta_i^{\beta_i}]^{-m}.$$

estimates (Kopp and Smith, 1980). The Cobb-Douglas can also be analytically inverted into its dual cost function, facilitating the calculation of allocative efficiencies. For present purposes, the Cobb-Douglas takes the form:

$$q = A \prod_{i=1}^k x_i^{\beta_i} \prod_{i=1}^m h_i^{\alpha_i} \prod_{i=1}^n o_i^{\gamma_i} u = q^* u, \quad 0 \leq u \leq 1 \quad (6)$$

where  $q$  is a producer's output,  $A$  is a given level of technology,  $x_i$  represents the set of  $i = 1 \dots k$  inputs and the  $\beta_i$ 's are the corresponding input coefficients. The standard production function estimates output,  $q$ , solely as a function of physical inputs  $x_i$ . However, Jensen and Meckling (1979) suggested an extended form of the production function which recognized that production did not occur in a physical vacuum. Knowledge  $h_i$  (human capital) and "organizational forms"  $o_i$  also influence the level of output by their parameters  $\alpha_i$  and  $\gamma_i$  respectively. Frontier output,  $q^*$  is reduced by the systematic inefficiency,  $u$ .

Data were gathered from agrarian reform cooperatives in the contiguous El Paraíso and Olancho regions of Honduras. Over 400 farmers belonging to 27 cooperatives were surveyed. Individual production data were collected by literate coop members or children of coop members trained in each cooperative to maintain investment records on all activities pertaining to individual land parcels. Cooperatives provide an excellent network for collecting individual data from a large number of farmers. The data cover a cross-section of collective and individual production parcels for one maize growing season, 1988-89. Fortunately, good to average rains occurred during the data gathering period.

Each coop participated in an extension program offered by Honduran Integrated Pest Management program (Spanish acronym, MIPH), sponsored by the Pan-American School of Agriculture in Zamorano, Honduras. Most coops received some form of extension assistance, but 20 percent of the coops served as a control group and received none. The type of extension service they received was randomly determined. Trained agronomists visited the groups on a regular basis to give lectures or supply printed information. MIPH focused on common problems faced by basic grain producers and suggested cost-effective means for overcoming them. Amiable assistance from MIPH and government agronomists was invaluable in corroborating data and understanding the various institutions influencing cooperative operations.

The specific variables included in the model along with their mean values and standard deviations are shown on Table 1.

The variables fall into three categories, traditional physical input variables, extension variables and institutional variables. *Land, Labor, Seed, Fertilizer, Herbicide, and Landprep*, represent traditional inputs. Since the model being estimated is the Cobb-Douglas, continuous variable inputs are in natural log form. All extension techniques are included in the model as binary variables.

*Collectivity*, the variable representing organizational form (Jensen and Meckling, 1979), is calibrated according to the point in the production season at which collective operations are yielded to the individual responsibility of each coop member. *Collectivity* is included because the extent of collective work differed across coops. All agrarian reform cooperatives were

Table 1. Variable List

Variable	Coefficient	Mean	Standard Deviation
<b>Traditional Variables</b>			
Technology (A)	Constant		
<i>Land</i>	Land measured in <i>manzanas</i> *	3.63	10.40
<i>Labor</i>	Labor measured in work days	89.63	263.20
<i>Seed</i>	Seed measured in pounds	132.14	451.68
<i>Fertilizer</i>	Fertilizer measured in quintals	11.39	43.39
<i>Herbicide</i>	Herbicide measured in pounds	9.55	26.42
<i>Landprep</i>	Total cost of land preparation	296.83	990.87
<b>Institutional Variables</b>			
<i>Collectivity</i>	Degree of collective work arrangements**	.24	.22
<i>Paraíso Region</i>	= 1 if producer is from the region of El Paraíso, 0 otherwise.	.61	
<b>Extension Variables</b>			
<i>Lecture</i>	= 1 if coop received extension lectures without additional teaching aids, 0 otherwise	.21	
<i>Publication</i>	= 1 if coop received printed extension publications and no personal lecture, 0 otherwise	.11	
<i>Lectureaid</i>	= 1 if coop received lectures accompanied by electronic visual aids, 0 otherwise	.23	
<i>Lecturepub</i>	= 1 if coop received both lectures and printed extension publications, 0 otherwise	.25	

\**Manzana* = 0.705 hectare

\*\*Parcels used completely in the collective mode are scored as one, those planted prior to parcelization are scored as one half, and those for which the only collective activity land preparation are scored as one fourth. Completely individual production is registered as zero.

initially established primarily as collective operations, but because of widespread financial breakdowns which were often attributed to collective production, coops began to experiment with broadening the scope of individual production. Some coop parcels were completely individual, others initiated the production season collectively, but later parceled collective plots to individual members, and some were completely collective. The *Collectivity* variable represents the point of time in the production season at which collective production was yielded to individual production.

Extension factors are included because coops agreed to participate directly in an extension program and were taught under distinct extension techniques, each of which may influence the frontier differently. In many extension studies, binary variables are included for particular areas where extension is provided, but farmers may not have had direct exposure to those services. All the participants in this study, with the exception of a control group, received a specific form of extension service. If certain forms of extension were better than others in improving efficiency, than coops benefiting from those forms are held to a higher frontier than those who were not. This reduces the influence of excluded variables that may be the real source of efficiency for particular coops and clarifies the comparison of efficiencies across coops.

### **Empirical Results**

Two alternative stochastic specifications, the half-normal and exponential distributions are assumed for the one-sided error,  $u$ , in estimating the frontier function. The distinct effect each distribution has on the frontier is not well known (Bauer, 1990), but Greene (1990) suggests that there is not much difference between the two. Maximum likelihood estimates and technical



and allocative efficiencies were estimated using the LIMDEP software program.

Table 2 displays ordinary least squares (OLS) and maximum likelihood (ML) estimates of the stochastic frontiers. The Cobb-Douglas model fits the data well. The  $R^2$  of the OLS is 0.88. All but one of the standard physical input variables, herbicide, are significant at the 0.01 probability level for all three regressions. The coefficients on *Collectivity* and *Paraíso Region* are positive and significant at the 0.01 level of probability for all estimations. All but one of the extension variables is significant at the 0.1 level of probability in the frontier functions.

Estimates of Cobb-Douglas production functions are elasticities of output with respect to variable input. The elasticity on *Land* is the largest in magnitude, over four times greater than the next highest variable input elasticity, on *Labor*. The land elasticity is also 0.09 greater in the frontier functions than in the average function, suggesting that the best practice farmers obtain more output per land than other farmers. The seed elasticity is 0.06 less in the frontier functions than in the average function, which implies that farmers below the frontier could improve overall efficiency by using more seeds. Maize production is emerging from traditional slash and burn methods in which land was abundant enough to allow soil rejuvenation cycles and seeds could be used more extensively. In the present systems, more efficient farmers use more seeds. The other variable input elasticities show less than 0.01 change between frontier and average functions.

The positive parameter estimates on *Collectivity* suggest that organizing work in a collective manner increases the *potential* for obtaining more output from given levels of input. The general effect of collectivization on all producers in the study is examined below through the comparison of technical and allocative efficiencies of each production system.

Table 2

## Maize Production Functions

Variable	OLS	Frontier	
		Half-Normal	Exponential
<i>Constant</i>	2.295*** (9.938)	2.806*** (14.49)	2.800*** (15.74)
<i>Land</i>	0.464*** (7.028)	0.556*** (10.78)	0.559*** (11.36)
<i>Labor</i>	0.129*** (3.287)	0.122*** (4.317)	0.123*** (4.557)
<i>Seed</i>	0.175*** (3.010)	0.116*** (2.690)	0.115*** (2.732)
<i>Fertilizer</i>	0.035*** (2.889)	0.023*** (2.540)	0.022*** (2.511)
<i>Herbicide</i>	0.016** (2.222)	0.011* (1.693)	0.010* (1.688)
<i>Land Preparation</i>	0.044*** (2.533)	0.049*** (3.738)	0.050*** (3.921)
<i>Collectivity</i>	0.112*** (6.900)	0.085*** (5.997)	0.086*** (6.258)
<i>Paraiso Region</i>	0.151*** (3.691)	0.099*** (2.872)	0.095*** (2.854)
<i>Lecture</i>	0.052 (0.861)	0.020 (0.336)	0.015 (0.271)
<i>Publication</i>	0.212*** (3.065)	0.129** (2.088)	0.125** (2.089)
<i>Lectureaid</i>	0.039 (0.67)	0.093* (1.717)	0.097* (1.830)
<i>Lecturepub</i>	0.171*** (2.756)	0.131** (2.209)	0.127** (2.230)
$\mu/\sigma$		2.856 (0.704)	
$\sigma_u/\sigma_v$		5.098** (2.124)	
$\sqrt{\sigma^2 v + \sigma^2 u}$		1.031** (1.961)	
$\varphi$			3.524*** (12.57)
$\sigma_v$			0.198*** (11.54)

t statistics are in parentheses

\* Significant at the .1 probability level.

\*\* Significant at the .05 probability level.

\*\*\* Significant at the .01 probability level.

R-squared:0.877  
Adjusted R-squared:0.873

Log-Likelihood:  
-11, 7.0200

Log-Likelihood:  
-114.7641

Variance  
components:  
 $\sigma^2(v) = 0.03935$   
 $\sigma^2(u) = 1.02273$

Variance  
components:  
 $\sigma^2(v) = 0.03907$   
 $\sigma^2(u) = 0.08053$

Debreu-Farrell technical and allocative efficiency measures are presented in Tables 3 - 5. Collective efficiencies are the calculated efficiency measure for the collective parcel of each coop, and individual parcel efficiencies are presented as averages for each coop. Two allocative efficiencies are presented. Similar to the approach of Nguyen and Martinez (1979), who imputed the standard wage for free labor in examining the relative efficiency of the Mexican *ejido* sector, allocative efficiencies are calculated for free labor and for labor that receives an imputed market wage. In the first, ( $w=0$ ), the price of labor is the total cost of all labor devoted to a given parcel divided by the total number of labor days, both free and paid. The other allocative efficiency, ( $w=5$ ), imputes the standard wage of five *lempiras* to account for the opportunity cost of labor.

The standard deviations of individual technical efficiency averages are less than a third of the average for all but two cases, suggesting that technical efficiency does not vary substantially within coops. The uniformity of efficiencies within coops may be explained by the communication provided by cooperatives as they are in part established to facilitate communication across large numbers of farmers. Empirical evidence (Martin and Taylor, 1995) attests to the facilitating role cooperatives play in communicating new technologies. It was also observed throughout the course of fieldwork that new inputs and new techniques were duplicated by other farmers within coops, in some cases reenforcing errors.

Table 3 Technical efficiencies

	<u>Half-Normal</u>			<u>Exponential</u>		
	Collective	<u>Individual</u>		Collective	<u>Individual</u>	
		Average	Std. error		Average	Std. error
Ideas en Marcha		0.80	0.07		0.82	0.06
El Boqueron	0.78	0.41	0.16	0.79	0.41	0.16
Empalizada	0.87	0.71	0.15	0.87	0.72	0.15
El Benque		0.71	0.19		0.72	0.02
Los Bienvenidos	0.91	0.76	0.13	0.91	0.77	0.13
El Esfuerzo		0.81	0.06		0.82	0.05
Los Peregrinos	0.77	0.78	0.08	0.78	0.79	0.07
Esquilinchuche		0.79	0.19		0.80	0.19
San Nicolas	0.50	0.52	0.55	0.51	0.52	0.55
Los Almendros	0.79	0.70	0.10	0.80	0.71	0.10
La Esperanza	0.79	0.73	0.14	0.79	0.74	0.14
Santa Cruz		0.77	0.11		0.79	0.11
Cayo Blanco	0.84	0.75	0.14	0.84	0.76	0.14
Zopilotepe	0.79			0.80		
Guaymuras	0.91			0.91		
La Concepción	0.91	0.81	0.10	0.92	0.82	0.10
San Juan de Linaca	0.90	0.85	0.06	0.91	0.86	0.06
La Puzunca		0.78	0.08		0.80	0.08
Tempiscapa		0.74	0.12		0.75	0.12
La Providencia	0.56	0.68	0.21	0.56	0.69	0.22
19 de Abril	0.74	0.70	0.21	0.76	0.71	0.21
El Coyolar	0.32	0.86	0.07	0.32	0.87	0.06
El Plomo	0.81	0.77	0.14	0.82	0.79	0.14
Los Dos Naranjos	0.87	0.82	0.06	0.88	0.83	0.05
Los Venecianos		0.76	0.11		0.78	0.10
La Libertad	0.54	0.72	0.15	0.55	0.74	0.14
Montañuelas	0.08			0.81		

Table 4 Allocative efficiencies - Half-Normal

	Collective	<u>Individual w=0</u>		<u>Individual w=5</u>	
		Average	Standard error	Average	Standard error
Ideas en Marcha		0.37	0.10	0.52	0.10
El Boqueron	0.24	0.08	0.09	0.09	0.09
Empalizada	0.32	0.30	0.24	0.32	0.23
El Benque		0.18	0.13	0.22	0.15
Los Bienvenidos	0.47	0.14	0.11	0.20	0.09
El Esfuerzo		0.33	0.05	0.33	0.05
Los Peregrinos	0.35	0.31	0.12	0.35	0.10
Esquilinchuche		0.30	0.20	0.37	0.20
San Nicolas	0.13	0.14	0.18	0.17	0.23
Los Almendros	0.38	0.15	0.11	0.24	0.07
La Esperanza	0.24	0.17	0.13	0.24	0.12
Santa Cruz		0.28	0.15	0.37	0.15
Cayo Blanco	0.25	0.10	0.06	0.12	0.06
Zopilotepe	0.24				
Guaymuras	0.42				
La Concepción	0.46	0.26	0.11	0.30	0.08
San Juan de Linaca	0.63	0.33	0.14	0.39	0.12
La Puzunca		0.24	0.13	0.28	0.09
Tempiscapa		0.20	0.10	0.17	0.08
La Providencia	0.16	0.20	0.16	0.24	0.16
19 de Abril	0.26	0.16	0.11	0.18	0.10
El Coyolar	0.05	0.37	0.07	0.36	0.08
El Plomo	0.29	0.22	0.12	0.20	0.07
Los Dos Naranjos	0.43	0.31	0.05	0.31	0.06
Los Venecianos		0.21	0.11	0.22	0.12
La Libertad	0.10	0.19	0.12	0.19	0.11
Montañuelas	0.34				

Table 5 Allocative efficiencies - Exponential

	Collective	<u>Individual w=0</u>		<u>Individual w=5</u>	
		Average	Standard error	Average	Standard error
Ideas en Marcha		0.46	0.09	0.52	0.08
El Boqueron	0.31	0.11	0.12	0.12	0.12
Empalizada	0.38	0.37	0.24	0.40	0.23
El Benque		0.23	0.14	0.27	0.16
Los Bienvenidos	0.51	0.17	0.13	0.25	0.11
El Esfuerzo		0.41	0.05	0.41	0.05
Los Peregrinos	0.46	0.39	0.13	0.45	0.09
Esquilinchuche		0.34	0.21	0.42	0.21
San Nicolas	0.18	0.15	0.20	0.18	0.26
Los Almendros	0.48	0.20	0.14	0.32	0.09
La Esperanza	0.32	0.22	0.15	0.21	0.12
Santa Cruz		0.34	0.17	0.45	0.14
Cayo Blanco	0.31	0.12	0.08	0.14	0.06
Zopilotepe	0.31				
Guaymuras	0.46				
La Concepción	0.51	0.31	0.12	0.37	0.08
San Juan de Linaca	0.68	0.38	0.16	0.46	0.13
La Puzunca		0.30	0.13	0.35	0.08
Tempiscapa		0.25	0.10	0.22	0.08
La Providencia	0.23	0.24	0.18	0.29	0.17
19 de Abril	0.36	0.20	0.13	0.23	0.11
El Coyolar	0.06	0.44	0.07	0.43	0.08
El Plomo	0.36	0.27	0.13	0.24	0.07
Los Dos Naranjos	0.49	0.38	0.05	0.38	0.05
Los Venecianos		0.28	0.13	0.27	0.13
La Libertad	0.15	0.24	0.14	0.24	0.12
Montañuelas	0.43				

The most salient feature that emerges is that individual parcels appear no more technically efficient than collective parcels. Efficiencies based on the half-normal and exponential distributions show that collective parcels are more technically efficient than individual parcels for 11 of the 16 coops that employed both modes of production. One of the most cited theoretical arguments against collective forms of enterprise, worker shirking, shows no empirical basis in these results. These findings correspond to Carter, et al. (1996), who report that 90 percent of surveyed coops did not consider shirking a problem. Two of the five remaining coops show individual parcels are only scarcely higher. Individual technical efficiencies for *Los Peregrinos* and *San Nicholas* (the only coop for which the standard error is higher than the average) exceed their collective measures by one and two points respectively. Differences are much greater in the cases where collectives are more technically efficient; at least nine points for seven coops, two show five point differences and the remaining two coops register differences of four points.

Allocative efficiencies are markedly lower than technical efficiencies for both collective and individual systems. They vary consistently with technical efficiencies across coops. Allocative efficiencies increase for 16 of the individual production systems, in both the half-normal and exponential distributions, when the standard wage of five *lempiras* is imputed for free labor. Higher allocative efficiencies for the case of imputed wages suggests that there is an opportunity cost for labor on individual parcels vis à vis other opportunities available to farmers. If labor had been over-employed on individual parcels, allocative efficiencies would decrease when the standard wage is imputed. It would suggest that the shadow price of labor for coop households is less than the average wage.

Averages of technical and allocative efficiency differences between collective and individual systems for all coops and only those with mixed systems are displayed on Table 6.

Table 6 Differences<sup>1</sup> in efficiency averages between collective and individual parcels

	Mixed <sup>2</sup> Coops		All Coops	
	Half-Normal	Exponential	Half-Normal	Exponential
<b>Technical Efficiency</b>				
Difference	0.00 (0.01) <sup>3</sup>	-0.00 (0.06)	-0.02 (0.55)	-0.02 (0.66)
<b>Allocative Efficiency</b>				
wage = 0				
Difference	0.09 (1.82 <sup>**</sup> )	0.08 (1.53 <sup>*</sup> )	0.06 (1.32 <sup>*</sup> )	0.05 (1.03)
wage = L5.00				
Difference	0.04 (0.86)	0.03 (0.59)	0.01 (0.19)	-0.00 (0.05)

<sup>1</sup> Collective average less individual average

<sup>2</sup> Efficiency scores exclusively for coops that had both individual and collective or "mixed" production systems.

<sup>3</sup> t statistics are in parentheses

<sup>\*</sup> Significant at the level of .1 probability level.

<sup>\*\*</sup> Significant at the level of .05 probability level.



Although degrees of freedom are limited due to the small number of collective parcels, a statistically significant difference in mean efficiency scores occurs in allocative efficiency when free labor receives no direct remuneration. Collective parcels in this instance are more allocatively efficient. These results demonstrate that free labor is used on individual parcels, but that when all inputs are paid, allocative efficiencies are not statistically and significantly different.

### Summary and Conclusions

This paper empirically examined relative efficiency of Honduran farmers operating under alternative modes of individual and collective production. Debreu-Farrell technical and allocative efficiency measures, derived from a stochastic production frontier, formed the basis of the comparison. Estimates of technical and allocative efficiencies were calculated for each production system. For each cooperative, the technical and allocative efficiency of the collectively worked parcel was compared with the efficiency averages of the individual producers who belonged to the cooperative.

The results of this paper counter conventional wisdom in that collective parcels appear no less technically nor allocatively efficient than individual parcels. These results indicate the nature of coop failure may be more attributable to managerial problems than to the popular notion of labor shirking as posited by Alchian and Demsetz (1972). The policy implications of the different sources of shirking are significant. Widespread worker shirking cannot be easily overcome due to high monitoring costs, but managerial weaknesses may be rectified through restructuring. An institutional analysis conducted in the light of these findings (Martin, 1996) suggests that misaligned incentives between coops and government support agencies hinder coops from operating as stable business enterprises

A further result is that individual producers are more allocatively efficient when a

standard wage is imputed for free labor, indicating that there is an opportunity cost for labor devoted to individual parcels. Collective allocative efficiency is also significantly higher than allocative efficiency of individual producers when free labor is not imputed a standard wage.

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