ECONOMIC GROWTH CENTER

YALE UNIVERSITY

Box 1987, Yale Station
New Haven, Connecticut

CENTER DISCUSSION PAPER NO. 148

AGRICULTURAL PRODUCTIVITY AND THE DISTRIBUTION OF LAND: THE VENEZUELAN CASE

James Hanson

June 1972

Agricultural Productivity and the Distribution of Land:

The Venezuelan Case

Latin American economists and radicals never tire of pointing out the impact of agrarian structure on the output and growth rate of the agricultural sector. They claim that the coexistence of "the latifundio" with its satellite "minifundia" and the widespread prevalence of share cropping and land occupation without title cause, not only a maldistribution of political power, but substantial economic misallocation. Through their monopsonistic control of the land, water and timber rights, and their manipulation of sharecropping and rental contracts, the large landlords can extract a substantial surplus from the peasants. Moreover, the effect of this exercise of power is to squeeze the peasants onto their own small plots, to which they must devote too much labor in order to survive. At the same time land on the large farms is underutilized and often left completely idle.

While the peasant's ability to migrate to the city mitigates the landlord's power of exploitation, moving costs are certainly high. And once the peon reaches the city the employment opportunities are poor. Moreover the large landowners have often used a variety of legal means to restrict workers' mobility such as police codes on vagrancy, army impressment for service on lands, payments in kind or token money, debt peonage, and the threat of military or police intervention by the overseer, who was often the local Chief of Police. In many cases, the landowners have also tried to prevent the development of feeder roads beyond their own plantations.[1] Finally, high population growth rates and the large fraction of the population which remains on the land reduce the impact of the large (absolute) migrations which have been observed, leaving real rural wages roughly constant.[2]

The net result of this agrarian structure is low productivity and agricultural stagnation;[3] the radical solution to the problem is of course a "cambio de estructura," a major land reform and restrictions on rental sharecropping contracts. If this occurs, then output will grow once and for all through the correction of static misallocation,[4] and again as the former tenents and minifundistas apply modern techniques which the latifundista was to lazy to adopt.

Running counter to this argument is the conservative view that property gravitates to those who administer it best. In other words, large farmers have obtained their holdings because they were more efficient than others and because they took advantage of technical improvements, such as the greater productivity of modern inputs. Being less tied to tradition than the peasant, the large land owners quickly switched to the most profitable crops and adopted new methods more rapidly. The resulting profits were then used to buy more land. If this view is true, then land redistribution would lead to a substantial fall in output in the short run and a slowing of technical progress in agriculture. This view is perhaps stated most concisely in the Mexican proverb that to give a beggar a donkey is simply a way of permitting him to ride to the devil.[5]

Finally, there is an intermediate case, which we shall term "Market Failure" based on the inability of market analysis to explain observed phenomena without reference to information and transactions costs. For example, one might take the view that the average productivity of a given bundle of primary inputs--land, labor, and capital--is greater on large farms because of their greater use of profitable intermediate inputs. The smaller farmer does not use these intermediate inputs to the same degree because of transactions costs (e.g. the capital cost of a tractor may be too great for a small plot, yet the transactions necessary to share one may prevent farmers from combining to make the purchase. However, the new small Japanese tractors may reduce this problem.) Alternatively there are additional information costs and risks involved when the small farmer adopts new fertilizers, switches to new crops, and gets credits. (On the other hand, the small farmers' credit costs may be higher because of discrimination in capital markets since in many cases the heads of the banks are the latifundistas). The remedy for low productivity and stagnant agriculture in this intermediate case of market failure, provided that the large landlords have not used their greater profits to buy up more land and obtain monopsony power,[6] is not land reform but the improvement of various markets, perhaps starting with government loans to small farms[7] to take advantage of the economics of pooling risks and with the provision of technical information.[8]

It should be obvious that in practice it is difficult to distinguish which of these three views--radical, conservative, or market failure--has greater validity. For example, if the lower use of intermediate inputs reflects costs of information, then case 3 blends into case 2. Further, misallocation in case 1 and case 3 refers only to underproduction of goods. It is quite possible that, given the income distribution, the utility provided by the combination of goods and risk produced and the satisfaction obtained through discrimination in capital markets, in land ownership, or in work on ones own land is maximized. However, in either case 1 or 3 a land reform which broke up large estates would increase agricultural output, if intermediate inputs were held constant. Finally, it is also possible that the contracts which are made reflect factors which are difficult to measure such as risk and that there is neither static nor dynamic misallocation.[9] However, as is traditional in empirical research, we shall forge ahead by ignoring these points.

It is also obvious that the age old equity-efficiency argument is tremendously relevant to the issue of land reform. The redistribution of income, wealth, and power which accompanies a major land reform has important welfare aspects, and may be the major argument for a land reform. However, we shall concentrate our efforts solely in the investigation of the static production aspects of land reform.[10] In particular our discussion will be confined to the case of Venezuela, which by Latin American standards has a relatively good set of data on the agricultural sector.

In the next section of this paper, the Venezuelan pattern of land tenure and distribution of farms by size of holdings will be discussed. Data presented there for the three census years (1936, 1950, 1961) will show that the uneven distribution of rural land which existed in Venezuela before the agrarian reform of the sixties, was certainly representative of the general Latin American picture.[11] Further, at least in the aggregate, the concentration of land ownership changed very little despite the efforts at land reform between 1945 and 1948 and the renewal of these efforts, together with some occupation of latifundia in the late fifties[12] and early sixties. On the one hand this would seem to reduce the danger that the structure of land ownership and investment is in disequilibrium,[13] increasing confidence in the statistical estimates of the production function. However, it would seem to present some problems in the testing of the hypotheses about the effects of uneven distribution on output and growth, for a stable ownership structure means it is difficult to separate the effect of ownership structure from the differences in the average productivity of states.

In Section 3 agricultural production functions are estimated for Venezuela using ordinary least squares and the analysis of covariance method. Section 4 develops a heretofor unused test for static misallocation and Section 5 applies it to the Venezuelan agricultural economy in 1950 and 1961. Section 6 concludes the paper with a summary of the basic findings, namely that the data seem to indicate that a substantial static misallocation of land existed in 1961 and that the land reform, which took effect at that time, combined with the devaluation and improved markets for intermediate inputs, probably explains most of the rapid growth of Venezuelan agriculture during the sixties. However, the major problem was one of ownership structure not tenure conditions.

II. Land Tenure in Venezuela

The Venezuelan agricultural economy would seem to be an excellent case for testing the relative merits of the three hypotheses advanced earlier (radical, conservative and market failure). From the three Venezuelan agricultural censi (1936, 1950, 1961) relatively good data on land tenure, farm size and inputs can be obtained. As will be shown below, the ownership of land is very uneven in Venezuela but the aggregate structure of ownership and tenure was relatively stable, at least until 1961.

Tables I and II summarize the available aggregate data on the percentage distribution of total land by farm size and tenure classifications. Each entry in Table I represents the percentage of land held under a certain tenure arrangement (owner, renter, share cropper, squatter) on farms of a certain size. Thus, Table I, Col. 4, line 3 shows that in 1950 1.5 percent of the total land was held under proprietorship on farms of 5 to 20 ha,

Table I

Venezuela

Percentage Distribution of Land Holdings by Farm Size and Tenure Class

	Number of Farms			Proprietors		Renters		Sharecroppers		Squatters		TOTAL		
	1936	1950	1961**	1950	1961	1950	1961	1950	1961	1950	1961	1936	1950	1961
Farm Size (ha)*	69,777	234,730***	320,094***	97,598	125,627	35,633	25,966	14,954	15,223	80,487	124,119			
Under 5	24,673	125,990	160,234	.4	.5	.2	.1	.1	.1	.4	.6	.3	1.1	1.3
5-20	25,932	69,565	99,189	1.5	1.6	.3	.3	.2	.2	.8	1.4	1.0	2.8	3.5
20-100	10,353	26,023	40,167	3.0	3.3	.4	.4	.2	.2	1.0	2.1	1.8	4.6	6.0
100-500	4,182	7,866	13,479	5.2	6.8	.5	.5	.2	.1	1.3	3.1	4.0	7.3	10.5
500-1000	1,304	1,864	2,802	4.4	5.7	.2	.2	.1	0	.8	1.1	3.9	5.5	7.0
Over 1000	3,338	3,422	4,223	68.7	66.6	1.7	.7	1.4	0	6.9	4.4	89.0	79.4	71.7
				83.2	84.5	3.3	2.2	2.2	.6	11.3	12.7	100.0	100.0	100.0

	Total land held	
1936/7	23,370,503.0 ha	source: MAC Reforma Agraria, Caracas, 1959, vol. II, p. 494.
1950	22,126,640.0 ha	: DGE II Censo Agropecuario I, pp. 39-69.
1961	26,004,861.1 ha	: DGE III Censo Agropecuario XIX, pp. 131, 157, 183.

* Each class does not include farms of the last size.

** 1961 figure includes 4617 rural exploitations without land.

*** In 1950, 6,058 exploitations with 795,367.3 ha (3.6% of land) were operated beneath multiple forms of tenure.
In 1961, 24,542 exploitations with 1,370,729.6 ha (5.3% of land) were operated beneath multiple forms of tenancy.

Table II

Venezuela

Percentage Distribution of Cultivated Land*

Farm Size	As a % of total land 1950	As a % of total land 1961	As a % of own land cultivated 1950	As a % of own land cultivated 1961
Under 5 ha	.9	.9	82	69
5-20	1.6	1.8	57	33
20-100	1.3	1.4	28	23
Over 100	2.1	2.3	2	3
Total	5.9	6.4	5.9	6.4

Tenure Class	As a % of total land 1961	As a % of own land cultivated 1961
Prop.	3.5	4
S.C. and Renters	.8	29
Occupants	2.1	17
Total	6.4	6.4

	Total Cultivated Land (Crops)
1936/7	730,000.0 ha
1950	1,302,116.0 ha
1961	1,669,351.4 ha

*Permanent and transitory crops, excludes cultivated pastures.

Sources: See Table 1.

while col. 4, line 7 shows that 68.7 percent was operated under proprietorship on farms of over 1000 ha. The column totals represent the total percentages of the land held under each class of tenure, e.g., col. 4, line 8 shows that proprietors held 83.2 percent of the land in 1950. The row totals represent land on farms of a certain size, e.g., farms between 5 and 20 ha in size held 1.0 percent of the land in 1936, 2.8 percent in 1950 and 3.5 percent in 1961.

The most obvious point to be made from inspecting Table I is the extreme inequality of land holdings, which is characteristic of so many Latin American countries.[14] This is especially true since much of the land in the last three tenure categories probably belongs to the large owners. Further, since farms held by different members of the same family and farms which are not in the same "municipio" are both treated as separate exploitations, concentration of ownership, as opposed to operation, is probably even higher than shown. The data in Table I also suggest a slight reduction in size inequality over time, with the land being divided up into more medium and smaller plots, and this is borne out by the Gini coefficients of concentration which were .925 in 1936, (strongly affected by the 89.0 percent in farms of over 1000 has. and excluding the lands of the dictator, Gomez), .946 in 1950, and .909 in 1961, where 1 represents perfect inequality--everything belongs to one unit--and 0 represents perfect equality of distribution.[15] While progress has been made since 1936, the reduction in inequality has, in fact, been slight in the decade before the land reform of 1960.

Table II shows that at least in 1950 and 1961 the percentage of cultivated land was much higher on small farms, though the percentages declined from 1950 to 1961. On the smallest farms (under 5 ha) it was over 80 percent in 1950 and 70 percent in 1961 compared with around 25 percent in the farms between 20 and 100 ha and less than 3 percent in the farms over 100 ha. The prevalence of uncultivated lands on large farms has been observed in most Latin American studies.[16] However some, though not all, of the differences in the percentages of cultivation are due to the fact that many of the large farms are cattle ranches in the llanos, which are not very useful for cultivation due to annual flooding. With small and medium sized farms cultivating so much of their available land, and large farms cultivating so little, we find that (a) a very small percentage of land is cultivated (5.9 percent in 1950, 6.4 percent in 1961), (b) that more than half of the cultivated land is on the farms under 100 ha (64 percent in both 1950 and 1961) and (c) the distribution of cultivated land is more even than that of total land, as shown by Gini coefficients of .565 in 1950 and .504 in 1961. Finally, we should note that although there has been some movement toward a more equal distribution of cultivated land, in the aggregate the relative fractions of land cultivated on the different size farms has not changed much between 1950 and 1961. This stability, as well as the relative stability of the various size and tenure classifications shown in Table I suggests that aggregate estimation of agricultural production functions is feasible, or at least more feasible than would be the case if there had been significant changes in size distributions and/or the structure of land tenure. However, the stability of land distribution in each state--the Gini coefficients of total land holdings usually change less than two percent--would seem to make it difficult to separate the effect of ownership structure from differences in the productivity of each state.

III. Testing for Static Misallocation and Aggregate Output

The usual approach to testing the three conflicting hypotheses (radical, conservative, market failure) about static misallocation and rates of technical change would require data on individual farms. Then production functions, technical change, and marginal products of different factors on the different farm sizes or farms cultivated under different tenure arrangements would be estimated and compared. Of course there are many pitfalls in this approach, such as the difficulty of separating biased technical progress and the elasticity of substitution.[17] Moreover, even assuming a simple cross-sectional Cobb Douglas function with neutral technical progress leads to the well-known statistical problems in identification, owing to the profit maximizing conditions.[18] In addition, the usual estimates of the variances of the marginal products are biased, and so it is difficult to construct confidence intervals with which to test the equality of, labor's marginal product on, say, large and small farms.[19] Since Venezuela, in common with most less developed countries, lacks such cross-sectional sample survey data, even this approach cannot be used.[20] As an alternative, an indirect estimation procedure, using as observations the state, district, and even "municipio" values of output data on different sizes of farms might be tried. However, while statewide data on outputs and most inputs is available by size of farm and in some cases by tenure classes, even a rough breakdown of labor use on different size farms and farms operated under different tenure classes is unavailable. Nonetheless, as will be described below, it is still possible to make some tests of the static efficiency.

As a preliminary to these tests we estimate a statewide production function in crop production.[21] To begin let us assume that the crop production of each state is subject to an aggregate production function which differs only in the constant term,[22] due to random, log normally distributed, multiplicative, interstate differences in soil, rainfall, etc. For the sake of simplicity, the form is assumed to be Cobb Douglas or linear in the logs, i.e.,

$$1] \quad \log C_j^t = \sum_1^n \beta_i \log X_{ij}^t + u_j^t$$

where C_j^t = gross value crop output, measured in 1957 prices (Banco Central de Venzuela, Memoria 1959, Caracas, 1961) in the j^{th} state in year t

X_{ij}^t = stock of the i^{th} factor used in the j^{th} state in year t

β_i = output elasticity of the i^{th} factor

u_j^t = the log of the random neutral-multiplicative difference in efficiency in state j in year t. It was assumed that the distribution of u_t is normal with constant variance. As an alternative, to correct for heteroskedasticity, estimates based on per farm data were tried. However, they showed little or no change in either the coefficients or standard errors of the regression.

Only stock variables were available (except fertilizer which is a flow) and it seemed that any attempt to derive a service flow[23] would only bias the estimates in an unknown direction. Further, by using the stocks of inputs and assuming that in the aggregate producers maximize expected outputs but are confronted with a random disturbance in any given year, we hope to reduce simultaneous equation bias.[24]

With the exception of the labor figures, all data from the study have been taken from the sources listed in Table I. As to labor, two estimates of the labor force engaged in crop production in each state during 1961 were used, one based on the 1950 population census (applying the 1950 ratios of crop to total agricultural workers to the figures for agricultural workers shown in the 1961 population census) and the other based on the results of a BCV sample survey on the percentage of hired time spent on crop as opposed to livestock production.[25] However there was little difference in the two results and the paper presents only those estimates based on the first method.

In an effort to reduce the problem of differences in land quality only cultivated land has been used. Thus pasture land was omitted from the independent variables and the value of livestock output from the dependent. In addition, the observations for the Venezuelan states of Apure, Nueva Esparta, and the Federal Territories were not included since it was felt that there were substantial differences between the land quality in them and in the rest of Venezuela.[26]

Table III contains the results of Equation (1) estimated for 1950, 1961, and for both years, using census data, together with the Standard errors of the estimated coefficients-output elasticities in parentheses. Coefficients which are significantly different from zero at the 95 percent level are indicated with one asterisk, at the 90 percent level with two asterisks.

In all these cases the sum of the coefficients is somewhat less than one, though not significantly different from one at the 95 level as shown by the F statistics at the bottom of the table (These F statistics were calculated from a comparison of the unconstrained and constrained production function, where the constraint was the requirement that the

TABLE III

	1950-1961	1950	1961
Constant	7.24* (.66)	6.85* (1.19)	7.38* (1.05)
L Tract	.10* (.05)	.10 (.07)	.10 (.12)
L Frtlz	-.07* (.03)	-.09* (.04)	.10 (.10)
L Irrig	.02 (.04)	.02 (.09)	-.03 (.07)
L Livestock	-.09 (.07)	-.04 (.10)	-.08 (.12)
L Lab	.10 (.21)	-.06 (.37)	.19 (.48)
L Land	.72* (.19)	.85* (.30)	.67* (.42)
L Cofca	.11* (.04)	.13** (.09)	.04 (.07)
Dummy	.09 (.12)		
Σ Coeff	.89***	.91***	.99***
R^2	.93	.94	.94
F	48	26	26
Obs	38	19	19
DF	29	11	11
SSE	1.121	.437	.427
F Test of Equal of Coef 50 & 60 DF = 7, 22		F = 1.09,	
F Test of ΣDif from 1, DF=1, DF	F = 1.73	F = .5	F = .03

* Sig. Dif. from zero at the .95 level
** Sig. Dif. from zero at the .90 level
*** Not sig. dif. from one at the 95% level

coefficients sum to one.) Thus the aggregate production function can be said to display the convenient property of constant returns to scale. However, even a sum somewhat greater than one might be expected as the dependent variable is gross output not value added, and in any case would not be disturbing as there is some difficulty in interpreting returns to scale in an aggregate production function.

The next to last line of the table represents the result of an F test for a difference in the output elasticities in the two periods, using the three regressions shown. Since the F statistic is so low we must conclude that the output elasticities are not significantly different at the 95 percent or even 90 percent level. Therefore it seems safe to assume that one Cobb Douglas production function prevailed in the two years and that a CES production function or non neutral technical change would not be attractive alternative assumptions.

As shown in the combined regression of Table III, the estimated output elasticities of tractors, trees, and land are significantly positive, while those of labor, and irrigation are positive but insignificant. While other empirical work has usually not found any strong relation between irrigation and output, the low labor coefficient relative to the standard error is surprising and might be attributed to errors in measurement, or to multicollinearity, since the simple correlation coefficient of land and labor is around .9. Finally, the coefficients of livestock and fertilizer are negative. The later result, so contrary to the usual empirical evidence, might be explained by errors in measurement,[27] by the high correlation coefficient between fertilizer and some of the other variables, particularly tractors (about .7 in the logs), or by a strong positive correlation between fertilizer use and farm size, which, if the radical's contention holds up, is inversely related to statewide output.

It is also possible to argue that these relatively poor results may be attributed to a simultaneous equation bias, due to an incorrect assumption of independence between the mobile factors and the error term. In other words, some states were, on the average, more productive, and historically attracted a relatively large stock of the more mobile factors. This obviously violates the assumptions required for unbiased regression estimates, namely that the error terms and independent variables are independent.[28]

The best way to correct for this "management" bias would be the explicit introduction of factor supply functions but, as mentioned earlier, factor price data is generally unavailable. Another alternative is the well known analysis of covariance approach (ACV) for dealing with cross sectional time series.[29] This approach involves splitting the error term into time, state, and random components through the use of separate intercepts or dummies for each state and each year.

Table IV presents the results of an unqualified use of the ACV approach, including estimates of the intercepts for each state. As can be seen, there is a substantial increase in the coefficients of labor and livestock. In addition, the coefficients of coffee-caco trees and irrigation also increase, while the coefficients of land and of tractors fall. While management bias in the usual firm models usually leads to an overestimate of the elasticities[30] in the aggregate the result if not so certain and would appear to depend, at least in part, on the relative factor mobilities. Coefficients of immobile capital would appear to rise, based on the Venezuela

TABLE IV

	ACV	Modified ACV
C	---	---
L Tract	-.02 (.08)	-.08** (.05)
L Frtlz	-.10* (.02)	-.06* (.02)
L Irrig	.07* (.04)	.10* (.03)
L Livestock	.23 (.26)	.15** (.11)
L Lab	.62* (.27)	.30** (.23)
L Land	.44* (18)	.54* (.15)
L Cofca	.39* (.11)	.43* (.08)
Dummy	-.01 (.15)	-.06 (.10)
Other	---	---
Σ Coeff	1.63	1.38
F · Test for Σ=1, DF=1, DF	5.8	7.2
R^2	.993	.986
F	59	71.6
Obs	38	38
DF	11	19
SSE	.112	.230

TABLE IV (Cont.)

State Intercepts

	No.	ACV	Modified ACV
DF[1]	1	-.31 (.65)	-1.21 (.41)
Anz	2	-1.30 (.52)	
Ar	3	-.36 (.49)	
Ba	4	-.33 (.54)	-.83 (.43)
Bol	5	-.12 (.38)	-.54 (.32)
Car	6	-.43 (.52)	
Coj	7	.30 (.38)	-.26 (.30)
F	8	-1.51 (.55)	
G	9	-.89 (.52)	
L	10	-1.45 (.61)	
Mer	11	-1.60 (.65)	
Mir	12	-1.16 (.58)	-1.64 (.42)
Mon	13	-1.13 (.56)	Guarico River States (9, 14, 18) -1.23 (.37)
Port	14	-.89 (.49)	Anz, Mon (2, 13) -1.55
Sucre	15	-1.60 (.64)	Dry Coastal Plain (8, 10, 15) -1.86 (.43)
Tach	16	-1.59 (.67)	
Tru	17	-1.91 (.63)	Andes (11, 16, 17) -2.12 (.45)
Yar	18	-.70 (.50)	Ar, Cara (3, 6) -.97 (.33)
Zulia	19	-1.14 (2.80)	1.43 (.93)

1] To calculate the appropriate state intercept, the figure shown should be added to the figure for Zulia.

evidence, where the sum of the output elasticities of land, trees, and irrigation increases, and in Timmer's estimation for the U.S.[31] On the other hand the coefficients of most mobile factors would appear to fall, as shown by the decrease in the coefficients of tractors and fertilizers. Finally, the factors with intermediate mobility-- livestock in the U.S. and Venezuela, and as argued in the introduction, labor in Venezuela, but not in the U.S.--would also tend to rise. And interpreted in this way, the rise in the Venezuelan labor coefficient indicates some immobility and holds some promise of empirically measurable monopsony power.

All the coefficients are now significant at the 95 percent level except livestock (significant at about the .8 percent level) and tractors. Fertilizer again remains significantly negative. The estimated sum of the coefficients is now much greater than one, and significantly different at the .95 level. However the sum is **not** significantly different than 1.06 which, as discussed above, seems reasonable when the dependent variable is gross value of output.

While the state dummies are generally significant and the hypothesis of a single constant is easily rejected, many of the dummies are obviously not very different from one another. In addition the coefficient of the time variable, which is usually taken to be technical change, has now shifted to (insignificantly) negative. And, of course, the assumptions of ACV method prohibits any test of nonneutral shifts in the production function with data from only two periods.

As pointed out elsewhere,[32] the ACV estimates neglect the variation between individual and period means and use only the deviations from these means in their estimates of the output elasticities, making them somewhat inefficient. One simple method that has been suggested for improving the ACV results along these lines is a combination of some of the state dummies based on an observed similarity of temperature, climate, rainfall, and land fertility.[33] In the Venezuelan case, it seems reasonable to argue that certain groups of states such as (1) the Venezuelan Andes (Mérida, dummy 11); Tächira (16), and Trujillo (17)); (2) the dry coastal states (Falcón (08), Lara (10), and Sucre (15)); (3) the states lying in the Guárico river basin (Guárico (09), Portugesa (14) and Yaracuy (13)); the states around Lake Valencia (Aragua (03) and Carabobo (06)); and the eastern agricultural states (Anzoategui (13) and Monagas (13)) are essentially the same in terms of long-run average fertility. If this is true, the states in each group would have the same intercept or dummy variable, and the same long-run attractiveness to mobile factors. Observed differences within these groups can then be interpreted as random disturbances, uncorrelated with the independent variables, increasing the efficiency of the estimates.

The results of these new regressions are also shown in Table IV. As is to be expected, following the previous argument, there is some decline in the individual coefficients, particularly labor's output elasticity. However all coefficients remain different from zero at the 95 percent level except labor (.85), and any loss in its significance is partially offset by the improvement in the "t" statistic of the livestock coefficient. Though the sum is still greater than one, it is much smaller, and not significantly different than 1.00 at the 95 percent level. As to the state dummies, again almost all are significant and a comparison with the first column shows almost no loss in the explanatory power, as measured by SSE or in R^2, due to the combination of states. In fact a test of the combined versus uncombined dummy hypotheses yields an F statistic of only 1.45, showing the two approaches are essentially the same. Finally the modified state coefficients seem to match our a priori conjectures about fertility quite well, with the area around Lake Maracaibo in Zulia, the most productive, the area around Valencia next, the Guárico basin third, and the dry coastal states followed by the Andes, which are subject to all the difficulties of mountain farming, bringing up the rear. Thus the modified ACV approach seems to provide the most reliable estimates of the cross state aggregate production function.

Given the crude nature of the data--stocks unweighted by prices, or rates of service flow, imperfect estimates of the stock of labor, etc.--it is surprising that the results are as good as they are. A comparison of the results with the estimates of Griliches (ACV, U.S. 1949, 54, 59) Ruttan-Hayami (38 country cross-section of LDC's & DC's 1960) and Timmer (U.S. 1960 to 1969), which are shown in Table V, indicates a striking similarity. Our labor coefficient (.30) lies within the range of the other estimates, our land coefficient is somewhat high and livestock somewhat low, but this is probably due to the difference in coverage-crop in Venezuela, crop plus livestock in the others. The coefficient of neutral technical change is similar to the value obtained by Griliches. And although the sum of the coefficients is somewhat larger than the others, it is not unreasonably greater than Griliches' result. Moreover, in the case of irrigation and trees--factors which were not treated separately or omitted due to lack of data in the other studies--the strong results of the Venezuela study tend to confirm the other investigators' conjectures. Only in the case of tractors and fertilizer are the results really different and this may be

TABLE V

	Griliches ACV 1949-59	Timmer OLS U.S. 1960-67	Timmer ACV U.S. 1960-67	Hayami and Ruttan OLS 38 Countries 1960
C	---	1.74	---	NR
L Tract-Machines	.20*	.37*	NR	.192* (.056)
L Frtlz	.11*	.15*	.05*	.161* (.053)
L Livestock	.39*	.25*	.31*	.191* (.096)
L Lab	.43*	.19*	.12*	.335* (.064)
L Land	.15*	.05*	.34*	.056 (.065)
Dummy	(54)-.01 (59)+.01	NR	NR	NU
Other	---	.16*	.12*	---
Σ Coeff	1.28	1.17	.94	.94* (.035)
R^2	.98	.97	.99	.955
Obs	117	364	364	38
DF	71	357	301	33

NR = Not Reported
NU = Not Used

due to errors in measurement, biasing the ACV coefficients downward, as Timmer has suggested in the explanation of his inability to estimate the capital coefficient satisfactorily.

IV. A Test of Static Misallocation

Turning to the question of static efficiency or the lack thereof, we test the radical view of static misallocation against the conservative view of economic efficiency by an indirect method. Let us assume constant returns to scale, competitive factor use, and, for the present, homogeneity of cultivated land throughout a state.

Under these conditions similar quantities of production factors would be applied to the same quantity of land, regardless of whether it was cultivated by small or large farmers or whether it was tilled by proprietors, share croppers, or tenants.[35] As a result, the marginal productivity of cultivated land, whether on large or small farms and independent of the tenure systems under which it was cultivated, would be equal. Redistribution of land from one group of farmers to another, other inputs held constant, would not change total statewide output. Equation (1) essentially assumes that these conditions hold, as total land was "constrained" to have a constant output elasticity and therefore each type has an equal marginal productivity.

An alternative way of arriving at the same proposition would be to think of each state as a large farm with its observed distribution of cultivated land between large and small farms and between the different tenure systems. Efficient allocation by a manager would require an intra-state allocation of the mobile inputs which would equate marginal products on the same quality land, whether it was part of a latifundio or a share-cropper's or squatter's minifundia. On the other hand, systematic misallocation by the farm managers in each state would mean that relatively too many factors were applied to the land on certain size farms or on farms which were operated under one of the three tenure classifications. Therefore, the land on farms of that size of that tenure system would have a higher marginal product than the other types of land.

As discussed earlier, the radicals argue that the effect of the "latifundistas" monopsony power and tenure rules is to reduce labor on the largest farms below the competitive optimum and to squeeze the peons onto small plots, to which, in order to keep alive, they apply too much labor. Thus, land on the minifundia would have higher productivity, land on the latifundia lower productivity. And while the radicals do not extend the argument to the intermediate size farms, presumably they too should use "too" much labor relative to the large farms. Since they are also regarded as modern, employing large amounts of intermediate inputs, one might expect that the marginal products of their cultivated land would be even greater. On the other hand, the conservative view would imply equal marginal productivity of land on all farm sizes and tenure classifications. In fact it seems very likely that marginal productivity of land on the largest farms should exceed that on the small, since it could be argued that the latifundistas chose the best land, and use more of the modern inputs.[36]

Our direct test of optimum allocation of labor versus misallocation is, therefore,

$$H_o : \frac{\partial Q}{\partial L_r} \geq \frac{\partial Q}{\partial L_s}$$

$$H_a : \frac{\partial Q}{\partial L_r} < \frac{\partial Q}{\partial L_s}$$

where Q = quantity of output measured in 1957 prices

L_i = land cultivated under tenure classification i or land cultivated on farm size i

i = r,s and r, s refer to different tenure classifications or farm sizes and class, "r" refers to a larger farm or one with more property rights than class "s." For example, when treating farms of different sizes, s, and r might take on values 0-100 ha and over 100 ha, class "r" always above "s" in size. However, when comparing the productivity of land on farms cultivated under the different tenure arrangements, r and s take on the values proprietor, renter, and sharecropper, squatter, with class "r" always referring to the group with more property rights.

Although there is obviously some overlap of size and tenure classifications, we will test separately for the competitive allocation of labor among farms of different sizes, and among farms operated under different tenure arrangements.

To apply this test, we need an unconstrained version of the cross-state production function of Equation (1). We would then test whether the assumption of the null hypothesis, i.e. constraining the aggregate production function to an equality of marginal products, significantly worsens the fit obtained with an unconstrained production function.

We assume the form of the unconstrained production function is:

$$2] \quad \log Q_j^t = A_j + A_t + \sum_{i=1}^{i=k} \beta_i \log X_{ij}^t + \sum_{i=k+1}^{i=n} \beta_i \log X_{ij}^t + u_j^t$$

where all variables have the same interpretation as previously and the factors uumbered k+1 to n are the amounts of land in state $_j$ which are cultivated on different size farms or under different tenure arrangements.[37]

Using Eq. 2 we can then test the proposition that the land quality in each size, class, or tenure is the same. This test is simply that there is no significant difference in the output elasticities of land cultivated under different tenure arrangements or on different size farms. If that hypothesis is accepted, we can then move to the test of equality of marginal products. Basically this test uses the CD property that the marginal product equals the average product multiplied by the output elasticity. Substitution into the null hypothesis above and simple manipulation yield:

$$\beta_r \; Q/L_r = (\partial Q/\partial L_r \div Q/L_r) \gtrsim (\partial Q/\partial L_s \div Q/L_s) \; Q/L_s = \beta_s \; Q/L_s$$

or

$$3] \quad H_o : \beta_r \gtrsim \beta_s L_r/L_s$$

Assuming equality (or H_o), this can be used as a constraint by substituting the right side of 3] for β_r and comparing the resulting constrained form with an unconstrained form of Eq. 2. This manipulation can be used because the form of Eq. 2 implies each type of land enters separately in determining aggregate output and thus the average product of each type of land has the same numerator, Q_j.

Further, the direction of the inequality could be determined by assuming the ratio of the differences in marginal products is a constant fraction, R, across states.

Then Equation 3 becomes

$$4] \quad \beta_r = R \; \beta_s L_r/L_s$$

and after substitution the test of our hypothesis becomes

$$H_o: MP_r \geq MP_s \equiv \overline{R \; \hat{\beta}_s} \gtrsim \hat{\beta}_s$$

$$H_a: MP_r < MP_s \equiv \overline{R \; \hat{\beta}_s} < \hat{\beta}_s$$

where $\wedge$ represents estimated values and

$\frac{\hat{}}{R\beta_s}$ is estimated by regression with a new variable,

$$\text{Log } X_{rj} \cdot L_{rj}/Lsj.$$

Differences in land productivity could be handled in similar fashion, by making assumptions about R based on estimated output elasticities.

V. Results of the Test: Venezuela

Table VI presents the results of the tests for static misallocation described in the previous section. In an effort to keep the presentation manageable the estimates of the state intercepts have been omitted and only the results for the modified ACV approach are shown. The results of the unmodified ACV and the OLS approaches, which are similar, are shown in the statistical appendix, Tables AI and AII.

Col. 1 of Table VI presents a regression (unconstrained) estimate of Eq. 2, using two types of land, land on farms over and under 100 has.[38] Both of the estimates (.40 and .15) are significantly positive at the 95 percent level. A test for differences in the two elasticities, was negative, as shown in the next column, which reports the constrained equation and the F statistic of the constraint of equal marginal products. (F = 2.13 DF 1, 18). Thus there is no statistical difference in land quality.

In contrast, the assumption of equality of land's marginal products is strongly rejected. Col. 3 presents the results of a regression estimate using Equation 3, i.e., assuming equality of marginal products and substituting for one of the output elasticities. This assumption or constraint significantly worsens the fitted regression line, as shown by a comparison of the standard errors of Col. 3 and Col. 1, where marginal products of land

TABLE VI

	COL. 1 Modified ACV Two Land Sizes	COL. 2 Constrained Equal Output Elasticities	COL. 3 Constrained Equal Marginal Products	COL. 4 Size of Difference in Marginal Products
L Tract	-.07 (.06)	-.09** (.06)	-.12* (.07)	-.11* (.06)
L Frtlz	-.06* (.03)	-.08* (.02)	-.10* (.03)	-.08* (.03)
L Irrig	.09* (.04)	.09* (.04)	.12* (.04)	.10* (.03)
L Livestock	.19** (.13)	.10 (.11)	-.09 (.15)	.07 (.14)
L Lab	.27 (.26)	.45* (.24)	.95* (.21)	.41** (.24)
C Cofca	.45* (.09)	.42* (.09)	.39* (.10)	.42* (.08)
Dummy (Time)	-.15* (.16)	.01 (.12)	.27 (.24)	.11 (.20)
L Land under 100 ha	.40* (.14)			
L Land Over 100 ha	.15** (.10)			
L Land < 100 & L Land > 100		.23* (.09)		
L Land (MP's =)			.04** (.02)	
L Land Under 100 ha				.47* (.13)
L Land Over 100·Lr/Ls				.04* (.02)
F vs. Col. 1 DF = 1, 18	---	2.13	5.80	n.a.
R^2	.984	.982	.979	.987
F	58	58	49	69
Obs	38	38	38	38
DF	18	19	19	18
SSE	.254	.284	.336	.214
SER	.12	.12	.13	.11

may differ but the fit is not necessarily the best. In other words, it would be a serious error to assume the marginal product of cultivated land is the same on small and large farms.

Finally, Col. 4 presents estimates of the direction of the inequality, as described by Eq. 4, where the marginal products differ by a constant ratio. The estimated coefficient of land on the farms under 100 ha (.47) is almost twelve times greater than the coefficient of land on large farms (adjusted following 4].). In turn this means the marginal product is also twelve times larger, in spite of the aforementioned high correlations between large farms and tractors, irrigation, and fertilizer. It also seems unlikely that this great difference could be explained solely by the differences in quality shown in Col. 1; in fact, to account for this difference at even the 95 percent significance level the land on small farms would have to be 5 times more productive.[39]

To summarize: Table VI shows that although land quality is roughly the same on farms over and under 100 has., its marginal product is much higher on smaller farms. By our earlier argument this can only occur if labor use on small farms is greater, for in general the larger farms tend to use more of the other, modern inputs. Thus the radical's monopsony power or at least some of the market imperfections discussed in footnote 8 such as preference for work on one's own land or non maximizing latifundistas seem to exist. It follows that a reduction in the unequal distribution of land would, ceteris parabis, increase output. And the percentage of land cultivated would probably rise. However if the simple market model also breaks down because of information costs, etc., which favor the large farms, then other inputs might fall with a land reform, offsetting the ceteris parabis effects. Thus any land reforming Venezuelan government would have to be careful to provide such inputs or risk losing any output gains.

The available evidence seems to indicate that such a policy was attempted in Venezuela during the sixties with some success, at least as measured by aggregate agricultural growth and competitiveness in world markets.

After passage of the Agrarian Reform Act of 1960, the ruling party and its peasant federation agreed to stop using land invasion as a tactic. Instead, both groups committed themselves to the creation of a new class of small family farm owners. It was their intent to organize settlements (now numbering almost 900) on purchased or public lands and within these settlements to parcelize the land, and provide housing, water, market roads and extension services. A special compesino program was organized by the government agricultural credit bank and modern inputs such as new seeds, fertilizers, and machinery were supplied at subsidized prices.[40] Though the definitive study has yet to be done, the program has drawn critics who have suggested that it was too expensive and too much[41] and others who suggested that it was too little, and too extensive.[42] However, one available study does support the results of this paper; finding that even those programs without much investment in auxiliary services would raise output. However, rates of return are low if the cost of land is included, and rise when more auxiliary services are added, lending support to the market failure approach.[43]

Based on the above evidence one might expect rapid agricultural growth in Venezuela during the early sixties. Though no causal relation can be proved, this is exactly what did occur. From a lagging sector in the fifties, agriculture became a leading sector in the sixties, in an economy suffering from a slowdown in the growth of its major export, petroleum.[44]

Production also seemed to increase in international competitiveness, as non-traditional agricultural exports grew at nearly double the rate of the economy during the period 1961 to 1966. Compared with other major Latin American countries, the overall performance is even more striking; only Venezuela and Mexico were able to increase per capita food output during the sixties.[45] Finally, the results of this paper would also suggest that once the static reallocation effects were achieved, agricultural growth would **slow** down without continued investment or technical progress. Again the aggregate evidence is consistent constant, showing some slowing of the agricultural growth rate in the late sixties,[46] though again no causal relation or proof of the hypothesis can be claimed.

Turning to the test of differences between the productivity of tenure classes, we first compare the output elasticities of land cultivated by proprietors, renters-sharecroppers, and squatters using the methods described by Eqs. 2, 3, and 4. Since data from 1950 on the distribution of cultivated land by tenure classes were unavailable, only the OLS method could be used. The results for regressions using the three classes are presented in Table VII, however, there was little or no difference when the comparisons were made between owners and non owners. As might be expected, given the paucity of observations and the difficulty with OLS, the results are much poorer than those by farm size. Although land cultivated by squatters has the highest output elasticity, there was no significant difference between the three coefficients. Further there was also no significant difference between the three marginal products, implying that any breakdown in markets should not be attributed to the tenure structure. Thus the results of this

TABLE VII

	COL. 1 OLS 3 Tenure Classes	COL. 2 OLS Equal Output Elasticities	COL. 3 OLS Equal Marginal Products
C	7.12* (1.13)	7.44 (.90)	12
L Tract	.09 (.09)	.09 (.09)	.23* (.07)
L Frtlz	.11** (.08)	.11** (.08)	-.05* (.08)
L Irrig	-.04 (.06)	-.07 (.06)	-.06 (.06)
L Livestock	-.12 (.12)	-.06 (.10)	-.17 (.11)
L Lab	.57** (34)	.51* (.23)	.97* (.20)
C Cofca	.03 (.07)	-.01 (.06)	.13 (.05)
L Prop	.10 (.17)		
L Rent, SC	.11** (.08)		
LSQT	.24* (.12)		
ΣLLD		.17* (.07)	
L Land (MP's =)			-.0035* (.0020)
F vs. Col. 1 DF = 2, 9		.72	1.96
R^2	.963	.956	.945
F	26	34	27
Obs	19	19	19
DF	9	11	11
SSE	.284	.331	.410

paper are in accord with the work of Cheung, who demonstrates that no static misallocation will arise from competitively determined sharecropping arrangements.[47] The crucial breakdown in markets would seem to be the result of the large farm-small farm structure, rather than the tenure structure.

This conclusion is also supported by an alternative analysis. Cheung finds static efficiency and would use differences in crop risks and transactions costs to explain differences in the percentage of sharecropped land. More recently Bardhan and Srinivasan have pointed out that Cheung neglects tenant maximization and when this is introduced there will be some misallocation.[48] They then show that parametric shifts in the wage would increase the percentage of land sharecropped, as would land augmenting innovation.[49] The authors confirm these results with tests on Indian data.

Applying the Bardhan-Srinivasan test to Venezuelan statewide data[50], we obtain the following regression, similar to that used in their original article:

$$\text{Log PCT Share Cropped} = .35 - 2.94 \text{ Log Wage} + .58 \text{ Log Irrigation}$$

$$\text{SE} \quad (5.3) \quad (2.00) \quad (.29)$$

$$DF = 15$$

$$R^2 = .30.$$ [51]

The low coefficient of determination is roughly the same as those in the original article and irrigation's coefficient is significant, with the correct sign. However, the coefficient of the wage has the wrong sign and is not significantly different from zero.

One explanation for this poor result would seem to be the treatment of the wage as parametric. If differences in wages are mainly the result of neutral technological differences in agriculture, for example, then the sign of the wage coefficient may be negative.[52] Alternatively, if low wages are the result of monopsony power in a state, due to uneven distribution of land, we would expect that a) the coefficient of the Gini variable would be negative as the monopsonist would tend to offer fewer leases and b) the negative correlation between the Gini coefficient and the wage rate would tend to increase the coefficient of wages. Following Bardhan and Srinivasan we introduce the Gini coefficient and obtain:

$$\text{Log PCT sharecropped} = \underset{(5.96)}{-6.96} + \underset{(2.4)}{.33}\ \text{Log Wage} + \underset{(.28)}{.40^{**}}\ \text{Log Irrigation} \quad \text{(SE)}$$

$$- \underset{(6.56)}{14.17^{*}}\ \text{Gini.} \qquad DF = 14 \qquad R^2 = .47$$

The only significant coefficient (at the 95 percent level) is associated with the Gini and it has the expected negative sign. Although it robs the other coefficients of significance, it does change the sign of the wage coefficient. These results seem to confirm the previous analysis; that the distribution of land is the crucial variable in any analysis of misallocation and market failure in rural Venezuela, not the tenure structure.

VI. Summary and Conclusions

This paper advances and tests three basic hypotheses about agricultural structure and agricultural output--conservative, radical, and market failure due to information costs, risks, etc. The radical view suggests that emphasis should be placed on sharecropping and monopsony power as methods of exploitation which, incidently, lead to a misallocation of labor toward the smaller farms and a loss of aggregate output. The empirical phenomena which would support this view would be a significant difference between the marginal products of land on a) small and large farms, and b) proprietor operated vs. sharecropper-occupant operated farms. To correct these deficiencies and increase agricultural output the radical would advocate a breakup of the large estates and restrictions on rental contracts, such as now exist in the Brazil and Colombia.

By contrast, the conservative would argue that large farmers are better farmers and their land is more productive because they are more perceptive, react more quickly, and use more inputs. The empirical implication of this view is that marginal productivities of land should be greater on large farms, with the cor esponding policy implication that a land reform would reduce total agricultural output.

Finally, the middle view--based on the inadequacy of simple market analysis--suggests that a variety of elements such as preference for work on ones' own land, utility rather than profit maximizing landlords, differences in risks, and information, would lead to differences in input proportions on small and large farms. While this view carries no presumption toward the relative sizes of land's marginal product, only the first two of the cited elements would lead to a difference favoring small over large farms. If this element dominates and assuming small farmers cultivate a greater percentage of their land, then agrarian reform would still tend to increase agricultural output, although the government might be forced to take some action to prevent other inputs from falling.

As a preliminary to a test of the validity of these hypotheses about marginal products, an aggregate Cobb Douglas Production Function was estimated by OLS and ACV, using Venezuelan state inputs and outputs as the variables. Venezuela was used because its land structure and slow growth of agricultural output seemed quite representative of Latin America during the fifties, while its data seemed relatively good.

The most reasonable estimates of the output elasticities were obtained by using a modified ACV approach. The results of this estimation were quite reasonable in terms of a) significance levels of coefficients over .95, b) similarity of estimates to other work (Griliches, Hayami-Ruttan, Timmer), c) a priori conjectures regarding the relative productivity of groups of states e.g. the Andes (low), Lake Maracaibo region (highest), Lake Valencia region (very high).

In addition the results confirmed the conjectures of other authors regarding the importance of irrigation and trees as productive elements of rural capital stock.

The estimated, statewide, aggregate production function was then used to test the three hypotheses (Radical, Conservative, Market Failure) about relative marginal productivities on a) large and small farms, b) farms operated by proprietors, renters, and sharecroppers. To make this test we treated each type of land as a separate element in the production function and estimated their output elasticity. A comparison showed these output elasticities could be treated as essentially equal for statistical purposes. Assuming this equality, a test was then made using the constraint that equality of marginal products would imply equality between one output elasticity and the other, multiplied by the ratio of the two inputs. This constraint showed that a) the marginal products of land on small and large farms were <u>essentially different</u>. b) the marginal products of land operated by proprietors, renters and sharecroppers and squatters or owners and non-owners were <u>essentially equal</u>.

This second result--supporting Cheung's contention that different tenure patterns are not evidence of misallocation, and that the important variable is the distribution of ownership--was confirmed by regression analysis of the percentage of land sharecropped along the lines suggested by Bardhan-Srinivasan. Only the Gini coefficient of land distribution had significant explanatory power and it seemed to be inversely related to the wage as well as the percentage sharecropped, as would be expected.

Finally, a regression was estimated with the small farm, large farm data which allowed the marginal products of land to differ from each other by a constant factor. This regression showed that cultivated land on large farms was roughly .08 as productive as land on small farms with an upper bound of .20. Since the ratio of output elasticities--one estimate of relative qualities--was only .37, this means that the observed differences in marginal products could not be explained by differences in land quality.

These empirical results would tend to provide support for the radical's call for Agrarian Reform, though they would also suggest that tenure arrangements should probably continue to be left to the market. Finally, since the larger farms do seem to be associated with greater use of modern inputs, any agrarian reform legislation should include provisions to improve the distribution of these inputs and the associated modern techniques. Some attempt was made to carry out such a land reform in Venezuela during the sixties and the aggregate data support the results of this paper, though they obviously are only correlated with the land reform and cannot be shown to have been caused by it. Immediately following the land reform, agriculture became a leading sector and increased in international competitiveness. However, as might be expected from a single improvement in static efficiency, the growth rate of agriculture declined by the end of the decade. To maintain the high growth rate, continued investment and continued technical improvement will be necessary.

Footnotes

[1]See Hanson and Lombardi [1971], Powell [1969], Powell [1971], pp. 45-50.

[2]See Berry [n.d.] and Navarette [1967]. The author's calculations show that rural money wages in Venezuela have not quite tripled between 1936 and the early 1960's, while manufacturing wages have increased almost sixfold. See for example DGE, I Censo Agro-Pecuaria [1936]; DGE, I Censo Industrial [1936]; DGE, Novena Censo de Poblacion [1961]; DGE, II Censos Económicas Manufactura [1963]; Min. de Trabajo, Estadística del Trabajo various issues. By contrast, an index of wholesale prices (linked in 1937 and 1957) doubled. See BCV, Memoria and BCV Informe Económico, various issues.

[3]For a broad treatment of low productivity and agricultural stagnation in Latin America between 1945 and 1960, see ECLA [1963].

[4]See the arguments cited by Kaufman [1967]. Other general works on the land problem and the radical arguments are Barraclough and Domike [1969] and Griffin [1969], pp. 63-86.

[5]This view also has adherents among the economics profession. For example Hagen [1968] offers the opinion that "where plantation agriculture is practiced, a shift to peasant ownership would typically cause a decline in production."

[6]A quote from a Brazilian work provides a vivid description of this process and suggests that more than profit motivates the landlord. "The saving thus generated in the three entrepreneurial sectors of economic activity of the farm ... that accumulated with the growth of livestock, and that generated by the commercialization of crops and animal production, these last two more monetary ... goes in large part to the purchase of land with which the coronel expands his dominance and strengthens the basis of his power and prestige. It is the most secure way he sees for investment, almost the only way which has traditionally expanded. More than its profitability, a non-economic good attracts him: the social value linked to the dominion over extensive properties, inherent in the very system which prevails," Marcos Vinicius Vilaca and Roberto C. de Albuquerque, Coronel, Coronets, (Rio de Janeiro: Editora Tempo Brasileiro, 1965).

[7]For a sample of this balanced view see the distinction made by Smith [1965] between land reform and agrarian reform, as well as Carroll [1961].

[8]Running counter to these arguments are some factors, also associated with market failure, which would tend to make small farms more productive: (1) land holding for portfolio reasons, (2) own consumption by small farms to avoid risk, (3) land holding for prestige, (4) land market imperfections such as restrictions on tenure, (5) labor market imperfections such as minimum wages, restrictions on tenure, and preference for work on owned plots. However, in the Venezuelan case lack of both inflation and agricultural

price fluctuation would seem to dampen the first two motives and minimum wage laws have not been enforced in rural areas. (See footnote 2). On the other hand, if there were no monopsony power and factors 3 - 5 were important, it still would mean that a redistribution of land would raise agricultural output.

9 See Cheung [1969].

10 Tests of the association between the structure of land tenure or farm sizes and the rate of neutral technical change were not powerful enough to distinguish any differences in the rates.

11 See Barraclough and Domike [1969], Carroll [1961], and ECLA [1963].

12 See Powell [1971] Chapters 3 and 5 and pp. 140-141.

13 Powell [1971] p. 111, points out that squatter occupation of latifundia was disavowed by both the government and the peasant federation shortly after the passage of the Agrarian Reform Law (February 1960). Warriner [1969] points out that in some cases the landlords organized the occupations in order to force the government to make overgenerous settlements. The willingness of the government to pay for expropriated land, and the fact that much of land reform consisted of settlement on unused public land would offset any presumption about negative effects of land reform on agricultural investment.

14 See CIDA [1965, 1966].

15 Calculated from the original sources cited in Table 1. The Gini coefficient is equal to the ratio of the area between the Lorenz curve and the 45^{o} line of equality and the area under the 45^{o} line. See Morgan [1962]. The method used was an approximation: $G = 1 -$

$$\sum_{i=1}^{k} (f_{i+1} - f_i)\,(y_i + y_{i+1})$$

where G = Gini coefficient, f_i = cumulative frequency of farms in class i, y_i = cumulative frequency of land in class i. The coefficient is an arithmetic summary of concentration. However it is somewhat insensitive to small percentage change in distribution favoring the lower groups and understates any movement toward equality. See Garvey [1951].

16 See CIDA [1965, 1966].

17 See Nerlove [1967].

18 See Nerlove [1965]. Nerlove suggests one way out is the assumption that firms minimize costs, but this seems unreasonable for farms. Also data on factor prices, which are required, is unavailable.

[19]Hoch [1962] follows the procedure outlined here but neglects the problem of estimating marginal products through the use of the (assumed) random dependent variable. See Carter & Hartley [1958], and Fisk [1966].

[20]This approach has been used on Brazilian data by Cline [1970]. Sample survey data on farms are used to demonstrate static misallocation in the sense of (a) amount of land left idle on large farms, and (b) declining value of net input per unit of land, valued at market prices, as farm size increases, in spite of the fact that cross sectionally there appears to be no relation between farm size and the CD constant. Lau and Yotopolous [1971] have used a profit function, rather than a production function, to demonstrate the relatively greater productivity of small farms. However, their profit calculations requires not only output but input value, data which are unavailable in Venezuela.

[21]This approach has been used by Griliches [1963[a], 1963[b], 1964]. Although there is obviously some bias due to the aggregation, little work has been done on estimating its nature and direction.

[22]Nerlove [1965] emphasizes the importance and meaning of this assumption for production functions estimated from cross sectional firm data. However, little work has been done on aggregate production functions.

[23]Griliches [1963[a], 1963[b], 1965] and Yotopolous [1967] convert stocks to flows.

[24]See Hoch [1962], Zellner, et. al. [1966].

[25]See BCV, Informe Económico 1964.

[26]Apure is a llanos or plains state which contains much of the country's cattle ranching and is subject to large annual flooding, Nueva Esparta is an island state, and the Federal Territories are mainly undeveloped lands in the jungle or on the Orinoco River Delta. Since 1963 the Territory Delta Amacuro has been agriculturally developed to reduce food shortages in the nearby, rapidly growing Cuidad Guayana.

[27]The figures are flows of metric tons of chemical fertilizer. They are unweighted by quality and neglect organic fertilizer completely. Moreover they do not include the intensity of fertilizer used in the state. The difference between organic and chemical may have confused some farmers, particularly in 1950, when illiteracy was high. Finally there may be a timing problem in the reporting, since the inputs are the amounts used in the crop year and since farmers may have reported the flow amounts employed for the harvest of 1951, rather than 1950.

[28]Nerlove [1965].

[29]Hoch [1962], Mundlak [1961].

[30]See Hoch [1962] and Nerlove [1965].

[31]See Timmer [1971]. Timmer's results are presented in Table V.

[32]Maddala [1971], Nerlove [1971a], Nerlove [1971b].

[33]See for example the rainfall and topographical maps of Venezuela. IBRD [1961], Griliches [1963[a], 1963[b], 1965] has used this approach.

[34]See Timmer [1971], pp. 786-787.

[35]See Cheung [1969]. Bardhan and Srinivasan [1971] argue that there is some difference in the use of inputs on land operated under sharecropping and other forms of tenure.

[36]For example, Logarithmic Regressions which explain fertilizer, irrigation, and tractors by the amount of cultivated land on different size farms show that the elasticity with respect to the farms over 100 ha is generally significantly different than zero and larger than one. The other elasticities, no matter what combinations are used, are generally insignificant.

[37]While this form does have the useful property that differences in quality can be observed it has two defects. First, it does not aggregate arithmetically to the form of Equation 1 if the null hypothesis is satisfied and second, the land variables are treated as aggregate complements, rather than aggregate competitors for mobile factors, unless we also impose the constraint that land area is fixed. However, in that case, output would rise only by switching land from one group to the other, which turns out to be basically what we are testing--the average and marginal productivity of different classes of land.

[38]Any division of by farm sizes is arbitrary, since the farms at the upper end of each class would probably most resemble those of the next class. To prevent introducing any further collinearity into the regression because of this bunching, a matrix of the simple correlation coefficients for the land in farm classes 0-5, 5-20, 20-100, over 100 has. was calculated. Then those classes with the largest correlation coefficients, 0-5, 5-20, 20-100 (roughly .9 between the second two and .75 between the first and the sum of the other two separately) were then combined since there seemed to be a sharp break between these three classes and the fourth, where the correlation was about .2, .3, and .5, respectively.

[39]This figure is obtained by calculating a 95 confidence interval for the value of "R" in Equation 4 which would just equalize the marginal products. To form this interval various values of R were tried in the equality:

$$\beta = R\beta_{\text{under } 100} \cdot (\text{Land over } 100/\text{Land under } 100,)$$

which was then used to replace β over 100 in Equation 4. Thus the value of R = 1/12 or a productivity twelve times greater on small farms would certainly equate the two marginal products. In fact values down to R = 1/5 fall into the 95 percent confidence interval around 1/12. If Col. 1 rather than Col. 4 is taken to be the unconstrained equation, then a value of R = 1/3 would still fall outside the range (95 percent confidence interval) in which marginal products of Col. 4 are equal.

[40]See Powell [1971]. In addition the Accion Democratica government continued the program of major irrigation works and provided a great many wells to small owners. See MAC, Estadística Agropecuaria 1969. Finally, the price of chemical fertilizer from the government run IVP was kept artifically low and constant until 1966. See BCV Informe Económico, various years. Price supports have also been used for campesino crops and many storage silos were built.

[41]See for example: Coutsmaris and Bosz [1963], IBRD [1961].

[42]For example, Jasperson [1969], suggests consolidation and concentration of the propram is needed. See also Warriner [1969].

[43]Jasperson [1969].

[44]See Heaton [1969] and BCV, Memoria; various issues, BCV Informe Económico 1969.

[45]USDA, Indices of Agricultural Production for the Western Hemisphere, May, 1969.

[46]BCV, Informe Económico, 1969.

[47]Cheung [1969].

[48]Bardhan and Srinivasan [1971].

[49]Rising wages would reduce demand for land by sharecroppers at every rental rate, but it would also increase the supply, since landlords would find that working the land with hired help was more expensive. Since both demand and supply (taking into account the amount of effort which the sharecroppers devote to land) are decreasing functions of the rental rate, with $D' > S'$; the equilibrium fraction of land which is offered rises. Irrigation can be thought of as a land augmenting innovation which raises the amount of land held by landlords, thereby raising the supply of leases at every rental rate.

[50]A wage was calculated by multiplying the class midpoints of the agricultural incomes reported in DGE, Noveno Censo de Poblacion and the class frequency. The land variable was the percentage of total land operated by sharecroppers, rather than the cultivated land variable used elsewhere in the paper. Since the Bardhan-Srinivasan model would lead to a corner solution, which would prevent the existence of either fixed price rental or sharecropping, regressions were also run using the percentage of total land operated by renters. In terms of sizes and significance levels of coefficients the results were qualitatively similar.

[51]The reported regression represents the "best" form in terms of the R^2 statistic.

[52]Bardhan and Srinivasan [1971] suggest that neutral technical change will decrease the percentage of land which is sharecropped, but treat the real wage as a parameter. See footnote 50.

Bibliography

Bardhan, P., and Srinivasan, T., "Cropsharing Tenancy in Agriculture: A Theoretical and Empirical Analysis," American Economic Review, LXI, No. 1 (March 1971), pp. 48-64.

Barraclough, S., and Domike, A., "Agrarian Structure in Seven Latin American Countries," in C. Nisbet, ed., Latin America, (New York: Free Press, 1969).

Berry, R. A., Agricultural Development in Colombia (unpublished).

Carroll, T., "The Land Reform Issue in Latin America," in A. Hirschman, Latin American Issues, (New York: 20th Century Fund, 1961), pp. 161-201.

Carter, H. O., and Hartley, H. O., "A Variance Formula for Marginal Productivity Estimates using Cobb-Douglas Production Functions," Econometrica, XXVI, No. 2 (April 1958), pp. 306-313.

Cheung, S., The Theory of Share Tenancy, (Chicago, University of Chicago, 1969).

Cline, W., Economic Consequences of a Land Reform in Brazil, (Amsterdam, North Holland, 1970).

Comité InterAmericano de Desarrollo Agrícola, Land Tenure Conditions and Socio-Economic Development of the Agricultural Sector, Argentina, Brazil, Chile, Colombia, Equador, Guatemala, Peru, (Washington, D, C., Pan American Union, 1965 and 1966).

Coutsoumaris, G., and Bosz, A., Evaluation Reports on the Agricultural Program of Venezuela's National Plan, 1963-1966, (Washington, D. C. 1963).

Economic Commission for Latin America, "Agriculture in Latin America," Economic Bulletin for Latin America, Vol. VIII, No. 2, (Oct. 1963), pp. 147-194.

Fisk, P. R., "The Estimation of Marginal Products for Cobb-Douglas Production Functions," Econometrica, XXXIV, No. 1, (Jan. 1966), pp. 162-172.

Garvey, G., Comments on J. Pechman, "Distribution of Income Before and After Income T·xes, 1941 and 1947," in Conference on Research in Income and Wealth, Studies in Income and Wealth, Vol. 13 (New York: NBER, 1951), pp. 214-220.

Griffin, K., Underdevelopment in Spanish America, (Cambridge; MIT, 1969).

Griliches, Z., "Estimates of the Aggregate Agricultural Production Function From Cross Sectional Data," Journal of Farm Economics, XLV, No. 2, (May 1963) pp. 419-428.

Griliches, Z., "The Sources of Measured Productivity Growth: U.S. Agriculture (1940-1960)," Journal of Political Economy, LXXI, No. 4, (August 1963), pp. 331-346.

Griliches, Z., "Research Expenditures, Education, and the Aggregate Agricultural Production Function," American Economic Review, LIV, No. 4 (December 1964), pp. 961-979.

Hagen, E., The Economics of Development, (Homewood, Ill.: Richard D. Irwin, 1968).

Heaton, L., The Agricultural Development of Venezuela, (New York: Praeger, 1969).

Hirschman, A., Journeys Toward Progress, (New York: 20th Century Fund, 1963).

Hoch, I., "Estimation of Production Function Parameters Combining Time Series and Cross Section Data," Econometrica, XXX, No. 1, (Jan. 1962), pp. 34-53.

IBRD, The Economic Development of Venezuela, (Baltimore: Johns Hopkins Press, 1961).

Jasperson, F., The Economic Impact of Venezuelan Agrarian Reform, (unpublished Ph.D. Dissertation, Indiana University, 1969).

Kaufman, R., The Chilean Political Right and Agrarian Reform, (Washington, D. C., 1967).

Lau, L., and Yotopolous, P., "A Test of Relative Efficiency and Application to Indian Agriculture," American Economic Review, LXI, No. 1, (March 1971), pp. 94-109.

Lombardi, J., and Hanson, J., "The First Venezuelan Coffee Cycle," Journal of Agricultural History, No. 2 (May 1970), pp. 355-367.

Maddala, G., "The Use of Variance Components Model in Pooling Cross Sections and Time Series Data," Econometrica, XXXIX, No. 2, (March 1971), pp. 341-358.

Morgan, J., "Anatomy of Income Distribution," Review of Economics and Statistics, Vol. XLIV, No. 3, (August 1962), pp. 270-283.

Mundlak, Y., "Empirical Production Function Free of Management Bias," Journal of Farm Economics, XLII, No. 1, (February 1961), pp. 44-56.

Nerlove, M., Estimation and Identification of Cobb Douglas Production Functions, (Chicago: Rand McNally, 1965).

Nerlove, M., "Recent Empirical Studies on the CES and Related Production Functions," in M. Brown The Theory and Empirical Analysis of Production, (New York: Columbia, 1967), pp. 55-122.

Nerlove, M., "Further Evidence on the Estimation of Dynamic Economic Relations from a Time Series of Cross Sections," Econometrica, XXXIX, No. 2, (March 1971), pp. 359-382.

Nerlove, M., "A Note on the Error Components Model," Econometrica, XXXIX, No. 2, (March 1971), pp. 383-396.

deNavarrete, I. M., "Income Distribution in Mexico," in T. Davis ed. Mexico's Recent Economic Growth (Austin, Texas: University of Texas, 1967).

Powell, J. D., "Agrarian Reform or Agrarian Revolution in Venezuela," in A. vonLazar and R. Kaufman, eds. Reform and Revolution (Boston: Allyn Bacon, 1969), pp. 266-280.

Powell, J. D., Political Mobilization of the Venezuelan Peasant, (Boston: Harvard, 1971).

Smith, T. Lynn, "Introduction: A General View of Agrarian Reform Proposals and Programs in Latin American," in T. Lynn Smith, ed. Agrarian Reform in Latin America, (New York: Knopf, 1965), pp. 3-62.

Timmer, C., "Using a Probabalistic Frontier Production Function to Measure Technical Efficiency," Journal of Political Economy, LXXIX, No. 4, (July, August 1971), pp. 776-794.

Warriner, D., Land Reform in Principle and Practice, (New York: Oxford, 1969).

Yotopolous, P., "From Stock to Flow Capital Inputs for Agricultural Production Functions: A Microanalytic Approach," Journal of Farm Economics, XLIX, No. 2, (May 1967), pp. 476-491.

Zellner, A., Kmenta, J., and Drèze, J., "Specification and Estimation of Cobb Douglas Production Function Models," Econometrica, Vol. 34, No. 4 (October 1966), pp. 784-795.

APPENDIX TABLE AI

	ACV Different Elasticities	ACV Constrained Equal Elasticities	ACV Constrained Equal Marginal Products	ACV Different Marginal Products
L Tract	.02 (.08)	.03 (.09)	.06 (.11)	-.01 (.09)
L Frtlz	-.07* (.03)	-.10* (.03)	-.11* (.04)	-.08* (.03)
L Irrig	.07** (.40)	.09* (.04)	.11* (.04)	.07** (.04)
L Livestock	.24 (.27)	.28 (.30)	.32 (.33)	.22 (.27)
L Lab	.58* (.29)	.72* (.32)	.95* (.29)	.59* (.27)
L Cofca	.43* (.17)	.36* (.13)	.37* (.14)	.41* (.11)
Dummy (Time)	-.26 (.20)	-.02 (.19)	.01 (.32)	-.13 (.27)
L Land Under 100 ha	.43* (.17)			
L Land Over 100 ha	.02 (.11)			
Σ L Land		.13 (.10)		
Σ L Land, MP =			.01 (.03)	
L Land Under 100 ha				.45 (.17)
L Land Over 100·Lr/Ls				.01 (.02)
F vs. Col. 1 DF = 1, 10		4.17	6.00*	
R^2	.993	.990	.989	.994
F	56	43	38	56
Obs	38	38	38	38
DF	10	11	11	11
SSE	.108	.153	.173	.104
SER	.10	.12	.13	.10

APPENDIX TABLE AII

	OLS Different Elasticities	OLS Constrained Equal Elasticities	OLS Constrained Marginal Products	OLS Different Marginal Products
Constant	8.25* (.73)	7.60* (.73)	7.95* (.94)	7.79* (.78)
L Tract	.12* (.05)	.13* (.05)	.19* (.05)	.10* (.05)
L Frtlz	-.05** (.04)	-.09* (.03)	-.05 (.04)	-.06** (.03)
L Irrig	.04 (.05)	-.01 (.05)	.03 (.06)	.04 (.05)
L Livestock	-.13** (.07)	-.08 (.08)	-.10 (.09)	-.10 (.08)
L Lab	.21 (.23)	.25 (.24)	.72* (.17)	.12 (.21)
L Cofca	.10* (.04)	.14* (.04)	.16* (.05)	.10* (.04)
Dummy (Time)	-.13** (.08)	.11 (.15)	-.16 (.17)	.04 (.15)
L Land Under 100 ha	.51* (.14)			
L Land Over 100 ha	.08 (.14)			
Σ L Land		.28* (.11)		
Σ L Land MP's =			.01 (.02)	
L Land under 100 ha				.68* (.18)
L Land Over 100·Lr/Ls				.03* (.02)
F vs. Col. 1 DF = 1,28		5.63*	11.9*	
R^2	.928	.9129	.897	.932
F	40	38	32	43
Obs	38	38	38	38
DF	28	29	29	28
SSE	1.148	1.381	1.635	1.072
SER	.20	.22	.24	.20