Resource Productivity and Income Distribution

With Implications for Farm Tenure Adjustment

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Resource Productivity and Income Distribution with Implications for Farm Tenure Adjustments

by Roger W. Strohbehn[1]

RAPID STRIDES IN FARM TECHNOLOGY IN RECENT DEcades have encouraged farm operators to combine more units of capital and land per unit of labor in order to achieve efficient resource use and maintain a competitive position in agriculture. As the per farm capital requirements for efficiently organized farms have risen, farm operators have begun considering alternative tenure arrangements to the time-honored goal of owner-operatorship of the farm resources.

These new or modified tenure forms include such arrangements as equipment rental, vertical integration, and farm incorporation. One of the perplexing questions in agriculture is whether the tenure system has accommodated the adoption of technology to enable farmers' income to keep pace with urban people, or whether the benefits of more efficient production have been siphoned off in rising land values.

The role of a tenure system is to provide an institutional framework through which entrepreneurs allocate resources among alternative uses in response to market forces and distribute the ensuing income among the resources. A measure of the effectiveness of a tenure system is its ability to associate resource costs and returns, or more specifically to equate factor costs and factor earnings, and thereby achieve efficient resource use.

If a dissociation of costs and returns exists among resource owners, the tenure system itself may be jeopardized. Thus the structure of the tenure system, the allocation of resources, and the distribution of income are highly interrelated and must be examined simultaneously. An appropriate starting point for an investigation of forces impinging on tenure arrangements would be a historical examination of the factor shares to determine whether the resources used in agricultural production have been properly compensated and whether this compensation is adequate to enable the farmer to acquire ownership of the resources in keeping with the traditional tenure goal.

If the distribution of farm earnings among the factors results in the

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association of factor costs and returns, the problem facing farm operators is one of how to gain access to a quantity of resources that is adequate for an efficient business and that will yield a satisfactory level of living for the operator and his family. On the other hand, if one of the residual claimants (land and operator labor) is overpaid while the other is underpaid, this would suggest the need for a different type of tenure modification, perhaps a major alteration of the tenure structure rather than a modification of the existing system.

The objectives of this study were to: (1) analyze the influence of imperfect mobility of farm operators upon farm resource income distribution; (2) examine the relation between imputed land values and actual land values; and (3) analyze the effect of rising land values on the ability of farmers to achieve the goal of owner-operatorship of their land. Two interrelated hypotheses were used to guide the investigation toward the accomplishment of these objectives: (1) the market value of farmland exceeds its imputed value based on the contribution of land to the product of the farms; and (2) a portion of labor and management earnings of farm operators is capitalized into land values. An analysis of farm account data for different types of farms and regions of Illinois was performed in testing the hypotheses.

Theoretical Orientation

Application of the usual assumptions of perfect competition and mobility of resources, which underlie micro-static economic theory, results in an equilibrium distribution of income to factors of production in accordance with the marginal contribution of each factor to total output. If one factor such as land is fixed, it becomes a residual claimant to income, otherwise the marginal productivity theory of distribution holds. By considering any residual shares to fixed resources to be consistent with their marginal contributions to output of the firm, an equilibrium situation may be expressed as:

$$(1) \qquad P_yY = P_1X_1 + P_2X_2 + \ldots + P_nX_n$$

In this equation Y is physical output, X_i's are resources, and P_i's are prices for the output and the resources. This expression indicates that the value of the output is exactly exhausted by the sum of the income shares to the resources and is consistent with Euler's theorem expressed in marginal productivity theory as follows:

$$(2) \qquad Y = X_1 \frac{\partial Y}{\partial X_1} + X_2 \frac{\partial Y}{\partial X_2} + \ldots + X_n \frac{\partial Y}{\partial X_n}$$

In this equation Y and X_i's are units of physical output and units of resources, respectively. The latter expression is the same as the first when each term is multiplied by the price of $Y(P_y)$ and the resulting marginal value products for the resources are considered equal to the respective resource prices. Empirical implementation of Euler's theorem was obtained by use of the Cobb-Douglas form:

$$Y = aX_1^{b_1}X_2^{b_2} \ldots X_n^{b_n} \tag{3}$$

In this equation $\Sigma b_i = 1$, and all variables were expressed in dollars. Estimation of marginal productivities of resources used on farms in this manner provided the benchmark for identifying and measuring departures from equilibrium returns to resources.

The hypothesized existence of disequilibrium in factor shares originates with technological change. The adoption of technology that substitutes capital for land and labor where there is immobility of land and labor will result in excess resources being used and a tendency for output to expand beyond the equilibrium level. If the price flexibility of Y at the farm level is less than -1.0, as is the case for many farm products, the value of the new total product will be less than the value of the output produced under the old technology.[1] Hence the equality sign in (1) will be changed to a "less than" sign as follows:

$$P_yY < P_1X_1 + P_2X_2 + \ldots + P_nX_n \tag{4}$$

In this new situation, the sum of the distributive shares exceeds the quantity to be shared, and reestablishment of equilibrium usually would require an exit of some of the resources made redundant by factor substitutions caused by technological advance. However, if the technological advance created a situation where larger quantities of land per farm would be needed in order to take advantage of the technological advance, land would not be a redundant factor, but the opposite. In this situation the adopting farm operators compete for the available supply of land for farm enlargement with a consequent increase in land prices.

This places much of the burden upon the farm labor (farm operator and family) to adjust by entry into nonfarm employment. However, farm operator labor tends to be fixed (immobile) because of lack of training for skilled nonfarm jobs, lack of knowledge of possible alternative employment, and nonmonetary values attached to entrepreneurial freedom and farm life. If a farm operator places a high premium on remaining

[1] See G. E. Brandow, "Interrelations Among Demands for Farm Products and Implications for Control of Market Supply," Pa. State Univ. Bul. 680, 1961, for estimates of price flexibilities of farm products. Price flexibilities at the farm level for selected products are: cattle, — 1.59; hogs, — 2.33; all milk, — 2.64; soybean oil, — 1.77; and corn, — 2.0.

a farm operator, and it is hypothesized that most do, he likely will undervalue his own labor in order to pay the higher prices for land needed to efficiently utilize new technologies. Under such circumstances, technological advance will be accompanied by land prices rising above the marginal productivity value of land, and correspondingly, the income share of farm operator labor will be below its marginal productivity value.[1]

Method of Analysis

Model Selection and Specification

Whole farm production functions of the Cobb-Douglas type were chosen for this study, since it is concerned with the distribution of returns from the total farm business to the factors of production. A production function, in a sense, becomes an accounting tool when it is used to determine the marginal factor shares for an allocation of the total income of the firm among the inputs. A firm in equilibrium would receive a dollar return for each dollar expenditure that included the opportunity cost of the dollar. In addition, the return to land and operator labor would be equal to their marginal factor shares.

The Cobb-Douglas function is particularly suited to the study because it specifies diminishing returns to individual inputs and is a homogeneous function that can be easily constrained to be a homogeneous function of degree one, indicating constant returns to scale.[2] The application of Euler's theorem requires constant returns to scale for the sum of the factor payments to just exhaust the total product when the factors are paid according to their marginal value products. The data can be fitted to both an unconstrained function and a constrained function and a statistical test performed to determine if the unconstrained fitted function differs significantly from constant returns to scale.

Estimates of the marginal productivities of six basic categories of farm inputs were derived from a production function as specified in the following equation:

$$Y = aX_1^{b_1}X_2^{b_2}X_3^{b_3}X_4^{b_4}X_5^{b_5}X_6^{b_6} \qquad (5)$$

In the following definitions of the variables, ϕ represents the opportunity cost on the capital tied up in the input from the time it was com-

[1] A more complete theoretical development of the influence of technology and resource immobility on income distribution can be found in R. W. Strohbehn, "Income Distribution on Selected Types of Illinois Farms and Implications for Tenure Adjustments," unpublished Ph.D. thesis, University of Illinois, 1965.

[2] G. Tintner, "Econometrics," pp. 89-91, John Wiley and Sons, New York, 1952.

mitted in the production process until a product was forthcoming. Similarly, ρ represents the rate of interest used to convert an inventory value into an annual service cost. Values of ϕ and ρ are shown in Appendix Table 1 for the three periods in the analysis.

Y = Value of production. [(Total cash sales of products and services) − (purchased feed and livestock) + (change in inventory values of grain and livestock) + (value of farm products consumed) − (property taxes)].

X_1 = Current value of land. A basic value of bare land is established for each farm according to the soil-productivity rating of the land to reflect market value. This value is adjusted each year according to the index of land prices in Illinois, as reported by the USDA.

X_2 = Total cost of labor. [Operator labor valued at the representative wage rate for the area] + [(actual hired labor cost) + (family labor valued at the representative wage rate for the area)] $[1 + \phi]$. The monthly wage rates used in each area and year are shown in Appendix Table 2.

X_3 = Land improvement cost. [(Building and fence repairs) + (building depreciation)] $[1 + \phi]$ + [(depreciated investment in buildings at the beginning of the year) (ρ)].

X_4 = Machinery and equipment costs. [(The sum of annual expenses for electricity and telephone, machinery repairs, machinery hire, and gasoline and oil, including the farm share of automobile expenses) + (machinery and the farm share of auto depreciation)] $[1 + \phi]$ + [(depreciated inventory value of machinery and the farm share of auto at the beginning of the year) (ρ)].

X_5 = Crop expenses. [(The sum of annual expenses for fertilizer and lime, seed and crop expenses, and on grain farms, miscellaneous operating expenses) $(1 + \phi)$] + [(depreciated investment in soil fertility at the beginning of the year) (ρ)].

X_6 = Livestock expenses. [(Annual livestock expenses, excluding purchased livestock and feed, and on livestock farms, miscellaneous operating expenses) $(1 + \phi)$] + [(investment in livestock, feed, and grain at the beginning of the year) (ρ)].

All of the variables were expressed in current dollars. Input variables, except land, represent annual costs including an opportunity cost of income foregone by using the money in the farm business; or in the case of durable capital items, an annual service cost equivalent to an opportunity cost of income foregone.

It may be argued that an opportunity cost should not be included as an explicit cost of the input. However, this is a cost that must be covered if the firm is to obtain the input for production. If the opportunity cost is not included, then the input must yield a marginal value product that is in excess of the dollar expenditure. In an accounting sense, this means that a dollar on the debit side of the ledger is not worth as much as a dollar on the credit side.

Selection of Empirical Data

To test the hypotheses stated above, a series of static analyses of farm account data of four types of farms in three separate time periods was used. Four different types of farms — grain, hog, beef and dairy — were chosen to permit selecting farms with similar input-output relationships, while at the same time permitting differences to be detected in the manner in which different types of farms combine capital resources with land and labor.

The different types of farms were selected from areas where the respective types of farms prevailed, so that greater uniformity of farms within each type would be achieved. These areas were the east-central area for cash grain farms, the western livestock area for hog and beef farms, and the general farming area in southern Illinois for dairy farms.[1] The counties from which the sample farms were selected are shown in Figure 1. A uniform set of information about farm firms over a wide area and an extended period of time was achieved by utilizing the individual farm business records of farmers who cooperate with the Department of Agricultural Economics and the Illinois Farm Bureau Farm Management Service.

A comparative study of record-keeping farms and a random sample of all farms revealed that record-keeping farms tended to be larger in land size, located on more productive soils, and used capital more intensively. The operators possessed superior management ability.[2] However, when the random sample farms were grouped to yield a set of farms that was similar to the record-keeping farms in terms of acreage and soil quality, it was found that differences in capital intensity between the two groups diminished and differences in the managerial measures disappeared. Record-keeping farms cannot be used to represent the entire

[1] R. C. Ross and H. C. M. Case, "Types of Farming in Illinois." Ill. Agr. Exp. Sta. Bul. 601. April, 1956.

[2] Allan G. Mueller, "Comparison of Farm Management Service Farms and a Random Sample of Farms in Western Illinois," Jour. Farm Econ., 36:285–292. May, 1954.

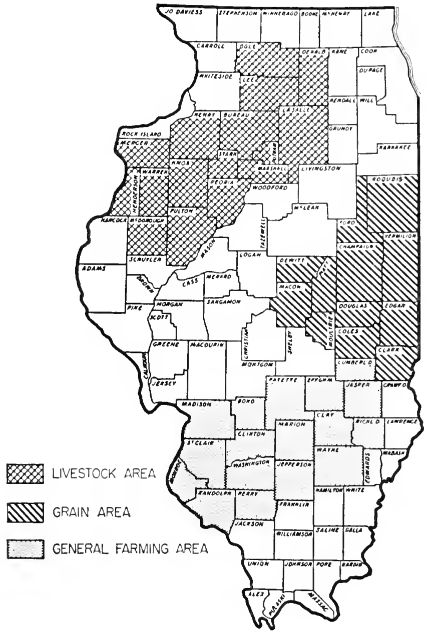

Figure 1. — Locations of sample areas in Illinois.

population of farms in a given area, but they are representative of the population of farms that is similar in respect to acreage and soil productivity.

In summarizing the farm account books, each farm is classified by type according to the following definitions:[1]

Grain farms. Farms on which the value of feed fed to livestock was less than one-half of the feed and grain returns and the value of feed fed to dairy or poultry was not more than one-sixth of the feed and grain returns.

Hog or beef farms. Farms on which the value of feed fed to livestock was more than one-half of feed and grain returns and either hog or beef cattle enterprises received more than one-half of the value of feed fed.

Dairy farms. Farms on which the value of feed fed to livestock was more than one-half of feed and grain returns and the dairy enterprise received more than one-third of the value of feed fed.

[1] Illinois Farm Bureau Farm Management Service, "Farm Business Analysis Report on Illinois Farms for 1959," Univ. Ill., Dept. Agr. Econ. July, 1960.

Dairy-grain farms. Farms on which the value of feed fed to livestock was less than one-half of the feed and grain returns and the value of feed fed to dairy was more than one-sixth of the feed and grain returns.

Dairy-hog farms. Farms that met the requirements for both dairy and hog farms.

This classification by type of farm was accepted for this study with the exception that combination dairy-grain or dairy-hog farms were included as dairy farms in this study.

To determine trends over time in resource productivity and in the pattern of distributive shares, farm account records were selected to represent the decade from 1949 to 1959. The selection of years for use in detecting changes over time presented a problem because of yield fluctuations and price changes. For the sake of simplicity, data from three periods corresponding to the Census of Agriculture taken in 1949, 1954, and 1959 were selected. Data from three consecutive years were averaged to obtain an observation for each individual farm to minimize the effect of "lumpy" investments that appear in the annual farm accounts. Averaging may also tend to even out some of the fortuitous consequences occurring to the farm business and provide a more representative account of each farm business.

Within the specified types of farms and designated periods, farms were identified for possible inclusion in the analysis if they met the following criteria: (1) the farm was classified as being the same type for the three consecutive years; (2) the operator remained the same during the three years; (3) the operator remained on the same farm during the three years and fluctuations in acreage operated did not exceed the smallest acreage operated by more than one-third; and (4) the farm did not have high-labor enterprises such as truck crops.

If the total number of qualifying farms in 1948-1950 and 1953-1955 exceeded 150, a random sample was drawn to yield at least 150 farms. Because the 1958-1960 data were already processed onto computer cards, the entire groups of farms meeting the selection criteria were used in the analysis for this period. Sample sizes were as follows:

	1948–1950	*1953–1955*	*1958–1960*
Grain farms	149	151	194
Hog farms	151	150	162
Beef farms	64	126	99
Dairy farms	..	87	119

In the remainder of this report the mid-years of 1949, 1954, and 1959 will be used to refer to data from their respective periods.

The Analysis

The analysis of factor payments to land and operator labor in this study contains some theoretical characteristics, even though actual farm data were used. In the case of land, the estimated marginal value product of land is compared with an imputed market rate of return to land as reflected in the current market valuation of land. In the case of operator labor, the estimated marginal factor share to operator labor is compared with a "market" return that is computed as a residual return to operator labor after all other factors have been paid according to their imputed market rates.

Thus the imputed market returns to land and operator labor do not represent what they actually received, but instead what they would have received if the payment to land is based on a percent of its current value and if other non-operator labor inputs receive a payment in accordance with their full market cost.

This study was not designed to identify or measure the determinates of farm land value. It is recognized that urban people and institutions, as well as farmers, may seek to own farm land, and that for a given tract of land at a given time, a number of factors enter into the determination of its value. Considering farm land in total, however, its valuation for use as an input in agricultural production must ultimately rest on its expected contribution to farm output.

If a buyer acquires a tract of land and later discovers that the market had underestimated an increase in the productivity of the land, the landowner would then be in a position to reap some capital gains. If the opposite occurred, however, a capital loss might be experienced. A full examination of the role of expected capital gains, demand for farm land for urban uses, non-farm investors in farm land, and other non-productivity influences on farm land value was beyond the scope of this study. The focus of this study was to determine the relation between current land value and its estimated productivity value.

Statistical Estimates

Only three groups of farms — hog farms in 1954, grain farms in 1959, and beef farms in 1959 — exhibited increasing returns to scale that were significant at the 0.05 level of probability. The hypothesis of constant returns to scale was not rejected for the remaining eight groups of farms.

Because the groups of farms with significant increasing returns to scale occurred in three different types of farms and in two time periods, constant returns to scale were assumed for all groups of farms and for estimates of the marginal value products from the constrained function used in the distributive shares analysis. The major effect of this assumption on the three groups of farms with increasing returns to scale was a reduction in the estimated elasticity of production of the labor input. Caution should be used in the interpretation of the respective labor productivities and labor shares for these three groups of farms.

Tables 1 through 4 present estimates derived from the constrained functions for the grain, hog, beef, and dairy farms, respectively. Each table contains the geometric means of the output and factors of production, the estimated elasticity of production for each factor, the corresponding marginal value product of each factor, and the resulting marginal factor share of the total product. Appendix Tables 3 through 6 present corresponding results from the unconstrained functions.

Table 1. — Constrained Estimates of Factor Productivities and Factor Shares on Illinois Grain Farms, 1949, 1954, and 1959[a]

	Geometric mean	Elasticity of production, b_i	Marginal value product	Marginal factor share (X_i) (mvp_i)
1949	N = 149	R^2 = .9207		
Y	$17,248			
X_1	65,233	.4519**	$ .1195	$ 7,795
X_2	2,954	.0531	.3100**	916
X_3	957	.0033	.0597*	57
X_4	3,788	.2478*	1.1282	4,274
X_5	751	.0998*	2.2912**	1,721
X_6	791	.1441**	3.1437**	2,485
Sum		1.0000		17,248
1954	N = 151	R^2 = .8899		
Y	$18,538			
X_1	91,894	.4429**	$ .0893	$ 8,210
X_2	3,275	.1472**	.8330	2,729
X_3	1,273	−.0117	−.1701**	−217
X_4	5,003	.0913	.3383**	1,693
X_5	2,608	.3016**	2.1440**	5,591
X_6	1,010	.2087	.5266	532
Sum		1.0000		18,538
1959	N = 194	R^2 = .9026		
Y	$ 22,094			
X_1	135,973	.2463**	$ .0400	$ 5,442
X_2	3,740	.1549**	.9149	3,422
X_3	1,716	−.0175	−.2248**	−387
X_4	6,242	.2434**	.8617	5,378
X_5	3,200	.2356**	1.6263**	5,205
X_6	1,137	.1373**	2.6686**	3,034
Sum		1.0000*		22,094

[a] The estimating equation was constrained to force the sum of the regression coefficients to equal one.

* Null hypothesis rejected at the 0.05 level of probability. The null hypotheses are: (1) $b_i = 0$, where i = 1 to 6; (2) $\sum_{i=1}^{6} b_i = 1$; and (3) $mvp_i = \$1$ where i = 2 to 6.

** Null hypothesis rejected at the 0.01 level of probability.

Some general observations of the estimates shown in Tables 1 through 4 may be useful to provide a background for the examination of the major hypotheses of the study. This discussion is not intended to be a complete analysis of the adjustments required to achieve an optimal allocation of resources on the farms. Its purpose is to call attention to some of the basic underlying relationships of resource productivity that influence the distributive shares analysis of the aggregate factors — real estate, labor, and capital.

First, the estimated marginal value products of labor, land improvements, and machinery inputs were less than their dollar cost on all types of farms and in all periods, except for the machinery input on grain farms in 1949. This indicates that too many units of these inputs were being

Table 2. Constrained Estimates of Factor Productivities and Factor Shares on Illinois Hog Farms, 1949, 1954, and 1959[a]

	Geometric mean	Elasticity of production, b_i	Marginal value product	Marginal factor share (X_i) (mvp_i)
1949	N = 151	R^2 = .8337		
Y	$16,515			
X_1	41,362	.2459**	$ .0982	$ 4,061
X_2	3,231	.0718	.3669**	1,186
X_3	1,364	.0068	.0820†	112
X_4	3,451	.1682*	.8049	2,778
X_5	392	.0384	1.6163	633
X_6	1,483	.4690**	5.2229**	7,745
Sum		1.0000		16,515
1954	N = 150	R^2 = .8874		
Y	$18,033			
X_1	67,207	.4014**	$ .1077	$ 7,238
X_2	3,556	.0432	.2192**	779
X_3	1,912	−.0527†	−.4966**	−948
X_4	4,887	.1293*	.4772*	2,332
X_5	1,542	.1300**	1.5208	2,344
X_6	2,129	.3487**	2.9532**	6,288
Sum		1.0000**		18,033
1959	N = 162	R^2 = .8517		
Y	$19,834			
X_1	83,660	.2818**	$ .0668	$ 5,588
X_2	3,777	.1207**	.6337	2,394
X_3	2,272	.0395	.3443**	783
X_4	5,784	.1501*	.5146*	2,975
X_5	1,614	.1187**	1.4582	2,354
X_6	2,427	.2894**	2.3648**	5,740
Sum		1.0000		19,834

[a] The estimating equation was constrained to force the sum of the regression coefficients to equal one.

* Null hypothesis rejected at the 0.05 level of probability. The null hypotheses are the same as those listed under Table 1.

** Null hypothesis rejected at the 0.01 level of probability.

† Null hypothesis rejected at the 0.10 level of probability.

Table 3. — Constrained Estimates of Factor Productivities and Factor Shares on Illinois Beef Farms, 1949, 1954, and 1959[a]

	Geometric mean	Elasticity of production, b_i	Marginal value product	Marginal factor share (X_i) (mvp_i)
1949	N = 64	R^2 = .8376		
Y	$23,825			
X_1	57,467	.2596**	$ .1076	$ 6,185
X_2	4,137	.0963	.5545	2,294
X_3	2,000	.0794	.9457	1,892
X_4	4,389	.1408	.7646	3,355
X_5	507	.0356	1.6712	848
X_6	2,283	.3883**	4.0522**	9,251
Sum		1.0000		23,825
1954	N = 126	R^2 = .7557		
Y	$18,072			
X_1	79,154	.3290**	$ .0751	$ 5,946
X_2	3,837	.0288	.1355*	520
X_3	2,450	.0333	.2456*	602
X_4	5,370	.2212*	.7444	3,997
X_5	1,748	.0609	.6296	1,101
X_6	2,489	.3268**	2.3729*	5,906
Sum		1.0000		18,072
1959	N = 99	R^2 = .6785		
Y	$ 24,458			
X_1	113,706	.3670**	$ .0789	$ 8,975
X_2	4,251	.0202	.1161	494
X_3	2,872	.0483	.4109	1,181
X_4	6,812	−.1098	−.3941†	−2,685
X_5	2,161	.2388**	2.7027†	5,841
X_6	3,500	.4355**	3.0434†	10,652
Sum		1.0000*		24,458

[a] The estimating equation was constrained to force the sum of the regression coefficients to equal one.
* Null hypothesis rejected at the 0.05 level of probability. The null hypotheses are the same as those listed under Table 1.
** Null hypothesis rejected at the 0.01 level of probability.
† Null hypothesis rejected at the 0.10 level of probability.

used in relation to the other inputs employed. A test of the hypothesis that the marginal value products of the inputs were equal to $1.00 revealed that the marginal value product could range from approximately 50 cents to $1.50 before they were significantly different from $1.00.

A second general observation to be noted is the high marginal value products estimated for the crop and livestock inputs on all types of farms and in nearly all periods. A high marginal value product for crop inputs may be the result of the difficulty of financing inputs that are nonasset-creating, such as fertilizer purchases.[1] This would be particularly true

[1] C. B. Baker and G. D. Irwin, "Effects of Borrowing From Commercial Lenders on Farm Organization," Ill. Agr. Exp. Sta. Bul. 671, pp. 21-22. 1961.

if the financial difficulty contributes more heavily to an inadequate fertilization program on farms with low total value of production. It would tend to raise the estimated elasticity of production of the crop input and, as a result, the marginal value product of the crop input would also be raised.

With this brief discussion of the basic input-output relationships of the selected groups of farms in this study, attention is now turned to the major hypotheses of the study.

Interpretation of Results

An examination of the marginal value products of land in Tables 1 through 4 reveals a moderate decline in the rate of return on current land value of about 3 percentage points among hog and beef farms from 1949 to 1959 and a decline of 1 percentage point among dairy farms from 1954 to 1959. Among grain farms the decline in the rate of return on land was more accentuated, dropping from 12 percent in 1949 to 4 percent in 1959. These trends can be clearly seen in Figure 2. A least-squares trend line fitted to these data indicates that the rate of return on current land value has declined 2.2 percentage points each five years

Table 4. —Constrained Estimates of Factor Productivities and Factor Shares on Illinois Dairy Farms, 1954, and 1959[a]

	Geometric mean	Elasticity of production, b_i	Marginal value product	Marginal factor share (X_i) (mvp_i)
1954	N = 87	R^2 = .7630		
Y	$ 9,633			
X_1	27,183	.2372**	$ .0841	$ 2,285
X_2	3,095	.2206*	.6866	2,125
X_3	916	.0071	.0742	68
X_4	3,604	.1160	.3100*	1,118
X_5	1,368	.2374**	1.6718	2,287
X_6	861	.1817*	2.0334	1,750
Sum		1.0000		9,633
1959	N = 119	R^2 = .8149		
Y	$16,280			
X_1	43,725	.1960**	$ .0730	$ 3,192
X_2	3,955	.1289†	.5307	2,099
X_3	1,486	.0875*	.9586	1,424
X_4	5,544	.2482**	.7289	4,041
X_5	1,589	.1260*	1.2911	2,051
X_6	1,463	.2133**	2.3738†	3,473
Sum		1.0000		16,280

[a] The estimating equation was constrained to force the sum of the regression coefficients to equal one.

* Null hypothesis rejected at the 0.05 level of probability. The null hypotheses are the same as those listed under Table 1.

** Null hypothesis rejected at the 0.01 level of probability.

† Null hypothesis rejected at the 0.10 level of probability.

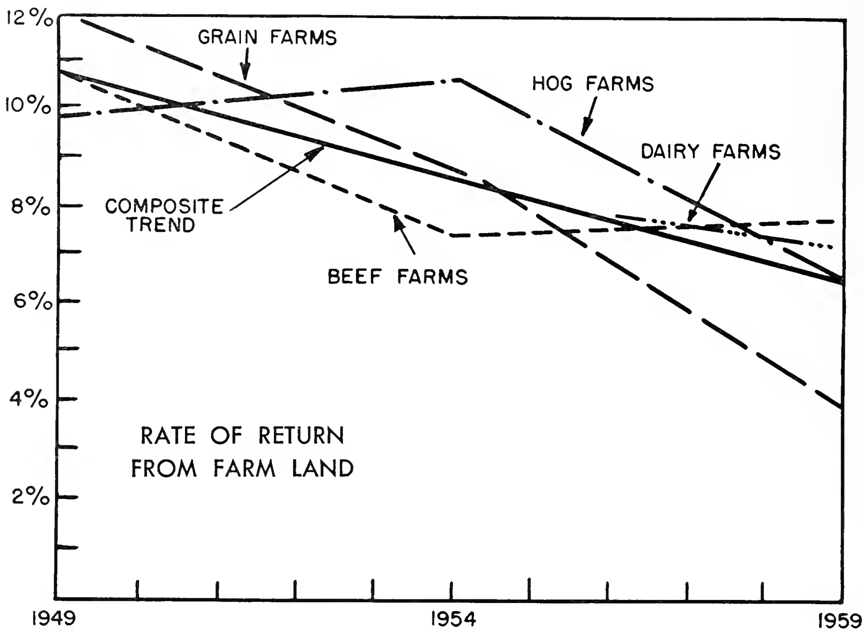

Figure 2. — Trends in rates of return on current land value.

during the decade. This decline in the marginal value product of land during the decade indicates that a larger portion of the income among all four types of farms was capitalized into land value at the end of the decade than at the beginning.

Evidence to support or refute the hypothesis that the market value of farm land exceeds its imputed value, based on the contribution of land to the product of the firm, was obtained by comparing the estimated marginal value product of land with an assumed market rate of return that would be expected by landowners on the investment in land.

Because land is a residual claimant and receives a return according to its ability to substitute for other inputs that carry a cost of production, rising land values would be expected to reflect increases in the productivity of land. If land values had risen according to the increase in land productivity, the marginal value product of land would be constant over time. Or, if there was a difference between the estimated productivity of land and the market evaluation of land productivity in the first period of the study, a change in the marginal value product toward the expected market rate would be anticipated in the succeeding periods.[1]

The mortgage interest rate is frequently used as an indicator of a

[1] Direct comparisons of changes in land productivity and in land value for these groups of farms are presented in Roger W. Strohbehn, *op. cit.,* pp. 86-90.

landowner's expected rate of return on the investment in land. This rate is not completely valid as an indicator, because it underestimates the "true" rate of return expected on land as a factor of production. The mortgage rate can be viewed as the opportunity cost of money tied up in land when it is valued at current market value. This opportunity cost is less than the "true" expected return since it is determined under conditions of relative certainty as evidenced by the conservative appraisal procedures followed in ascertaining the loan value of the land, the down payment required, and possession of title of the land by the lender as a safeguard against the uncertainty associated with farm income and loan repayment. The landowner also considers the mortgage rate as an underestimate of the "true" expected return, because crop yields and prices are subject to uncertainty and some return is necessary to compensate for accepting the monetary hazards of operating under such conditions.

If the landowner expects a management return on land, this would also raise the expected return on land. In addition, if the landowner expects the land to generate the saving necessary to acquire debt-free ownership of the land, a sinking fund factor should be included in the expected return on land for the equity buildup. The sinking fund allotment can be viewed as an annual franchise or license payment that an operator makes by choosing to own land as a means of assuring himself an entrepreneurial position in agriculture each year. Since this "right to farm" is attached directly to the land, the owner-operator can recover his franchise payments by selling his land after his farming career has ended.

Whether the landowner expects a return on land that covers a land management return, a sinking fund allotment, and a return for accepting the challenge of uncertainty, is open for debate. These additional expected returns were included in the analysis because to omit them requires the assumptions of (1) perfect knowledge to nullify any management function; (2) equity in land to be derived entirely from labor and other nonland income; and (3) certainty that current yields and prices will continue in the future. None of these assumptions appears to be in harmony with the existing conditions and the traditional method of land acquisition by farm operators.

The "true" expected rate of return on land was assumed to include (1) the opportunity cost of money invested in land, valued at current market prices, as indicated by the mortgage rate of interest; (2) a management return on land equivalent to the typical charge of a professional farm manager, computed as a percentage of the marginal share to land — 7 percent on grain farms and 8 percent on livestock farms; (3) an equity charge to permit the land to be repurchased during the operating career of each generation, as indicated by the 40-year sinking fund rate; and (4) a charge for uncertainty of 1 percent on the current value of land.

Comparisons of the marginal value products of land and the expected market rate of return in Table 5 reveal that grain, hog, and dairy farms in 1959 had marginal value products of land that were less than the expected rate of return. However, only on the grain farms was the marginal value product significantly less than the expected market rate of return. On the dairy farms in 1959 and on all types of farms in 1949 and 1954 the marginal value product of land was larger than the expected rate of return, being significantly larger on grain farms in 1949 and hog farms in 1954. These comparisons indicate that the proportion of farm income being capitalized into land value increased over time and that by 1959 the market had elevated land prices to a level that exceeded the productivity value of land.

Table 5. — Comparisons Between Marginal Value Products of Land and Expected Market Rates of Return on Selected Types of Illinois Farms, 1949, 1954, and 1959

Type and period	Marginal value product[a]	Expected market rate of return	t ratio
GRAIN			
1949	$ .1195 (.0123)	$.0727	3.805**
1954	.0893 (.0106)	.0717	1.660
1959	.0400 (.0059)	.0703	5.136**
HOG			
1949	.0982 (.0207)	.0722	1.256
1954	.1077 (.0141)	.0740	2.390*
1959	.0668 (.0114)	.0728	.526
BEEF			
1949	.1076 (.0366)	.0730	.945
1954	.0751 (.0199)	.0714	.186
1959	.0789 (.0284)	.0738	.180
DAIRY			
1949	No data available		
1954	.0841 (.0276)	.0721	.435
1959	.0730 (.0228)	.0733	.013

[a] Standard errors are in parentheses.
* Significant difference at the 0.05 level of probability.
** Significant difference at the 0.01 level of probability.

Return to real estate

The treatment of land and land improvements as a single market unit of real estate in a distributive shares analysis enables land, as a residual claimant, to receive the gain or loss associated with the investment in land

Table 6. — Comparisons (in Dollars) Between the Expected Market Return and the Marginal Share to Real Estate on Selected Types of Illinois Farms, 1949, 1954, and 1959

	1949		1954		1959	
	Return to real estate[a]	Cumulative difference[b]	Return to real estate[a]	Cumulative difference[b]	Return to real estate[a]	Cumulative difference[b]
GRAIN						
Marginal share return	$ 7,852 (1,201)		$ 7,993 (1,427)		$ 5,055 (1,194)	
Expected market return:						
Mortgage interest	2,935	$4,917**	4,255	$3,738**	6,662	$−1,607
Land improvement expense	957	3,960**	1,273	2,465	1,716	−3,323**
Management return	550	3,410**	559	1,906	354	−3,677**
Sinking fund allotment	610	2,800*	836	1,070	1,156	−4,833**
Charge for uncertainty	652	2,148	919	151	1,360	−6,193**
HOG						
Marginal share return	4,173 (1,497)		6,290 (1,434)		6,371 (1,518)	
Expected market return:						
Mortgage interest	1,861	2,312	3,112	3,178*	4,099	2,272
Land improvement expense	1,364	948	1,912	1,266	2,274	−2
Management return	334	614	504	706	509	−511
Sinking fund allotment	387	227	611	151	711	−1,222
Charge for uncertainty	414	−187	672	−521	837	−2,059
BEEF						
Marginal share return	8,077 (3,650)		6,548 (2,468)		10,156 (5,268)	
Expected market return:						
Mortgage interest	2,586	5,491	3,665	2,883	5,571	4,585
Land improvement expense	2,000	3,491	2,450	433	2,872	1,713
Management return	646	2,845	523	−90	812	901
Sinking fund allotment	537	2,308	720	−810	967	−66
Charge for uncertainty	575	1,733	792	−1,602	1,137	−1,203
DAIRY						
Marginal share return	No data available		2,353 (1,309)		4,616 (1,699)	
Expected market return:						
Mortgage interest			1,259	1,094	2,142	2,474
Land improvements			916	178	1,486	988
Management return			189	−11	370	618
Sinking fund allotment			247	−258	372	246
Charge for uncertainty			272	−530	437	−191

[a] Standard error in parentheses.
[b] Marginal share to real estate minus cumulative sum of expected return to real estate.
* Significant difference at the 0.05 level of probability.
** Significant difference at the 0.01 level of probability.

improvements. The factor share to real estate, either market or marginal, is simply the sum of the land share plus the land improvement share.

If the estimated marginal shares to real estate are taken as the best estimate of the actual productivity of real estate, and similarly, if the hypothetical expected market return to real estate is assumed to accurately reflect the landowners expected return, then these two estimates may be compared for an additional test of the hypothesis relating to land values. Such comparisons in Table 6 indicate that the marginal share was less than the total expected return for all groups of farms in 1959; hog, beef, and dairy farms in 1954; and hog farms in 1949. Furthermore, the difference between the marginal share and the expected return became less advantageous for the landowner between 1949 and 1959.

This again indicates that a growing portion of farm income was being capitalized into land value during the decade and that the market value of land was tending to diverge from its productivity value. For the eight groups of farms on which the expected return exceeded the marginal share, more farm income had been capitalized into land value than could be justified on the basis of the contribution of real estate to the total product of the farm.

Evidence from the sample data in support of the hypothesis that the market value of farm land exceeds its imputed productivity value was statistically significant only in the case of grain farms in 1959. However, the analysis does indicate that an increasing proportion of farm income was capitalized into land value during the decade from 1949 to 1959. The analysis also indicates that the marginal share to real estate decreased relative to the expected market rate of return during the decade to the disadvantage of the landowner. Thus the whole analysis does lend support, although not conclusively, to the hypothesis that the market value of land has exceeded its productivity value.

Return to operator

Evidence to support or refute the hypothesis that farmers tend to capitalize part of their labor and management return into land value was obtained by comparing the proportion of the total value of production accruing to the farm operator, as determined by a marginal share computation, with a corresponding residual "market" share. If farmers had capitalized part of their labor and management into land value, the operator's marginal share would be greater than his residual "market" share.

The marginal share accruing to the operator was comprised of a marginal return to the labor of the operator, plus a management or entrepreneurial return on the nonreal estate capital inputs. This share is shown algebraically as:

$$\text{Oms} = (\bar{X}_2\text{mvp}_2 - \bar{X}_2\text{h}) + (\bar{X}_4\text{mvp}_4 + \bar{X}_5\text{mvp}_5 + \bar{X}_6\text{mvp}_6 - \bar{X}_4 - \bar{X}_5 - \bar{X}_6) \tag{6}$$

Definitions of the terms in this equation are:

Oms = Operator's marginal share;
$\bar{X}_2$ = geometric mean of the labor input;
$\bar{X}_4$ = geometric mean of the machinery and equipment input;
$\bar{X}_5$ = geometric mean of the crop input;
$\bar{X}_6$ = geometric mean of the livestock input;
h = fraction of nonoperator labor in the labor input; and
mvp_i = marginal value product of the respective inputs.

The first term of the right-hand side of equation (6) represents the marginal return (loss) to operator labor after hired and nonoperator family labor had been paid at full market cost. The second term represents an entrepreneurial risk and management return (loss) to the operator on the nonreal estate capital inputs. Computing the marginal share to the operator by this method reflects a distribution of the value of production of the farm among the inputs in such a way that nonreal estate inputs were paid their market costs, including an opportunity cost, while the real estate and operator inputs were paid according to their marginal productivities. This distribution utilizes marginal productivity with the modification that the assumption of perfect knowledge is dropped and the operator accepts the entrepreneurial task of resource allocation under the expectation of receiving a return for undertaking the risk and uncertainty associated with it.

The residual "market" return to the operator for his labor and managerial skills was computed by subtracting all real estate and nonreal estate operating expenses, including nonoperator labor, from the total value of production. The annual market cost of real estate was determined as the sum of the annual land improvement expense, plus the mortgage interest payment computed on the total current land value. The residual income to the operator must cover any expected equity accumulation in land, plus a return for the uncertainty involved in the farming operation.

The marginal share to the operator was low in the 1954 period in relation to 1949 and 1959 for all types of farms except beef farms, which had low marginal shares to the operator in both 1954 and 1959. This can

Table 7. — Marginal and Residual Market Share Returns to Operator Inputs on Selected Types of Illinois Farms, 1949, 1954, and 1959

Type and period	Value of production	Percentage share to operator	
		Marginal	Residual market
GRAIN			
1949	$17,248	15.9	38.8
1954	18,538	3.0	16.3
1959	22,094	22.8	7.7
HOG			
1949	16,515	32.7	38.4
1954	18,033	8.7	15.8
1959	19,834	11.2	11.2
BEEF			
1949	23,825	25.5	40.2
1954	18,072	.2	2.6
1959	24,458	−.3	6.7
DAIRY			
1949	No data available		
1954	9,633	1.7	3.5
1959	16,280	7.8	13.9

be seen by studying figures in Table 7. The low marginal share to the operators on hog farms in 1954 and beef farms in 1954 and 1959 was largely caused by the method of computing the labor component of the operator's share. Operator labor was required to bear the entire burden of the low marginal value product of total labor. Hog farms in 1954 and beef farms in 1954 and 1959 had negative operator labor earnings. (See Appendix Table 7.) Grain and dairy farms in 1954 had low marginal shares to the operator because of the negative return in the entrepreneurial risk component of the operator's share (Appendix Table 7). Low yields of corn and soybeans in 1954 may have been a contributing factor to the low operator share in that period. In the remainder of the analysis, attention will be directed to the first and last periods of the study.

Comparisons between the operator's marginal and residual market shares in 1949 reveal that the market share on all types of farms was substantially larger than the marginal share. Operators in this period received a market share of approximately two-fifths of the value of production — a quantity that was greater than their marginal contribution to the farm business. This income transfer to the operators presented a situation of relative prosperity for the farmers in this period, as contrasted with the later periods. Between 1949 and 1959, resource adjustments had taken place that increased the amount of nonreal estate capital and acreage per farm, while land values had increased by 71 percent. These changes resulted in a sharp decline in the operator's market share.

On grain farms in 1959, the residual market share to the operator was only one-third as large as the marginal share. This is a clear indication that part of the operator's labor and management earnings on these farms had been capitalized into land value. On hog farms the evidence in support of the hypothesis is not quite so strong. The marginal and residual market shares were identical in 1959. This means that the entire marginal share to land had been capitalized into land value, forcing the landowner-operator share to absorb any sinking fund allotment to acquire land and leaving nothing to the landowner as a land management return or a return to cover uncertainty of income to real estate inputs.

If these three items are considered as reasonable expected returns by the landowner-operator, then it appears that the land market had capitalized part of the owner-operator's expected earnings into land value.

In the case of beef farms in 1959, the operator's negative marginal share makes it difficult to support or refute the basic hypothesis. This group of farms had significant increasing returns to scale in the unconstrained model. The fairly high marginal value product to total labor in the unconstrained model was sharply reduced by the assumption of constant returns to scale in the constrained model. Hence, caution should be used in evaluating operator earnings on beef farms in 1959. Perhaps it will be sufficient to point out that the residual market share of 6.7 percent provided a return of only $1,633 as an indication of low operator earnings on these beef farms.

Among the dairy farms there was only slight evidence to support the basic hypothesis, since the operator's residual market share was larger than the marginal share in 1959 — 13.9 percent and 7.8 percent, respectively. If land is expected to generate its own savings, provide a return for real estate management, and allow for uncertainty, then the difference of 6.1 percent noted above was 1.2 percent below the necessary amount to cover these items. This means that land was very close to being appropriately priced on these dairy farms and that operators were only about $200 short of receiving their marginal product.

It should be remembered that the farms used in this analysis represented farms of above-average size in land and capital use and the operators on these farms had above average management ability. If a random sample had been drawn of all farms within a specified type, the results of this distributive shares analysis would probably indicate a smaller operator's residual market share relative to the marginal share than was found in the analysis of data from the Farm Bureau Farm Management Service records. This implies a larger income transfer from operators to real estate would be expected for the entire population of farms within each type than was observed in the sample groups of this analysis.

Capital accumulation for land purchase

One consequence of the steady decline in the agricultural parity ratio and the rising trend in land values from 1949 to 1959 is the increased difficulty that confronts farmers as they try to accumulate savings from their labor and management earnings for the purchase of land. This is illustrated in the following example. Two tenure situations are presented for identical farmers (operating with resources and productivities indicated in the production function analysis) for grain, hog and beef farms. Farmers in both situations are assumed to have started farming in 1949.

Farmers under alternative A bought their 1949 land on a 100-percent loan and additional land in 1959 to bring their total acreage up to the average for that period. Farmers under alternative B, however, rented their land until 1959, at which time they purchased the total acreage per farm for that period. As a down payment, they used a savings fund equal to a 10-year annuity of the annual sinking fund allotment that would have been required to amortize the 100-percent loan of alternative A. In other words, under alternative A a farmer bought land when he started farming and put his savings in land, whereas under alternative B a farmer put an equivalent amount of savings in an annuity fund and used it to purchase land 10 years later. The residual market income to farmers under alternatives A and B for 1959 and their net worth in land at the end of the 1959 production year are compared in Table 8.

The residual market income to the operators under alternative A for grain, hog, and beef farms was $3,423, $3,314, and $3,195, respectively. These are to be compared with corresponding residual market income to operators under alternative B of $986, $1,769, and $1,046 for grain, hog, and beef farms, respectively. Farmers operating under alternative A would be able to meet their amortization payment with a modest sacrifice from family living. However, farmers under alternative B would find it difficult to maintain an adequate level of living while purchasing land at 1959 land values. In addition, capital gains that occurred during the decade were realized only by farmers under alternative A. This served to increase the net worth in land of alternative A farmers so that it was approximately six times larger than the net worth of farmers under alternative B.

Capital gains and farm income

In addition to the conventional "production" income discussed in the preceding analysis, the contribution of nonconventional income from capital gains to the welfare of the resource owners should also be recognized. The importance of capital gains as a source of income has been discussed in the literature with increasing frequency.[1] Real capital gains arise from an interaction of such forces as expectations about the future flow of income from an asset, net credit position of resource owners, changes in the purchasing power of money, and changes in the discount rate that is used to convert future income into a present value.

To the extent that farm families own assets that have increased in value (primarily real estate), they may be able to capture this capital gain when they sell the asset and thus consider the increase in value as a component of their income. Capital gains are unrealized income until the asset is sold. However, if the farm families substitute the expected annual capital gain on real estate for their savings, they may be able to increase their current consumption by spending the amount that would have been set aside in some form of savings.[2] Because capital gains are influenced by such elusive and transitory factors as buyers' confidence in the real estate market and anticipation of an increase in the stream of income to real estate, capital gains cannot be considered as a perfect substitute for savings as a means of raising current disposable income.

The role of capital gains in the welfare of farm families is an important and complex factor. The complexities of capital gains are not unrelated to the problem of determining the distributive shares of conventional income, but they do represent a set of additional considerations. The thorough analysis of these considerations is beyond the scope of this study.

The inclusion of anticipated capital gains in an analysis of farm income and resource valuation introduces speculative considerations that are beyond the realm of marginal analysis. For the purposes of this study, perhaps it will be sufficient to recognize that capital gains have occurred during the decade under study to the benefit of the landowners. This had the effect of raising the annual rate of return on their investment in real estate by an additional percentage ranging from 5.3 percent to 8.9 percent, depending on the amount of equity the owners held in their real

[1] D. E. Hathaway, "Agriculture and the Business Cycle," pp. 51-76, Policy for Commercial Agriculture, Joint Economic Committee, 85th Cong., U.S. Government Printing Office, Washington, D.C. 1957. E. W. Grove, "Farm Capital Gains — A Supplement to Farm Income?" *Agricultural Economics Research,* pp. 37-42 **12**:2. April, 1960. D. M. Hoover, "The Measurement and Importance of Real Capital Gains in the United States Agriculture, 1940 Through 1959," *Jour. of Farm Economics,* **44**:929-940. November, 1962. D. H. Boyne, Changes in the Real Wealth Position of Farm Operators, 1940-1960, Mich. Agr. Exp. Sta. Tech. Bul. 294. 1964.

[2] D. H. Boyne, *op. cit.,* p. 30.

Table 8. — Allocation of 1959 Value of Production Under Two Alternatives With Respect to Purchase or Rental of Land at the Beginning of the Farming Career in 1949 on Selected Types of Illinois Farms

	Grain	Hog	Beef
Value of production	$22,094	$19,834	$24,458
Nonreal estate expense	12,005	11,254	14,381
Land improvement expense	1,716	2,274	2,872
Alternative A			
Mortgage payment on 100% loan on 1949 land value	2,935	1,861	2,586
Mortgage payment on 100% loan on land added in 1959 at 1959 value	1,197	634	756
Sinking fund allotment on 1949 land	610	387	537
Sinking fund allotment on land added in 1959	208	110	131
Residual income to operator	3,423	3,314	3,195
Alternative B			
Mortgage payment on loan of 1959 land value, minus 10-year annuity of 1949 sinking fund allotment	6,295	3,866	5,248
Sinking fund allotment on above loan	1,092	671	911
Residual income to operator	986	1,769	1,046
Ten-year annuity of sinking fund	7,496	4,755	6,599
Capital gain on 1949 land	46,315	29,367	40,802
Net worth in land under alternative A	54,629	34,619	48,069
Net worth in land under alternative B	8,588	5,426	7,510

estate.[1] Estimates of capital gains that accrued to individuals who owned land in 1949 were presented in Table 8 for grain, hog, and beef farms. A long-term continuation in the rate of capital gains observed during the period from 1949 to 1959 is unlikely, however, since it appears that the market underestimated land productivity in 1949.

Real estate for agricultural uses derives its value primarily through its contribution in the production of commodities demanded by society. Capital gains on real estate in any given time period depend heavily on the ability (or lack of ability) of the real estate market to estimate this contribution.

Evidence in this study indicates that the market underestimated the productivity value of real estate in 1949. By 1959 the market had adjusted itself to approximate the productivity value of real estate on dairy farms in southern Illinois, but it overestimated the productivity value on grain farms in east-central Illinois and on hog and beef farms in west-central Illinois. Thus, the landowners represented in this study who

[1] Real estate values in Illinois increased an average of 7.1 percent annually during the decade under study, while the purchasing power of the dollar declined by 1.8 percent annually (measured by the consumer price index). Thus, the range in real capital gain extends from 5.3 percent for owners with 100 percent equity to 8.9 percent for owners with zero equity in their real estate.

acquired real estate in 1949 obtained part of their capital gains at the expense of the previous owner because of imperfections in the real estate market in 1949. Owners of grain, hog, and beef farms obtained a portion of their capital gain from the previous owner and a portion from the future landowners, because present owners would extract a quantity of money from the future owners for the anticipated future increases in real estate productivity.

It should be pointed out that from a theoretical standpoint, technology that substitutes capital for land or that increases output for an inelastic market will have the effect of reducing the total acres required for agricultural production. Hence, if the market was free to establish a new equilibrium position, capital losses would be expected from new technology of this type.

Summary and Implications

An application of efficiency criteria to the problem of determining the distributive shares, specifies that resources are to be paid according to their marginal value products. If the firm is operating at a level of production characterized by constant returns to scale, as tends to be the case under perfect competition, a marginal share distribution among the resources will just exhaust the total product of the firm. One test of the effectiveness of a tenure system is its ability to enable each resource to receive its marginal factor share of the total product.

The analysis of the functional distribution among the factors of production has shown that the marginal share to operator labor was low on each type of farm and in each time period. A partial explanation for this is that the adoption of labor-saving technology renders part of the existing labor redundant, resulting in a low marginal product to labor until resource adjustments can be made. Since operator labor is fixed to the firm, the operator seeks adjustments that will make full utilization of his time and equipment by spreading his labor over more acres. It is at this juncture that the immobility feature of operator labor exerts pressure on the tenure system as an institution to associate factor costs and returns.

Competition among farm operators for the limited supply of land may encourage them to bid up the price of land (rental or purchase) in an effort to acquire the additional land needed for efficient use of machinery and equipment in combination with the available labor. As the competition for land becomes more intense, the price of land may exceed the value of land based on its marginal productivity contribution to the total product of the farm. If a farmer has limited alternatives for employment outside of agriculture or places a high premium on operating a farm, he is likely to accept a low return to his own personal efforts and bid up the price of land in an effort to acquire the necessary land that will assure himself a position in farming. This is particularly so if the farmer is in a high-equity position that enables him to achieve a reasonable level of income for family living while purchasing additional land. Actions such as this represent an income transfer from operator labor to land and result in a dissociation of costs and returns.

Although the analysis in this study was not designed to determine the reasons behind the rise in land values, the analysis does indicate that the trends in land value and the trends in land productivity during the decade from 1949 and 1959 have not been moving in harmony. To the extent that the interaction of the immobility feature of operator labor and the economic necessity of farm expansion has been a major force in the land market, it does appear that operators on grain and hog farms in Illinois had capitalized part of their labor and management earnings into land value by 1959. On beef and dairy farms the marginal share to the operator was low in relation to income of nonfarm workers, but the land market had not succeeded in capitalizing part of this return into land value.

The dissociation of costs and returns on the grain and hog farms may be an indication that the struggle for owner-operatorship may be a cancerous development that could destroy the owner-operator tenure system itself. If buyers of land at current high prices discover that they cannot meet both the interest payment and the sinking fund components of their amortization payments, land ownership will shift to lending agencies. Under conventional lending arrangements, farm operators will have a type of leasehold possession of the real estate through a contract of perpetual debt, with a fixed commitment in place of a negotiable rental contract. If such circumstances evolve in agriculture, the lack of equity accumulation by the operator means that the operator would be unable to share in any capital gains that accrue to land. However, the operator's fixed commitment to the perpetual debt acts as a buffer to the lender against possible capital losses that may occur as a result of lower product prices and reduced farm earnings. Thus the operator would be denied participation in capital gains, but would be required to forestall capital losses to the lender at the expense of the farm family's level of living.

Evidence from this study indicates that achievement of the traditional goal of owner-operatorship of the real estate inputs of the farm business may be jeopardized by the trend of rising land values and a lower residual market share to the operator. Accumulating savings from the operator's residual market share for the purchase of land in 1959 would be very difficult if the general production and price relationships of 1959 continue in the future. An operator who began his farming career as a tenant in 1949 and purchased land in 1959 would have a residual operator labor income from the 1959 production of \$986, \$1,769, and \$1,046 on grain, hog, and beef farms, respectively.

The low marginal shares to the operators that were observed in this study indicate that if the traditional tenure goal of owner-operated farms is to continue, the expected return to land must cover the cost of land acquisition. This implies that the discount rate used to calculate a present value of land from the expected annual marginal contribution of land should include a sinking fund rate. This would not violate the efficiency condition of equating factor costs and returns for an effective tenure system, but instead simply recognizes that under a tenure system of owner-operated farms, land must provide a return that covers its purchase price in any given year. The operator would thus be relieved of relying on his low marginal return to his personal efforts as the source of savings for the purchase of land.

Viewing the return to land and the consequent valuation of land from this standpoint places land in the same category as other resources in that the return to a resource is expected to cover its purchase price for periodic replacement. The only difference is that in the case of land the owner is acquiring an equity in a resource that has negligible depreciation over time when properly managed and, therefore, provides a saving fund to the owner-operator.

The difficulty of accumulating sufficient savings from the operator's labor and management earnings during his operating career for the acquisition of land he operates, indicates the need for a reevaluation of public land tenure policies. One such review could be oriented toward whether the goal of owner-operatorship is still relevant for a large segment of agriculture, and if so, what policy changes are needed to facilitate the achievement of this goal under the present conditions of high per farm capital requirements. On the other hand, if this goal has ceased to have wide public support, the review could be focused on what tenure policy changes are needed that are consistent with the goal of a wide distribution of private entrepreneurship of farm businesses and equitable returns to efficient producers. This implies that other policies should be directed toward the problems of inefficient producers with respect to resource adjustments, retraining and mobility of operator labor, and income supports.

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APPENDIX

Appendix Table 1. — Interest Rates Used to Represent Opportunity Costs of Capital Used by Farm Businesses, by Years

Input	Year and opportunity cost rates					
	1949		1954		1959	
	ϕ	ρ	ϕ	ρ	ϕ	ρ
Hired and family labor	$.029	....	$.031	.....	$.034	....
Land improvements	.029	$.045	.031	$.0463	.034	$.049
Machinery and equipment	.021	.045	.024	.0463	.027	.049
Crop inputs	.033	.045	.036	.0463	.039	.049
Livestock inputs	.029	.058	.031	.0620	.034	.068

Appendix Table 2. — Monthly Wage Rates Used to Value Unpaid Labor, by Areas and Years[a]

Year	East-central and western livestock areas	General livestock area
1948	$175	$160
1949	175	160
1950	175	160
1953	175	160
1954	175	160
1955	185	170
1958	200	185
1959	215	200
1960	215	200

[a] Source: Illinois Agricultural Statistics, Annual Summary, 1951, 1956, and 1962.

Appendix Table 3. — Estimated Factor Productivities and Factor Shares on Illinois Grain Farms, 1949, 1954, and 1959

	Geometric mean	Elasticity of production, b_i	Marginal value product	Marginal factor share (X_i) (mvp_i)
1949	N = 149	R^2 = .9207		
Y	$17,248			
X_1	65,233	.4513**	$ .1193	$ 7,784
X_2	2,954	.0568	.3316*	980
X_3	957	.0037	.0667*	64
X_4	3,788	.2494**	1.1356	4,302
X_5	751	.0993**	2.2806**	1,713
X_6	791	.1441**	3.1421**	2,485
Sum		1.0046		17,328
1954	N = 151	R^2 = .8899		
Y	$18,538			
X_1	91,894	.4429**	$ .0893	$ 8,206
X_2	3,275	.1467*	.8304	2,720
X_3	1,273	−.0117	−.1704**	−217
X_4	5,003	.0909	.3368**	1,685
X_5	2,608	.3017**	2.1446**	5,593
X_6	1,010	.0288	.5286	534
Sum		.9993		18,521
1959	N = 194	R^2 = .9053		
Y	$ 22,094			
X_1	135,973	.2444**	$ .0397	$ 5,398
X_2	3,740	.2145**	1.2672	4,739
X_3	1,716	−.0114	−.1468**	−252
X_4	6,242	.2723**	.9638	6,016
X_5	3,200	.2317**	1.5997**	5,119
X_6	1,137	.1205**	2.3415**	2,662
Sum		1.0720*		23,682

* Null hypothesis rejected at the 0.05 level of probability. The null hypotheses are: (1) $b_i = 0$, where $i = 1$ to 6; (2) $\sum_{i=1}^{6} b_i = 1$; and (3) $mvp_i = \$1$, where $i = 2$ to 6.

** Null hypothesis rejected at the 0.01 level of probability.

Appendix Table 4. — Estimated Factor Productivities and Factor Shares on Illinois Hog Farms, 1949, 1954, and 1959

	Geometric mean	Elasticity of production, b_i	Marginal value product	Marginal factor share (X_i) (mvp_i)
1949	N = 151	R^2 = .8354		
Y	$16,515			
X_1	41,362	.2528**	$ .1009	$ 4,174
X_2	3,231	.1174	.6001	1,939
X_3	1,364	.0162	.1961†	267
X_4	3,451	.1818**	.8700	3,002
X_5	392	.0346	1.4577	571
X_6	1,483	.4557**	5.0748**	7,526
Sum		1.0585		17,479
1954	N = 150	R^2 = .8937		
Y	$18,033			
X_1	67,207	.4174**	$ .1120	$ 7,527
X_2	3,556	.1117*	.5664	2,014
X_3	1,912	−.0404	−.3810**	−728
X_4	4,887	.1780**	.6568	3,210
X_5	1,542	.1230**	1.4384	2,218
X_6	2,129	.3194**	2.7054**	5,760
Sum		1.1091**		20,001
1959	N = 162	R^2 = .8517		
Y	$19,834			
X_1	83,660	.2816**	$ .0668	$ 5,588
X_2	3,777	.1201*	.6307	2,382
X_3	2,274	.0395	.3445**	783
X_4	5,784	.1499*	.5140*	2,973
X_5	1,614	.1187**	1.4587	2,354
X_6	2,427	.2894**	2.3650**	5,740
Sum		.9992		19,820

* Null hypothesis rejected at the 0.05 level of probability. The null hypotheses are the same as in Appendix Table 3.
** Null hypothesis rejected at the 0.01 level of probability.
† Null hypothesis rejected at the 0.10 level of probability.

Appendix Table 5. — Estimated Factor Productivities and Factor Shares on Illinois Beef Farms, 1949, 1954, and 1959

	Geometric mean	Elasticity of production, b_i	Marginal value product	Marginal factor share (X_i) (mvp_i)
1949	N = 64	R^2 = .8395		
Y	$23,825			
X_1	57,467	.2723**	$ .1129	$ 6,488
X_2	4,137	.1420	.8178	3,383
X_3	2,000	.0716	.8529	1,706
X_4	4,389	.1515†	.8224	3,610
X_5	507	.0336	1.5789	801
X_6	2,283	.3894**	4.0637**	9,277
Sum		1.0604		25,264

Appendix Table 5. — Continued

	Geometric mean	Elasticity of production, b_i	Marginal value product	Marginal factor share (X_i) (mvp_i)
1954	N = 126	R^2 = .7570		
Y	$18,072			
X_1	79,154	.3474**	$ .0793	$ 6,277
X_2	3,837	.0432	.2035*	781
X_3	2,450	.0360	.2655*	650
X_4	5,370	.2550*	.8582	4,609
X_5	1,748	.0577	.5965	1,043
X_6	2,489	.3096**	2.2479†	5,595
Sum		1.0489		18,955
1959	N = 99	R^2 = .6951		
Y	$ 24,458			
X_1	113,706	.3834**	$ .0825	$ 9,377
X_2	4,251	.1664	.9574	4,070
X_3	2,872	.0780	.6642	1,908
X_4	6,812	.0456	.1637	1,115
X_5	2,161	.2204**	2.4945†	5,391
X_6	3,500	.3451*	2.4116	8,440
Sum		1.2389*		30,301

* Null hypothesis rejected at the 0.05 level of probability. The null hypotheses are the same as in Appendix Table 3.
** Null hypothesis rejected at the 0.01 level of probability.
† Null hypothesis rejected at the 0.10 level of probability.

Appendix Table 6. — Estimated Factor Productivities and Factor Shares on Illinois Dairy Farms, 1954, and 1959

	Geometric mean	Elasticity of production, b_i	Marginal value product	Marginal factor share (X_i) (mvp_i)
1954	N = 87	R^2 = .7729		
Y	$ 9,633			
X_1	27,183	.2382**	$ .0844	$ 2,294
X_2	3,095	.3143**	.9782	3,028
X_3	916	−.0055	−.0578†	−53
X_4	3,604	.1496	.3999*	1,441
X_5	1,368	.2466**	1.7365	2,376
X_6	861	.1976*	2.2108	1,903
Sum		1.1408		10,989
1959	N = 119	R^2 = .8182		
Y	$16,280			
X_1	43,725	.2054**	$ .0765	$ 3,345
X_2	3,955	.1804*	.7426	2,937
X_3	1,486	.0888*	.0729	1,446
X_4	5,544	.2674**	.7852	4,353
X_5	1,589	.1182*	1.2110	1,924
X_6	1,463	.2169**	2.4136†	3,531
Sum		1.0771		17,536

* Null hypothesis rejected at the 0.05 level of probability. The null hypotheses are the same as in Appendix Table 3.
** Null hypothesis rejected at the 0.01 level of probability.
† Null hypothesis rejected at the 0.10 level of probability.

Appendix Table 7. — Marginal Share and Market Distributions of the Value of Production, and Estimated Real Estate Charges on Selected Illinois Farms, 1949, 1954, and 1959

	1949		1954		1959	
	dollars	percent	dollars	percent	dollars	percent
GRAIN FARMS						
Value of production	17,248	100.0	18,538	100.0	22,094	100.0
Marginal distribution:						
Marginal share to real estate	7,852	45.5	7,993	43.1	5,055	22.9
Machinery, crop, and livestock expense	5,330	30.9	8,621	46.5	10,579	47.9
Nonoperator labor expense	1,336	7.7	1,365	7.4	1,426	6.4
Operator's share of marginal return to labor	−420	15.9	1,364	3.0	1,996	22.8
Entrepreneurial risk	3,150		−805		3,038	
Market distribution:						
Interest payment to land plus land improvement expense	3,892	22.6	5,528	29.8	8,379	38.0
Machinery, crop, and livestock expense	5,330	30.9	8,621	46.5	10,579	47.9
Nonoperator labor expense	1,336	7.7	1,365	7.4	1,426	6.4
Residual to operator	6,690	38.8	3,024	16.3	1,710	7.7
Real estate charges:						
Sinking fund allotment	610	3.5	836	4.5	1,155	5.2
Charge for uncertainty of land income	652	3.8	919	5.0	1,360	6.2
Management return on real estate	550	3.2	559	3.0	354	1.6
HOG FARMS						
Value of production	16,515	100.0	18,033	100.0	19,834	100.0
Marginal distribution:						
Marginal share to real estate	4,173	25.3	6,290	34.9	6,371	32.1
Machinery, crop, and livestock expense	5,326	32.3	8,558	47.5	9,825	49.5
Nonoperator labor expense	1,608	9.7	1,613	8.9	1,429	7.2
Operator's share of marginal return to labor	−422	32.7	−834	8.7	965	11.2
Entrepreneurial risk	5,830		2,406		1,244	
Market distribution:						
Interest payment to land plus land improvement expense	3,225	19.6	5,024	27.8	6,373	32.1
Machinery, crop, and livestock expense	5,326	32.3	8,558	47.5	9,825	49.5
Nonoperator labor expense	1,608	9.7	1,613	8.9	1,429	7.2
Residual to operator	6,356	38.4	2,838	15.8	2,207	11.2
Real estate charges:						
Sinking fund allotment	387	2.3	611	3.4	711	3.4
Charge for uncertainty of land income	414	2.5	672	3.7	837	4.2
Management return on real estate	334	2.0	504	2.8	509	2.6

	1949		1954		1959	
	dollars	percent	dollars	percent	dollars	percent
BEEF FARMS						
Value of production	23,825	100.0	18,072	100.0	24,458	100.0
Marginal distribution:						
Marginal share to real estate	8,077	33.9	6,548	36.2	10,156	41.5
Machinery, crop, and livestock expense	7,179	30.1	9,607	53.2	12,473	51.0
Nonoperator labor expense	2,488	10.5	1,890	10.4	1,908	7.8
Operator's share of marginal return to labor	−194	25.5	−1,370	.2	−1,414	−.3
Entrepreneurial risk	6,275		1,397		1,335	
Market distribution:						
Interest payment to land plus land improvement expense	4,586	19.2	6,115	33.8	8,444	34.5
Machinery, crop, and livestock expense	7,179	30.1	9,607	53.2	12,473	51.0
Nonoperator labor expense	2,488	10.5	1,890	10.4	1,908	7.8
Residual to operator	9,572	40.2	460	2.6	1,633	6.7
Real estate charges:						
Sinking fund allotment	537	2.3	720	4.0	966	4.0
Charge for uncertainty of land income	575	2.4	792	4.4	1,137	4.6
Management return on real estate	646	2.7	523	2.9	812	3.3
DAIRY FARMS						
Value of production	No data available		9,633	100.0	16,280	100.0
Marginal distribution:						
Marginal share to real estate			2,353	24.4	4,616	28.4
Machinery, crop, and livestock expense			5,833	60.6	8,596	52.8
Nonoperator labor expense			1,282	13.3	1,794	11.0
Operator's share of marginal return to labor			843	1.7	305	7.8
Entrepreneurial risk			−678		969	
Market distribution:						
Interest payment to land plus land improvement expense			2,175	22.6	3,629	22.3
Machinery, crop, and livestock expense			5,833	60.6	8,596	52.8
Nonoperator labor expense			1,282	13.3	1,794	11.0
Residual to operator			343	3.5	2,261	13.9
Real estate charges:						
Sinking fund allotment			247	2.5	371	2.3
Charge for uncertainty of land income			272	2.8	437	2.7
Management return on real estate			189	1.9	370	2.3

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