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RELATIVE ECONOMIC EFFICIENCY IN THE DOMINICAN REPUBLIC AND IMPLICATIONS FOR LAND REDISTRIBUTION PROGRAMS

by

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Abstract

The effectiveness of land reform policies in the Dominican Republic is analyzed by investigating the relationship between farm size and economic efficiency (both technical and allocative efficiency). Empirical tests for equal economic efficiency between small and large rice farmers in the Dominican Republic are conducted based upon an estimated production function, input, and output prices for each group of farms. The empirical results are based on 1976 farm-level data for 302 rice farms in the country. The results indicate that while small and large groups of farms are equally price efficient, large farms are more technically and therefore economically efficient than small farms.

Relative Economic Efficiency in the Dominican Republic and Implications for Land Redistribution Programs

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Introduction

Throughout this century, developing countries have initiated reforms in their systems of land tenure as part of an effort to foster technical change and to modernize their agricultural sector. Such reforms include land redistributions from relatively large land holders to landless and/or smaller farmers, imposition of ceilings on private land holdings, and organization of government sponsored farming cooperatives for landless farmers. Policies that transfer land from large farms or government owned land to small and landless farmers may be justified on an economic basis if they lead to a simultaneous increase in output and/or improvements in the distribution of that output (Barnum and Squire).

The impact of tenancy status and size on economic efficiency (EE) has received considerable attention from economists interested in developing countries. The major focus of these studies has been to test empirically whether farms with different land tenancy arrangements or farms with different size classifications are equally efficient. The results of these studies are quite mixed. For example, while two studies found that smaller farms in India were more EE than larger farms based on 1950's data (Lau and Yotopoulos; Yotopoulos and Lau), another study of the same region using 1960's data concluded that there were no differences in EE between small and large farms (Sidhu). Another study of Indian agriculture concluded that small farms are less EE than larger farms (Huang, Tang, and Bagi). A study of padi farming in Northwest Malaysia provided empirical evidence that farmers classified as owners and tenants, as well as by size were equally EE (Barnum and Squire).

The results of empirical estimates of technical and price or allocative efficiency have far-reaching economic implications for evaluating, establishing, or revising government resource reallocation programs for agriculture. With such knowledge, policy makers may revise land reform programs to improve the overall economic efficiency of the economic sector under evaluation.

In this bulletin, the results of an empirical test of whether small and large rice farms are equally EE are used to examine the effectiveness of land

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redistribution policies in the Dominican Republic (DR).[1] Using farm level data, a set of hypotheses are formulated and tested based on an estimated production function fitted from cross-sectional data on rice production for the DR. Finally, a related test for returns to scale in rice farming is also conducted to examine whether this sector is characterized by decreasing, constant, or increasing returns to scale.

There are two motivations for this research. First, while much has been learned about the relationship between farm size and efficiency in Indian agriculture,[2] far less is known about this relationship in the Dominican Republic. The Dominican Republic has had land reform policies since the early 1960's and thus provides an excellent case study to be added to the literature. Second, most of the previous research on efficiency have used data from the 1950's and 1960's with few studies using more current data. As a result, less is known about efficiency and size relationships based on more current data sets. This study is based on farm level data from a more recent period, 1976, and therefore should provide an interesting comparison to past results.

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[1]Tests for relative economic efficiency by tenancy status are not conducted because these data are not available.

[2]The main reason for the large body of research of this type on India is due to the existence of a large and reliable data set from the Indian Farm Mangement Surveys (Bardhan).

Land Redistribution Programs in the Dominican Republic[3]

Land or agrarian redistribution policies in the DR began around 1962. There were three major reasons why the government decided to pursue a policy of land redistribution. First, the government wanted to provide landless peasants with the opportunity to own land. Existing distribution of land was viewed as highly inequitable and the policy was seen as a means to reduce this disparity. Second, the government wanted to improve output by making the very small farmers more efficient through increasing their land holdings. An additional motive was to increase land utilization, which was relatively low at the time. Third, the redistribution of land that went into state and collective farms was viewed by key policy makers as a means of providing work for the unemployed.

Between 1962 and 1975, the government acquired 318,250 hectares of land for their redistribution programs. Of this land, 46% was taken from publicly owned land; 24% was acquired from "special quota" land, which means that the government received the land as a payment for making some improvements on the land of a private owner; 15% was purchased from large land owners; and 15% was collected from idle land, previously not owned. The land acquired through the redistributional programs were distributed to the Dominican Agrarian Institute (IAD), and state and experimental farms. The IAD was established as the official (independent) agency in charge of land reform. Since 1962, the IAD has placed 36,353 families on an estimated 179,200 hectares of land acquired by the programs.

Until 1972, the IAD settlements were on an individual family basis. Since 1972 the redistribution of riceland has been carried out by the formation of collective farms. At the time of the policy change, it was felt that output could be increased by organizing landless families into collective units. The individual family settlements had shown little success in increasing output, primarily due to a deficiency of technical and service assistance to the individual settlements. These farms are organized by issuing members provisional certificates to part of the land on the collective, but they must work all the land together. Members are advanced monthly subsistence income from the IAD and then pay it back after the crop is harvested and sold. The proceeds are shared by all members of the collective.

The political and social success of the DR's land reform programs has been mixed. The 36,353 families that received land have contributed to the expansion of output and increased their incomes. However, these families represent only 9% of the estimated 400,000 landless families in the DR. The

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[3]This section is based on the following two sources: Fletcher, L.B. and Graber, E. 1980. Economic Growth, Equity, and Agricultural Development in the Dominican Republic. Monograph No. 12, International Studies in Economics, Ames: Iowa State University; and The International Bank for Reconstruction, World Bank. 1978. Dominican Republic: Its Main Development Problems. Washington, D.C.

program has been carried out at a very slow pace, and has not been successful in getting new tenants to use more modern techniques in producing rice. Only the large-scale cooperative experiments have adopted modern, more efficient, techniques. As will become apparent in the next sections, the program has not been effective in increasing the EE of smaller rice farmers in the DR.

The Model and Data

The concept of economic efficiency consists of two components: technical efficiency and price efficiency (Yotopoulos and Nugent). Technical efficiency (TE) is a measure of the level of output relative to the amount of inputs used to produce some commodity. One firm is relatively more TE than another firm if it can either produce the same output with less inputs, or produce more output with the same amount of inputs as the other firm. The notion of price efficiency (PE) is based on the profit maximizing input allocation conditions of neoclassical theory of the firm. One firm is said to be relatively more PE than another firm if it is more successful in equating the value of the marginal product to input price for all variable inputs (maximizing profits) than the other firm. These two measures of relative efficiency are used as conditions for relative EE. One firm is more EE than another firm if one of the following three conditions hold: 1) the firm is more TE and equally PE as the other firm, or 2) the firm is equally TE and more PE as the other firm, or 3) the firm is more TE and more PE as the other firm.

In order to study relative EE between small and large rice farms, a production function for each group is estimated and compared. A Cobb-Douglas functional form was selected for this study for three reasons. First, it is linear in logarithms and easy to directly estimate. Second, the important economic parameters have straight forward interpretation. Finally, this functional form fit the data quite well.[4]

There are certain disadvantages of direct estimation of production functions that are worth noting. One problem often questioned is the issue of whether the independent variables are true exogenous variables. Some contend that the inputs are actually endogenous since they are jointly determined with output, which, if true, would result in simultaneous equation bias problems. A second problem with respect to Cobb-Douglas production functions is that the elasticity of substitution is constant and equal to unity, which may be quite restrictive in some applications. The issue of simultaneous equation bias may not be a problem in this study since there exists a lag between when input decisions are made and when output is realized. Zellner, Kmenta, and Dreze have demonstrated that if a time lag exists in this context, then direct estimation of the production function using ordinary least squares will yield unbiased estimates of the output elasticities. The limitation of a unitary elasticity of substitution inherent in the Cobb-Douglas functional form was not a serious shortcoming for this study. This is true since the intention of this research was not to estimate the elasticity of substitution, but rather to conduct efficiency tests. Hence, the Cobb-Douglas production function is judged appropriate based on these reasons.

To capture differences between small and large farms in technical and price efficiency, intercept and slope dummy variables on all inputs based on farm size are used. Thus estimated coefficients for both farm groups were

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[4]The final estimated equation has an adjusted R-square of 0.849.

obtained by running one regression. The estimated equation used in the analysis can be written in natural logarithmic form as:

(1) $$\text{Log } Y = A_o + \sum_{i=1}^{4} A_i\, Di + \sum_{j=1}^{6} B_j \text{ Log } X_j + \sum_{j=1}^{6} C_j\, D_1 \text{ Log } X_j + U$$

Y = rice output, measured by the pounds of rice produced annually by each farm.

Ao = a constant term measuring managerial ability.

X_1 = total pounds of seed, purchased and nonpurchased, used annually in rice production by each farm.

X_2 = animal power, measured in animal days, used in rice production by each farm.

X_3 = machinery, expressed as the amount paid for machinery services annually, in rice production by each farm.[5]

X_4 = fertilizer and chemicals, measured by the annual value of all fertilizer and all chemicals, used in rice production by each farm.

X_5 = total labor, quantified by the annual amount of contract, hired, and family labor (man days), used in rice production by each farm.

X_6 = cultivated land used in rice production by each farm.

D_1 = intercept dummy variable used to test for relative TE between small and large farms in production. $D_1 = 1$ if greater than or equal to 80 tareas, 0 otherwise.

D_2 = intercept dummy variable used to determine whether there are differences between the primary rice-growing region and the rest of the country. $D_2 = 1$ if in the primary region, 0 otherwise.

D_3 = intercept dummy variable used to determine whether there are differences between farms that use irrigation and farms that do not use irrigation. $D_3 = 1$ if irrigation is used, 0 otherwise.

D_4 = a dummy variable used to determine whether there are differences

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[5]If a farmer owned her/his machinery, then an imputed rental value was calculated for each stage of production in which the machinery was used. This value was based on average machine rental values per tarea of equivalent size farms in the same region.

between farms located in level areas and farms located in hilly areas. $D_4 = 1$ if not in a hilly location, 0 otherwise.

U = error term, assumed to have a zero expected value, a finite-uniform variance, and is independently distributed of all independent variables.

Equation (1) has the following interpretation. The constant term, A_o, and slope coefficients, B_j, represent the production function for small rice farms. The estimated production function for large farms is derived from the coefficients estimated for the small farms plus the respective coefficients for the intercept dummy variable (A_1) and slope dummy variables (C_j). Because data were not available for the amount of water used in irrigated farms and for land quality, three other intercept dummy variables were included in the model as proxies for irrigation and land quality. The coefficients are added to the constant term (Ao) for farmers that use irrigation, are located in level land areas, or are located in the primary rice producing region of the DR.

The coefficients on the variable inputs of the Cobb-Douglas production function represent the elasticities of production with respect to inputs. They are interpreted as the percentage change in rice output given a 1% change in the amount of X_j used. Marginal productivity of each input j is derived by taking the partial derivative of Y with respect to factor X_j, i.e.,

(2) $$\frac{\partial Y}{\partial X_i} = B_j \frac{Y}{X_j} + C_j D_1 \frac{Y}{X_j} = \frac{Y}{X_j} [B_j + C_j D_1] \quad \text{for } i=1,\ldots,6$$

The sample used in estimating the rice production function and the input and output price data is taken from cross-sectional data for the DR for 1975-1976. These data were collected in a comprehensive survey by the U.S. Agency for International Development entitled A Sector Analysis of the Dominican Republic.[6] The sample included 302 rice farms of which 142 were classified as small farms and 160 were classified as large farms. A small farm ($D_1=0$) is defined as any operation with 8 to 79 tareas (1.231 to 12.154 acres) and a large farm ($D_1=1$) is defined as any farm with more than 79 tareas. It should be noted that this definition is subject to criticism in the sense that it defines size by the amount of total farm land rather than amount of output, income, or rice land. Thus, it is possible for a farm with more than 79 tareas to grow less rice than a farm with less than 79 tareas. However, for policy purposes this appears to be the most popular way of defining farm size and thus is adopted for this study.

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[6]This is the most recent comprehensive data set for the DR. Several smaller surveys have been conducted since then for various commodities. However, data from the former survey is judged to be more complete and reliable than more recent data and is therefore chosen for this research. The author wishes to thank Duty Greene for making this data available for this project.

The Hypotheses and Results

The first hypothesis to be tested is whether or not small and large farms are equally TE. This is achieved by testing whether the coefficient of the size intercept dummy variable is statistically different than zero. This involves using a two-tailed t-test of the following hypothesis:

(3) H_O: $A_1 = 0$
H_A: $A_1 \neq 0$.

The coefficient A_1 is a measure of the technical efficiency of large relative to small farms. If this coefficient is statistically significant and positive (negative), then it is concluded that large farms are more (less) TE than small farms. This parameter is sometimes called a measure of "management bias" because it quantifies the managerial ability of farmers as a multiplicative factor in the production function.

The results of estimating equation (1) with ordinary least squares are presented in Table 1. Initial estimates of equation (1) resulted in several intercept and slope dummy variables being statistically insignificant from zero. Therefore, the final equation, as presented in Table 1, deletes all slope and intercept dummy variables statistically not different from zero.[7]

The null hypothesis of equal TE between small and large farms is rejected at the 10 percent significance level. Since A_1 is positive and statistically different from zero, it is concluded that large farms are relatively more TE than small farms. The results suggest that large rice farms, on average, have an intercept term in their production function that is 37.5 percent larger than the average small rice farm in the DR.

The next hypothesis to be tested is for constant returns to scale in rice production, i.e.:

(4) H_O: $B_1{}^i + B_2{}^i + \ldots + B_6{}^i = 1$ (i = small, large farms)

H_A: $B_1{}^i + B_2{}^i + \ldots + B_6{}^i \neq 1$

Using a t-test on the sum of all output elasticities, the null hypothesis (4) could not be rejected at the 10 percent level for small and large farms. Therefore, it is concluded that both groups experience constant returns to scale in rice production technology.

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[7]The coefficients on the three intercept dummy variables for irrigation (A_2), land quality (A_3), and region (A_4) were not statistically different from zero at the 10 percent significance level. The coefficients on four of the six slope size dummy variables for animal power (C_2), fertilizer and chemicals (C_4), labor (C_5), and land (C_6) were not statistically significant from zero at the 10 percent significance level.

Table 1. Regression Results of Estimating Equation (1).[1]

	Estimated Coefficient for Small Farms	Estimated Coefficient for Large Farms[a]
Intercept (Ao)	3.440 (7.73)	4.730 (9.96)
Seed (X_1)[b]	0.193 (3.05)	0.060 (0.92)
Animals (X_2)	0.077 (2.45)	0.077 (2.45)
Machinery (X_3)[b]	0.065 (1.94)	0.024 (0.63)
Fertilizer and Chemicals (X_4)	0.141 (5.46)	0.141 (5.46)
Labor (X_5)	0.150 (2.22)	0.150 (2.22)
Land (X_6)	0.564 (7.30)	0.564 (7.30)
$\sum_{i=1}^{6} B_i$[c]	1.19 (1.48)	1.02 (0.66)
Dummy Variables:		
Size (D_1)		1.294 (2.72)
Adjusted R-Square	0.849	
Number of Observations	302	

1 These results are for equation (1) re-estimated with all insignificant dummy variables from an initial regression deleted. All figures in parentheses are t-values.

a Coefficients for large farms are equal to the small farm coefficient plus the slope dummy variable.

b The slope dummy coefficients on seed and machinery were significant at the 5 percent significance level. All other slope dummy coefficients were not statistically significant at the 10 percent level.

c Tests for constant returns to scale indicated that this hypothesis could not be rejected at the 10 percent significance levels for large and small farms.

The third hypothesis to be tested is that small and large farms are equally price efficient. One way to test this is to compare the ratio of the value of the marginal product (VMP) to the factor price (call this ratio k) on all six inputs for large and small farms, i.e.:

(5) H_0: $k_i^S - k_i^L = 0$

H_A: $k_i^S - k_i^L \neq 0$

where: $k^i = VMP_{Xi}/P_{Xi}$ for $i = 1,\ldots,6$; S = small, and L = large farms.

Estimates of the VMP, standard error of the VMP, and pooled standard error of k, along with data on input and output prices for each group are required to test hypothesis (5). The VMP for each group is estimated by multiplying the marginal physical product (MPP, see equation (2)) by the average price of rice received by each group. The estimate of the standard error of the VMP of the ith input for small and large farms is given by the following formula (Carter and Hartley):

(6) $$SE(VMP) = P_R \frac{\bar{Y}}{\overline{X_i}} (Var(B_i))^{1/2}$$

where: P_R = price of rice per pound;

$\bar{Y}$ = geometric mean of production;

$\overline{X_i}$ = geometric mean of input i;

B_i = estimated elasticity of production coefficient of input i.

Using (6), the pooled estimate of the standard error of k is given by:

(7) $$\text{Pooled } SE(k) = \frac{DF^S SE(k^S) + DF^L SE(k^L)}{DF^S + DF^L}$$

where: DF = degrees of freedom (S=small, L=large)

$SE(k^j) = SE(VMP^j_{Xi})/P_{Xi}{}^j$; j=small and large farms.

The results of the test of hypothesis (5) are presented in Table 2. The null hypothesis cannot be rejected at the 5 percent significance level for all six inputs. Hence, it is concluded that small and large farms are equally PE. It is important to recognize that this result does not imply profit maximizing behavior on the part of both groups. Rather, it means that there are no statistical differences in the way that small and large farms allocate inputs according to the relationship between their VMP and input price for each factor.

Finally, to see how successful each group is in allocating inputs by profit maximizing rules, a set of absolute price efficiency tests are performed. A firm is absolutely price efficient in allocating a variable input if the VMP of the input is equal to the price of the input, i.e.

Table 2. Equal Allocative Efficiency Tests Between Small and Large Farms.[a/]

Variable	Small Farm		Large Farm
Total Seeds (X1)			
k_{X1}[b/]	4.2 (1.46)		2.2 (2.4)
Pooled SE(k)		(1.96)	
H_o: $k^S = k^L$	Do Not Reject H_o	at 5% Significance Level	
t-Value		1.02	
Animal Days (X2)			
k_{X2}[b/]	4.37 (1.76)		8.09 (3.256)
Pooled SE(k)		(2.56)	
H_o: $k^S = k^L$	Do Not Reject H_o	at 5% Significance Level	
t-Value		1.453	
Machinery (X3)			
k_{X3}[c/]	2.90 (1.505)		0.902 (1.463)
Pooled SE(k)		(1.483)	
H_o: $k^S = k^L$	Do Not Reject H_o	at 5% Significance Level	
t-Value		1.35	
Fertilizer and Chemicals (X4)			
k_{X4}[c/]	2.56 (0.74)		2.74 (0.5082)
Pooled SE(k)		(0.492)	
H_o: $k^S = k^L$	Do Not Reject H_o	at 5% Significance Level	
t-Value		0.366	
Total Labor (X5)			
k_{X5}[b/]	0.30 (0.1339)		0.32 (0.1448)
Pooled SE(k)		(0.1397)	
H_o: $k^S = k^L$	Do Not Reject H_o	at 5% Significance Level	
t-Value		0.143	
Land (X6)			
k_{X6}[d/]	15.08 (2.052)		16.02 (2.178)
Pooled SE(k)		(2.12)	
H_o: $k^S = k^L$	Do Not Reject H_o	at 5% Significance Level	
t-Value		0.44	

a/ Standard errors are given in parentheses.

b/ Output and inputs are measured in physical terms. Consequently, $k = VMP/P_{xi}$. $SE(k) = SE(VMP)/P_{xi}$.

c/ Output measured in physical terms and input measured in value terms. Consequently, $k = VMP$. $SE(k) = SE(VMP)$.

d/ Output and input are measured in physical terms. However, the price of land is missing. The k value here is the VMP and ignores the price of land. This is a way of comparing equal allocative efficiency and is correct assuming that the price of land is the same between groups.

(8) H_O: $VMP_{xi} - P_{xi} = 0$

H_A: $VMP_{xi} - P_{xi} \neq 0$

for all inputs and each group of farms. The results of these tests for the small and large farms are presented in Table 3.

The results indicate that small farms optimally allocated their machinery input and large farms efficiently allocated their machinery and seed inputs. However, small farms underallocated seed, animal power, and fertilizer and chemicals, while overallocating labor. Large farms tended, on average, to underallocate animal power and fertilizer and chemicals, but overallocated labor similar to the small farms.

The results of these tests indicate that small and large farms are equally price efficient, but not equally technically efficient. However, both groups, on average, did not follow optimal decisions in allocating all of their inputs to rice production. Large farms appear to be more TE than small farms, which may be due to better managerial skills of larger farmers. This suggests that large farms are more EE since the intercept of their production function is larger than that for small farms, while the allocation of resources is the same.

Table 3. Absolute Allocative Efficiency Tests for Small and Large Farms.[a]

Variable	Small Farms	Large Farms
Total Seeds (TS)		
APP_{TS} [b]	1.46	1.92
VMP_{TS}	0.03192 (0.011)	0.0132 (0.014)
P_{TS}	0.0075412	0.0059683
H_o: $VMP_{TS} = P_{TS}$	Reject at 5% Signifance Level	Accept at 5% Significance Level
t-Value	2.22	0.52
Animal Days (AD)		
APP_{AD} [b]	978.5	1,878.3
VMP_{AD}	8.732 (3.523)	16.17 (6.512)
P_{AD}	2.00	2.00
H_o: $VMP_{AD} = P_{AD}$	Reject at 5% Significance Level	Reject at 5% Significance Level
t-Value	1.91	2.18
Total Labor (TL)		
APP_{TL}	41.5	56.4
VMP_{TL}	0.716 (0.32)	0.9383 (0.42)
P_{TL}	2.39	2.90
H_o: $VMP_{TL} = P_{TL}$	Reject at 5% Significance Level	Reject at 5% Significance Level
t-Value	5.23	4.67
Land (L)		
APP_L [a]	232.3	255.6
VMP_L	15.08 (2.052)	16.02 (2.178)
P_L	?	?
Ho: $VMP_L = P_L$	?	?
t-Value	?	?
Fertilizer and Chemicals (FC)		
APP_{FC} [c]	158.3	175.8
VMP_{FC}	2.56 (0.474)	2.74 (0.5082)
P_{FC}	1.0	1.0
H_o: $VMP_{FC} = P_{FC}$	Reject at 5% Significance Level	Reject at 5% Significance Level
t-Value	3.29	3.42
Machinery (M)		
APP_M [c]	384.4	346.8
VMP_M	2.9 (1.505)	0.902 (1.463)
P_M	1.0	1.0
H_o: $VMP_M = P_M$	Accept at 5% Significance Level	Accept at 5% Significance Level
t-Value	1.26	0.067

a/ Standard Errors are given in parentheses.

b/ Output and inputs measured in physical terms. Therefore, the VMP is given by the price of rice times $\pi\frac{Y}{X}$. Thus, the price of input is compared to the VMP to test for equilibrium.

c/ Output measured in physical terms and input measured in value terms. Therefore, the VMP is obtained by multiplying the price of rice by $\pi\frac{Y}{X}$ is actually VMP/\$. Thus, this VMP is compared to 1.0 to test for equilibrium.

Summary and Implications

This study evaluated the effectiveness of land reform programs in the DR by testing for relative EE between small and large rice farms. Based on an estimated Cobb-Douglas production function, it was concluded that while small and large farms were equally PE and both experienced constant returns to scale, large farms were more TE than small farms. These results were most likely due to better managerial skills of larger farmers as a group because they tend to be better educated than smaller farmers. Thus, contrary to several studies in different countries (e.g., Yotopoulos and Lau, and Sidhu), this study concluded that large farms in the DR are more EE than small farms.

The findings in this research imply that there is no statistical case for continuation of the existing land reform policies on an economic efficiency basis. The continuation of these policies will have a negative effect on EE. Policy makers in the DR that are in favor of continuing the existing program (without modifying it) should justify their position on social or political grounds, or base them on normative economic criteria because, based on the purely positive economic tests conducted here, carrying out more of the same policies will not result in greater EE.

The results of this study do not necessarily imply that land redistribution programs should not be pursued in the DR. Rather, the conclusions suggest that continuance of present land reform programs without any policies designed to improve TE among smaller farmers is economically less efficient than no policy at all. Therefore, a policy conclusion of this research is land reform programs in the DR should be accompanied by additional programs designed to improve technical efficiency among small farms in the DR if EE is to be improved.

Perhaps more resources for technical and service assistance to such farmers are required to make small farmers more economically viable. As was previously mentioned, the government has been relatively unsuccessful in getting new or small tenants to use more modern techniques in producing rice. Because there are many individual settlements in the DR, technical and service assistance could be quite expensive. One way to reduce these costs would be a policy of more collective or state farms and fewer individual settlements in the future. The costs of technical training could then be minimized because the targeted groups would not be as dispersed. Before such a change is instituted, however, the relative economic efficiency among individual settlements, state, and collective farms should be studied. If one type of organization is found to be relatively more EE than the others, then land reform policies should adopt the most efficient type of public farm.

There are several directions for future research that would be useful. A study that includes more than two size categories would provide more detail on which farms are the most and least economically efficient. This would be beneficial to decision makers in targeting groups for technical and service assistance. Also, to obtain a more comprehensive view of the relationship between EE and size, other important farm commodities should be examined in addition to rice. Finally, since the model used in this study was static, it would be useful to look at EE for different time periods. For example, a similar analysis to this could be conducted for an earlier and later period to compare how efficiency between small and large farms has evolved.

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