Marginal Productivity of Resources And Imputation of Shares For Cash and Share Rented Farms

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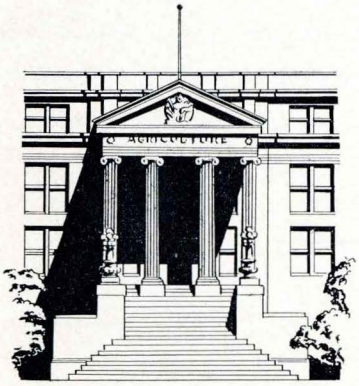

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CONTENTS

SUMMARY

This study has three major objectives: (1) to derive production functions for farms operated under different leasing and tenure arrangements, (2) to compare the marginal productivity of resources used under these various situations, (3) to explore the use of computed marginal productivities as a basis of allocating income shares to tenant and landlord.

The data which serve as the basis of the study are from sample surveys in the Tama-Muscatine soil area of east-central Iowa, the Clarion-Webster soil area of northern Iowa and the Shelby-Grundy-Haig (and associated soils) in southern Iowa. Production functions for crops in these areas are as follows, where Y is the annual value of crop production, X_1 is labor measured in months, X_2 is cropland measured in acres and X_3 is the value of all capital services used on crops:

1950 sample in Tama-Muscatine soils

Crop-share leases:

$$Y = 4.57X_1^{0.119} \quad X_2^{0.773} \quad X_3^{0.318}$$

Cash leases:

$$Y = 9.00X_1^{0.095} \quad X_2^{0.965} \quad X_3^{0.305}$$

1951 sample in northern Iowa

Crop-share leases:

$$Y = 43.26X_1^{0.097} \quad X_2^{0.731} \quad X_3^{0.202}$$

Owner-operated farms:

$$Y = 13.00X_1^{0.085} \quad X_2^{0.967} \quad X_3^{0.153}$$

All farms:

$$Y = 18.75X_1^{0.076} \quad X_2^{0.912} \quad X_3^{0.165}$$

1951 sample in southern Iowa

Owner-operated farms:

$$Y = 6.97X_1^{0.089} \quad X_2^{0.824} \quad X_3^{0.342}$$

All farms:

$$Y = 5.22X_1^{0.088} \quad X_2^{0.795} \quad X_3^{0.393}$$

Marginal productivities derived from these functions differ for various lease types as would be expected from theoretical considerations. The marginal productivities are higher for labor and capital under crop-share leases than under cash leases in the 1950 Tama-Muscatine sample. The marginal productivities are higher for land under cash leases than under share leases. Owner-operated farms have higher marginal productivities for land but lower productivities for capital and labor than crop-share rented farms. Highest productivities are expected for capital and labor on farms which apply less of these two resources per acre of land. Lower labor/land or capital/land ratios usually denote application of fewer farm practices or less of a particular resource such as fertilizer.

All production elasticities for the individual functions were significant at levels of 1 to 20 percent. However, in testing the differences between marginal productivities of (a) share-rented and cash-rented farms or (b) share-rented and owner-operated farms, only the values for land were significant. Productivities were significantly greatest on cash-rented farms. For all tests of departure of marginal productivities from rental payments, the t values were significant at 1- to 5-percent probability levels.

When product shares were compared with the proportion of resource services furnished by tenant and landlord under standard share arrangements, the two were similar in northern Iowa. The proportion of production services furnished by the tenant was 54.3 percent, while his share of the product was 53 percent. The tenant shares were less similar in southern Iowa, where they were 67.7 and 51 percent respectively. It appears doubtful that share arrangements in southern Iowa should parallel so closely those of northern Iowa. The relative value productivity of resources furnished by landlord and tenant in the two areas does not parallel the relative shares of the product.

Computed marginal productivities were tested as a method of allocating income between landlord and tenant. This method does not appear useful for allocating incomes if the data are based on farm aggregates. However, tenants and landlords still need to use marginal analysis in deciding on rental arrangements and rental rates or shares. These marginal quantities can be computed by budgeting methods and need not be as refined as those computed in this methodological study.

The use of aggregates is limited because of difficulties involved in the magnitude of production elasticities. Hence, the problem needs further study.

Marginal Productivity of Resources and Imputation of Shares for Cash and Share Rented Farms[1]

BY EARL O. HEADY

The farm operator has alternative means of obtaining control of resources. These several means allow him to use the services of resources in the production process and to acquire income for his own family in the process of producing foods and fibers for other consumers. The alternative means of obtaining control of resources and use of production services include: ownership, borrowing of capital, renting through cash and share arrangements and exchange of services through trading work and machinery with his neighbors.

The method of obtaining control of resources and the use of resource services thus become important problems in farm management and production economics. What method will allow the individual farm manager the greatest income from the funds he controls? What method allows the most efficient use of resources from the standpoint of the over-all economy? This study is one of a series dealing with leases in relation to farming efficiency; it is directed at answering these over-all economic questions.

ROLE OF LEASING FORMS IN PRODUCTION ECONOMICS EFFICIENCY

The type of farm lease can either aid or retard efficiency in farming. Previous studies have shown conceptually that either share or cash leases can include arrangements which cause the farm operator to use capital, labor and land resources in a non-optimum manner.[2] These imperfections need not be inherent in the lease form. They can stem from the leasing customs and institutions which have grown up and been perpetuated over time.[3] Sharing arrangements, particularly leases, can cause resources to be used inefficiently on rented farms. Rental payments under share leases represent a variable payment within the farm business. Therefore, they affect the cost function from which the tenant makes decisions. The sharing provisions can cause him to use too few resources for one enterprise or for the farm business as a whole. They can cause him to use a combination of crop enterprises which is inconsistent with efficiency. They can retard use of efficient practices such as fertilization or conservation measures (or, they may allow use of a practice such as fertilization, but the tenant may use less than the optimum amount).

Certain rules of production economics can be established for share leases. These rules provide the framework for evaluating the empirical or factual findings of lease studies. They also provide a framework within which farming efficiency can be as great under a share lease as under a cash lease or under ownership operatorship. The rules, explained in the technical terminology of production economics, are as follows:[4]

(1) *The arrangements for sharing costs and production for each particular crop must be the same.* In other words, if the share of the crop is to be divided on a 50-50 basis, costs (or, at the minimum, the direct variable costs) also must be shared on a 50-50 basis. For example, suppose the cost of a new practice is $3.50 per acre and the return from it is $6. Use of this practice will be profitable for the operator who owns his farm and gets all the return from new methods. However, it will be unprofitable for either a tenant or a landlord who pays all the cost ($3.50) and gets back only half the return ($3). Still, if the "equal share of costs and returns" principle is applied, the cost to either the tenant or landlord will be $1.75, and the return will be $3 to each under a 50-50 arrangement. The practice then will be equally profitable to both.

The condition or rule specified above is to assure that the tenant, or the landlord, will invest an optimum amount of capital and other resources in an individual enterprise. It also is to assure that the proper or economic amount of materials (such as fertilizer) representing each practice for the enterprise will be used.

(2) *The shares of all competitive crops must be the same.*[5] That is, if the rental share is to be 50-50 for one crop, it should not be 35-65 for another crop. If different shares are given for different crops, the allocation of labor, materials and other resources between enterprises probably will not be of a pattern to give maximum farm profits or to give the consumer the maximum of desired products from a given collection of resources.

For example, suppose the gross return per acre is $40 for crop A and that its cost per acre is $16. The net of $24 will cause the owner-operator or cash ten-

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[1] Project 1135. Iowa Agricultural Experiment Station.

[2] Heady, Earl O. Economics of leasing systems. Jour. Farm Econ. 29:659-678. Aug., 1947.
Heady, Earl O. and Kehrberg, Earl W. Relationship of crop-share and cash leasing systems to farming efficiency. Iowa Agr. Exp. Sta. Res. Bul. 386.
Heady, Earl O. Economics of agricultural production and resource use. Prentice-Hall, Inc., New York. 1952. Ch. 15.

[3] Heady, Economics of agricultural production and resource use. Ch. 15.

[4] All farms must attain certain equilibrium conditions. These conditions, as applied in agriculture, are outlined in Heady, Earl O. Economics of agricultural production and resource use. Prentice-Hall, Inc., New York, 1952. Ch. 4-8. However, the rented farm must attain certain additional conditions (*ibid.*, Ch. 17).

[5] The same rule can be applied to crops which are complements or are independent in a supplementary sense. However, if slight deviations are made for crops of this nature, the optimum enterprise combination is not likely to be violated.

ant to produce this crop rather than B, if B grosses only $31 per acre and has costs of $8 per acre. Still, the share tenant who pays all of the costs and gives half the return for A and 40 percent of the return for B as rent will find B more profitable. If the tenant gives a rent of half of each crop or any other equal proportions for the crops, A also will be more profitable for him.

(3) *The prospects for returns over time, considering the normal uncertainties of weather and the market, must be the same under the lease as they would be in its absence.* This condition can best be guaranteed through (a) compensation for unexhausted investments should the tenant need to move before full returns have been realized from an investment, or (b) a lease long enough to guarantee full returns. Under many kinds of farming, compensation may be more nearly feasible than a lease of sufficient length. However, it should be based on expected earning power of investments rather than unexhausted investment alone. Suppose, for example, that a tenant has two investment opportunities. Both will return 20 cents on the dollar and are equally attractive. However, if one requires 3 years to pay out and a compensation clause is provided to give the tenant back only his investment should he move in 2 years, this investment will not appear profitable. Why should he invest in it with the possibility of getting back only $1 for each $1 invested? He will be better off to invest in the other opportunity which returns $1.20 for each $1 invested within the year.

(4) *The share of income going to each party of the lease must represent the product of the resources furnished by this person.* In other words, shares which are not in line with the contributions of leasee and lessor are likely to cause the "controlling" party to specify inefficient use of resource. Resources will not be used in a manner consistent with demand of consumers, as expressed in market prices, and with the production possibilities of the farm.

OPTIMUM PROGRAMS UNDER FOUR CONDITIONS

If the conditions outlined above are used, they guarantee that the farming program which is most profitable for the tenant also will be most profitable for the landlord. In any case where the most profitable program for one party is not also best for the other, one of the above optimum conditions ordinarily is being violated. If the lease incorporates the four basic conditions outlined above and if it encourages a single farm organization which is optimum for both crop-share tenant and landlord, then it also allows a farming system which would be optimum under owner-operation or a cash lease.

CASH RENTS

A cash lease needs only the specifications listed under condition 3 in respect to time and condition 4 in respect to marginal products and shares to help guarantee efficiency. Condition 2 is automatically attained since the tenant pays all of the marginal costs (i.e., all variable costs which determine marginal costs) and receives all of the marginal product. (He gives no shares as rent.) Since cash rent is a fixed cost, it does not give rise to tenant or landlord shares of expenses which are inconsistent with shares of crop. Also, since it is a constant cost per acre and does not enter into marginal costs, it does not affect the operator's decision on crops. With cash rent of $5 per acre for the farm mentioned previously, the cash tenant will find crop A to be most profitable.

The main imperfections in the cash lease are those growing out of the risks and uncertainties attached to the commitment of a large fixed payment in the future. The rent remains the same, in contrast to share renting, even if crops fail.

A second characteristic of the cash lease also may cause inefficient farming. It is the fact that the tenant, since he pays a fixed rent with no share of surplus returns going to the landlord, may try to exploit the farm as greatly as possible before he moves. He alone benefits from any surplus returns which may be drawn from the land.

Both cash and share leases have their respective advantages and disadvantages in promoting or retarding efficient farm management. The conditions or principles outlined above can help guarantee that leases promote efficient farming. However, it is supposed that a large number of leases, both cash and share, do not include the basic production economic conditions specified above.[6] Hence, to what extent does inefficient farming result due to imperfect leasing arrangements? How do the two leases affect resource productivities?

OBJECTIVES AND DATA

The purpose of this study is to explore some of the basic productivity or efficiency conditions of leases on Iowa farms. A previous study dealt with the effect of share and cash leases on the adoption of efficient farm practices.[7] This study deals more specifically with the marginal return of resources used under these two major leasing arrangements.

To the extent that the conditions specified previously are violated under one lease and not the other, the marginal returns of resources might be expected to differ under the two systems because tenants: (1) use different quantities of resources, (2) use resources for different enterprise combinations or (3) combine resources in different proportions. Also, the returns to tenant and landlord might be expected to differ from the marginal products of the resources furnished by each. Thus the specific objectives of this study are: (1) to predict marginal resource productivities under different tenure arrangements, (2) to compare marginal resource productivities under share and cash leases and (3) to compare the share of farm returns for landlords and tenants with (a) the marginal

[6] See Hurlburt, Virgil L. Farm rental practices and problems in the Midwest. North Central Regional Publication No. 50 (Iowa Agr. Exp. Sta. Res. Bul. 416) for empirical indications of numbers of farms which do not attain the conditions listed.

[7] See Heady, Earl O. and Kehrberg, Earl W. Relationship of crop-share and cash leasing systems to farming efficiency. Iowa Agr. Exp. Sta. Res. Bul. 386.

This study also suggests the extent to which leasing practices follow the basic production economics principles outlined above.

products of resources furnished by each and (b) the share of income computed by alternative methods.

The study is a fundamental one dealing with the application of a basic production economics method to a particular farm management problem. Prediction of marginal resource productivities for alternative types of leases has not been attempted previously. The following point needs emphasis in interpretation of the analysis: Cash and share leases each have certain advantages over one another. However, the imperfections contained in each may cause resource productivities to be similar if the samples for each type of lease include farms with both the positive and negative characteristics of each lease.

SOURCE OF DATA

The data upon which this analysis is based come from two basic samples. The first basic sample, taken in 1950 to include the 1949 production year, included a Tama-Muscatine soil area in east-central Iowa. Two random samples of 70 farms each were drawn from lists of crop-share and cash-rented farms.

A list of all rented farms was prepared from information in county PMA and county treasurers' offices. This list was then shown to each township PMA chairman who specified, for his township, farms which were rented under crop-share or cash leases. Each farm in these two categories was assigned a number. Sample units, represented by individual farms, were then selected by means of random numbers.

The second basic sample, taken in 1951 to represent the 1950 production year, was drawn for northern and southern Iowa. This sample, drawn on a random area basis, was selected to provide inferences for all farms over 30 acres in size in the two areas of the state. The sample was drawn to include 150 farms in each region.[8] Rented farms were then segregated from owned farms for certain productivity estimates which follow. In some cases, alternative leasing conditions, as they are typically found on farms, have been tested against productivity coefficients derived for the entire 1951 sample of farms, without respect to tenure.

DERIVATION OF BASIC PRODUCTION FUNCTIONS

The first empirical step in this study is the derivation of production functions from which marginal resource returns can be computed. The marginal products provide the basic statistics for later efficiency comparisons and for gauging the extent to which tenant or landlord returns are in line with the productivities of their resources. The production functions derived in this study are for crops only.

In obtaining the original questionnaires, use of resources was separated for crops and livestock, and only crop activities are analyzed in this study. This procedure was followed since crop-share arrangements mainly affect crop decisions. Livestock decisions are not affected by the crop-sharing arrangement, though they may be affected by the building decisions the landlord makes.

The samples used in this study provide soil areas which are relatively homogeneous for the derivation of production functions. Additional sample data were available to which the current method might be applied. However, the number of farms included in these samples for any one soil area was small. To combine several soil areas would likely have given "mongrel" production functions which have little meaning.[9] Hence, analyses were completed for only the geographic areas mentioned. It is believed that the current samples are drawn from areas which are homogeneous enough to provide relatively uniform basic production functions.

CROP PRODUCTION FUNCTIONS FROM 1950 SAMPLES

Crop production functions were predicted for both the crop-share and cash samples taken in 1950. The production function used is of the Cobb-Douglas, least-squares type. The variables included, identical for both types of leases, were:

Y is the value of crop production, measured in dollars, during the 1949 production year. It includes the value of all crops produced, including hay and pasture, regardless of whether the crops were fed, sold, stored or used otherwise.

X_1 is the amount of labor used on crops during the same year, measured in months.

X_2 is the amount of land, measured in acres.

X_3 is the amount of capital services used on crops and is measured in dollars. It represents the annual inputs of capital services for 1949. It does not include capital investment. Included are the annual expenses for seeds, seed treatment, tractor fuel, machinery repairs and depreciation, fertilizer and all other annual outlays for crops.

All input categories and the value of crop output are for the farm as a whole, rather than for tenant or landlord shares. The derived production functions are as follows:

Crop-share:

$$Y = 4.57X_1^{0.119} \quad X_2^{0.773} \quad X_3^{0.318}$$

Cash leases:

$$Y = 9.00X_1^{0.095} \quad X_2^{0.965} \quad X_3^{0.305}$$

The t values are given in table 1 with an indication of the probability levels which they represent. All regression coefficients are significant at a probability level of 10 percent or less. While the labor coefficients are significant at a probability level between 5 and 10 percent, these appear acceptable for use in later analysis—especially if the variance of the coefficients is remembered.

CROP PRODUCTION FUNCTIONS FROM 1951 SAMPLES

Crop production functions of the same algebraic form were derived for both the 1951 samples in

[8] The 1950 samples also did not include any farms under 30 acres in size.

[9] See Heady, Earl O. Elementary models in farm production economics research. Jour. Farm Econ. 30:201-225. May, 1948.

TABLE 1. MEAN INPUTS AND t VALUES FOR REGRESSION COEFFICIENTS DERIVED FOR CASH AND CROP-SHARE LEASES IN 1950 TAMA-MUSCATINE SAMPLES.

Input item	Crop-share	Cash
	Mean resource inputs	
Labor	9.0	9.4
Land	195	187
Capital	1,893	1,978
	Value of t for regression coefficients	
Labor	2.20†	1.89‡
Land	8.67*	10.59*
Capital	2.12†	2.16†

*$p<0.01$
†$0.05>p>0.01$
‡$0.10>p>0.05$

northern and southern Iowa. The same classification of variables was used except that land now includes only cropland (including hay) and excludes all permanent pasture. Value of crops produced does not include permanent pasture. Each of these samples was, in turn, broken down into further strata. Farms were classified as follows: crop-share lease, cash lease, livestock-share lease and owner-operator. (Part owners were not included in these classifications but were included for estimates of the all-farm functions.)

A crop production function estimate was made for each one of these groups. However, the samples were so small for livestock-share and cash leases (either for the observations in northern and southern Iowa alone, or for observations in both areas pooled) that none of the coefficients proved significant. Accordingly, they were dropped from the analysis. The crop-share sample for southern Iowa also was so small and included such large standard errors that it was dropped. Remaining, then, were the production functions for crop-share leases in northern Iowa, owner-operator farms in northern and southern Iowa and all farms (the original sample, including all tenure groups) in both areas. The crop production functions are listed below for these five classifications and related statistics are given in table 2.

Northern Iowa, crop-share (60 farms):

$$Y = 43.26X_1^{0.097} \quad X_2^{0.731} \quad X_3^{0.202}$$

TABLE 2. MEAN INPUTS AND t VALUES FOR REGRESSION COEFFICIENTS DERIVED FOR TENURE GROUPS IN 1951 NORTHERN AND SOUTHERN IOWA SAMPLES

Input item	Northern Iowa crop-share	Northern Iowa owners	Northern Iowa all farms	Southern Iowa owners	Southern Iowa all farms
	Mean resource inputs				
Labor (mo.)	8.9	9.9	9.5	9.0	8.7
Land (acres)	179	152	167	112	115
Capital ($)	1,891	2,532	2,168	1,562	1,420
	Value of t for regression coefficients				
Labor	1.98‡	2.20†	1.96‡	1.79‡	3.20*
Land	7.44*	8.78*	7.30*	2.08†	5.92*
Capital	2.15†	3.06*	5.24*	1.47§	2.89*

*$p<0.01$
†$0.05>p>0.01$
‡$0.10>p>0.05$
§$0.10>p>0.20$

Northern Iowa, owner-operator (75 farms):

$$Y = 13.00X_1^{0.085} \quad X_2^{0.967} \quad X_3^{0.153}$$

Northern Iowa, all farms (142 farms):

$$Y = 18.75X_1^{0.076} \quad X_2^{0.912} \quad X_3^{0.165}$$

Southern Iowa, owner-operator (83 farms):

$$Y = 6.97X_1^{0.089} \quad X_2^{0.824} \quad X_3^{0.342}$$

Southern Iowa, all farms (143 farms):

$$Y = 5.22X_1^{0.088} \quad X_2^{0.795} \quad X_3^{0.393}$$

MARGINAL PRODUCTIVITIES

Marginal productivities are provided in table 3 for the resource categories and samples mentioned earlier.[10] All marginal product figures are given in value terms. They are dollars return per $1 of capital, per acre of land and per month of labor. The term "marginal productivity" refers to the amount added to total value of product by "adding one more unit of the particular resource." The "one unit addition" in this case refers to addition beyond the mean quantity of resources given in previous tables.[11] A marginal return figure does not have the same meaning as an average return figure. "Average return" refers to the return, as a mean, for all units of resources used. "Marginal return" refers to the return of only the added unit. Average return is always greater than marginal return when marginal returns are diminishing as is the case of all the individual figures presented. Also, the marginal return of all previous units of resources is higher than the one shown under this diminishing-returns situation (i.e., the marginal return is higher for each resource unit less than the mean than it is for the mean productivities shown in table 3).

The differences in the marginal productivity figures are in the direction expected, given certain known imperfections in lease forms and the resource ratios found on the farms. Comparing crop-share and cash leases from the 1950 Tama-Muscatine sample, the former has higher marginal products for labor and

[10] The standard errors of the regression coefficients in both samples are those listed below:

Sample	Standard error		
	Labor	Land	Capital
1950 Tama-Muscatine samples			
Share lease	0.0540	0.0891	0.1502
Cash lease	0.0503	0.0911	0.1412
1951 Northern Iowa samples			
Share lease	0.0490	0.0981	0.0939
Owners	0.0386	0.1101	0.0500
All farms	0.0388	0.1250	0.0313
1951 Southern Iowa samples			
Owners	0.0501	0.3956	0.2303
All farms	0.0269	0.1343	0.1360

[11] The marginal products dY/dX have been computed as follows, where $\bar{X}_1$, $\bar{X}_2$, and $\bar{X}_3$ refer to the geometric mean input of labor, land and capital; k refers to the constant of the equation; and b_1, b_2 and b_3 refer to the elasticity coefficients associated with the three resource categories:

$$\frac{dY}{dX_1} = b_1 \, k \, \bar{X}_1^{b_1-1} \quad \bar{X}_2^{b_2} \quad \bar{X}_3^{b_3}.$$

TABLE 3. MEAN RESOURCE PRODUCTIVITIES AND MEAN VALUE OF CROP PRODUCT FOR 1950 AND 1951 SAMPLES.

Sample	Labor $/mo.	Land $/acre	Capital $/$	Crop product $
1950 Tama-Muscatine sample:				
Crop share	93.96	28.17	1.18	7,106
Cash	71.27	35.89	1.09	7,053
1951 northern Iowa sample:				
Crop share	92.98	34.68	0.91	8,493
Owners	68.60	50.82	0.48	7,909
All farms	68.04	46.83	0.65	8,551
1951 southern Iowa sample:				
Owners	54.80	40.82	1.22	5,550
All farms	48.05	33.08	1.32	4,771

capital but a lower figure for land. To the extent that costs and production are not shared in the same proportions, less labor and capital are applied on each acre of land.[12] The lower the labor/land or capital/land ratios, the larger are the marginal product figures for labor and capital. Similarly, the marginal productivity of land will be low if the labor/land and capital/land ratios are small and diminishing returns hold true. (Diminishing returns are denoted by elasticities or exponents which are less than 1 in the equations shown previously.)

It has been shown in a previous study that these labor/land and capital/land ratios are smaller for crop-share than for cash leases.[13] However, the application of less capital and labor per acre may not result alone from share arrangements. It also may result from a greater number of persons who are related in the cash leasing sample. A lease between two related persons often results in more certainty for a longer planning period and, hence, in the investment of more capital. The higher labor/land and capital/land ratios under the cash lease may also result from a more favorable capital position of cash tenants. The more favorable capital position may result from the relatively low cash rental rates in the period prior to the study. Cash rates which were much lower than share rates for 10 to 15 years would allow cash tenants to accumulate capital more easily than share tenants.

Comparison of the crop-share and owner sample from the 1951 northern Iowa samples shows exactly the same pattern of marginal productivities. In table 3, the figures for labor and capital are higher and the figure for land is lower on the share-rented farms than on the owner-operated farms. Again, these differences are expected to the extent that imperfections in share leases cause the tenant to use lower labor/land and capital/land ratios than the owner.

As the figures in table 2 show, the labor/land ratio is 8.9/179, or 0.05 on share-rented farms and 9.9/152, or 0.07 on owner farms. The capital/labor ratio is 1,891/179, or 10.56 on share-rented farms and 2,532/152, or 16.65 on owner farms. The marginal product figures are in line with these ratios. However, the marginal product for labor is higher on share-rented farms in the 1951 northern Iowa sample than on the owner farms in the 1951 southern Iowa sample. Similarly, capital productivity in the former area is lower than in the latter area.[14]

SIGNIFICANCE TESTS BETWEEN RENTAL METHODS

As mentioned previously, the productivity differentials pointed out above form a pattern which is expected when certain conditions of share-lease forms are considered. The differentials are highly uniform —in the sense that they give higher or lower marginal coefficients where they are expected between share-rented and cash-rented or owner-operated farms. However, it is important to consider sampling variance and to test the significance of these differences. The t values for these tests are given in table 4.[15]

[12] Heady, Earl O. and Kehrberg, Earl W. Relationship of crop-share and cash leasing systems to farming efficiency. Iowa Agr. Exp. Sta. Res. Bul. 386.

[13] *Ibid.*

[14] This same finding is expressed in another study where it is explained in some detail. One reason, evidently, why crop capital productivity is so low in northern Iowa is the very large investment in machinery—one component of the capital services on crops. On many farms in this area—one about as highly mechanized as is found in Corn Belt agriculture—machinery has been added to a point where marginal returns are very low as a convenience to lessen drudgery and increase pleasure of farm work as well as for profits. (See Heady, Earl O. and Shaw, Russell. Resource returns and productivity coefficients in selected farming areas of Iowa, Montana and Alabama. Iowa Agr. Exp. Sta. Res. Bul. 425.)

[15] The t's have been computed as follows, where we wish to compare the elasticity for one resource (X) of one sample, denoted by the subscript a, with that of another sample, denoted by the subscript b. In this equation, b refers to the elasticity coefficient, s refers to the standard error, $\overline{Y}$ refers to the mean product, and $\overline{X}$ refers to the mean input, both considered as constants.

$$t = \frac{b_a - b_b \dfrac{\overline{Y}_b}{\overline{Y}_a}\dfrac{\overline{X}_a}{\overline{X}_b}}{\sqrt{s_a^2 + \left(\dfrac{\overline{Y}_b}{\overline{Y}_a}\dfrac{\overline{X}_a}{\overline{X}_b}\right)^2 \left(s_b^2\right)}}$$

The term

$$\frac{\overline{Y}_b}{\overline{Y}_a}\frac{\overline{X}_a}{\overline{X}_b}$$

is used since it is necessary to compute the value of b'_a, the regression coefficient which would have given a marginal product in sample a equal to that of sample b (M_b) when the product and input is of the magnitude in sample a. In other words, we wish to determine b'_a to equal

$$M_b = b'_a \frac{\overline{Y}_a}{\overline{X}_a} = \text{marginal product } (M_b) \text{ in sample } b.$$

(*continued next page*)

TABLE 4. VALUES OF t FOR TESTING DIFFERENCES IN MARGINAL PRODUCTIVITIES OF RESOURCES IN DIFFERENT TENURE GROUPS.

Sample and item tested		Value of t
1950 Tama-Muscatine crop function		
Marginal product of labor:	share lease vs. cash lease	0.42‡
Marginal product of land:	share lease vs. cash lease	1.88†
Marginal product of capital:	share lease vs. cash lease	0.13‡
1951 Northern Iowa crop function		
Marginal product of labor:	share lease vs. owner	0.32‡
Marginal product of land:	share lease vs. owner	2.25*
Marginal product of capital:	share lease vs. owner	0.98‡

*$0.05>p>0.01$
†$0.10>p>0.05$
‡$p>0.30$

Only the t values for land are significant at a probability level ordinarily acceptable for data of this nature. The standard errors are large with respect to the relatively small differences in the mean marginal products. However, significant differences can exist for marginal products computed for other resource quantities. Since the different tenure groups use different mean quantities of resources (tables 1, 2 and 3), it is likely that significant differences would exist for marginal products computed for equal resource quantities.[16] The differences between the marginal products for land are significant, considering sampling variance: Cash-leased farms on Tama-Muscatine soils had a significantly higher marginal product, at the mean of the land input, than share-leased farms. Owner farms in northern Iowa also had significantly higher returns to land than share-leased farms.

In evaluating the differences between crop-share and cash leases and their respective tests, the following point should be kept in mind: Each lease has characteristics which are different but which encourage or discourage use of resources along the lines of the production economics principles outlined earlier. Hence, the fact that a resource productivity may prove, in a probability sense, to be somewhat similar under both does not mean that a particular aspect of production is efficient or inefficient under each. A share lease, for example, may encourage a more efficient use in one department of the farm business and a less efficient use in another department. These two facets of resource use may "cancel each other" in comparisons between two lease types. The classification of resources in this study is too broad to allow examination of these details of resource use.

[15] (*cont'd*)

Since $M_b = b_b \dfrac{\overline{Y}_b}{\overline{X}_b}$

then we have the equality $b'_a \dfrac{\overline{Y}_a}{\overline{X}_a} = b_b \dfrac{\overline{Y}_b}{\overline{X}_b}$.

Therefore $b'_a = b_b \dfrac{\overline{Y}_b}{\overline{Y}_a} \dfrac{\overline{X}_a}{\overline{X}_b}$.

[16] For example, the mean marginal products can be computed for owner-operators in the 1951 northern Iowa sample, supposing them to use the same quantity of resources for crops as the share tenants. The mean input of share tenants in table 2 is 179 acres of land, 8.9 months of labor and $1,891 for capital. The marginal product of capital on owner farms for the quantities of resources is 0.60. If, using an overly simplified test, we compare this marginal product against that of share-leased farms with the same resources, the "computed" b' is 0.0013, when the *actual* product and inputs are those of the share-rented farms (see footnote 15). With the square root of the sums of the standard errors, we have a t value of

$$\frac{0.202 - 0.0013}{\sqrt{(0.049)^2 + (0.039)^2}} = \frac{0.2007}{0.0623} = 3.22,$$

a quantity significant at the 1-percent level.

COMPARISON OF RENTAL RATES WITH MARGINAL RESOURCE PRODUCTIVITIES

The amount of rent paid under a lease represents the market price of the resource services furnished by the lessor. Hence, it is of interest to compare the market price or rental rate of these resources with their computed marginal products.

In a competitive industry such as agriculture, the price (i.e., the rental rate in this case) of a resource, in the long run, tends to approach the marginal productivity of the resource. As is pointed out later, some differential is expected because of risk and uncertainty, and the time aspects of production and rental contracts. The comparison can be made best for land. The landlord does not furnish labor or capital under a cash lease and furnishes only a small amount of capital expense under a share lease.

The data of table 5 show that the several rental rates listed differ significantly from the marginal

TABLE 5. RENTAL RATES, MARGINAL PRODUCTIVITIES FOR LAND, AND t VALUES FOR COMPARISON OF RENTAL RATES AND MARGINAL PRODUCTIVITIES OF LAND.

Item	Value
1950 Sample: Tama-Muscatine crop functions	
Average rental per acre for share-rented farms	$18.90
Average rental per acre for cash-rented farms	10.29
Marginal product for land per acre on share-rented farms	28.17
Marginal product for land per acre on cash-rented farms	35.89
Value of t for average share rent compared to marginal product of land on share-rented farms†	7.68*
Value of t for cash rental rate compared to marginal product of land for cash-rented farms†	12.81*
1951 Sample: Northern Iowa crop functions	
Average rental per acre for share-rented farms	20.21
Average rental per acre for cash-rented farms	13.67
Marginal product for land per acre on share-rented farms	34.68
Value of t for average share rent compared to marginal product of land on share-rented farms†	3.13*
Value of t for average cash rent compared to marginal product of land on share-rented farms†	4.53*

*$p<0.01$
†These value have been computed as

$$t = \frac{b - p\left(\dfrac{\overline{X}}{\overline{Y}}\right)}{s}$$

where b is the elasticity of the land input, p is the rental price, $\overline{X}$ is the mean land input, $\overline{Y}$ is the mean product and s is the standard error for b.

product figure for land with which they are compared.[17] One criterion of an efficient leasing system in a static economy is that rental returns should approach the marginal product of the resource. However, there are reasons why differences should and do exist.

One is the fact that rental contracts are made in advance of the year's production. Income from resources cannot be predicted with accuracy, particularly where there are large variations in prices and yield. Rental rates and marginal products might be expected to approach each other only over a period of years. Data for 1 or 2 years are not sufficient for measuring the tendency.

A second reason why these two quantities might differ is uncertainty. It is generally known that product and resource prices are discounted when uncertainty exists in planning future production. This discount is, in the case of a tenant manager, a "reward" for the risks which he takes in committing resources and expenses with imperfect knowledge of future prices and yields and, hence, of income.

Finally, the rental often includes a return for management or capital services furnished by the landlord. However, addition of a return for these services is not great enough to lower the t values in table 5 to a non-significant level.

Finally, it should be remembered that the time for which the basic data were obtained was one in which farmers and other persons were expecting a decline in farm prices. Rental rates, particularly cash rates, may have been at a level to represent not the price level realized at the end of the 1949 and 1950 production years but the anticipation of the levels in a period as early as 1947 or 1948. When expectations and uncertainty are considered, deviations between market rental rates and marginal resource product perhaps should not be taken to denote economic disequilibrium.

Further investigation of this phenomenon is needed and should include samples in a time when the economy is fairly stable or when expectations are in this direction. Additional periods also should be included which represent large changes or large expected changes. The present study provides one benchmark for comparison of productivity coefficients which might be derived from other samples in time.

PROPORTION OF INCOME TO LANDLORD AND TENANT COMPARED TO AVERAGE VALUE OF RESOURCE SERVICES

This section of the study compares the share of farm income to the landlord and tenant with (1) the relative contribution of resource services which each furnishes to the total farm business and (2) the relative marginal productivities of the same resource services. It is an exploratory analysis of how farm rental resources are priced in comparison to their average and marginal returns.

COMPARISON OF ALTERNATING PRINCIPLES IN IMPUTING SHARES

The theory of competitive and static economy assumes that the prices of resources (i.e., the rental shares to tenant and landlord) should equal or approach their marginal products. In other words, the total return to landlord and tenant should be the sum of the marginal products of the individual resources furnished by each. This condition provides a basis for allocating resources for production in a manner consistent with the greatest long-run return to the farm and the desires of consumers. (It is not a condition stating how income should be distributed to tenant and landlord if consumer welfare for their two households is to be maximized.)

If total income of the farm were allocated to landlord and tenant on the basis of marginal resource productivity, the share of each would be determined as follows: multiply the number of units of each resource by the marginal productivity of the respective resource. Farm operators and owners do not have detailed information on marginal coefficients; they can only estimate productivities in a rough way.

The productivity figure used ordinarly is an average product rather than a marginal product. The average product of all resources aggregated into a simple input category is used by landlords and tenants when they compute the value of the resource services contributed by each and divide the year's production on the basis of the ratio X_t/X_l where X_t refers to the value of resource services contributed by the tenant and X_l is the value of resource services contributed by the landlord. The average product is used since the total product is, in effect, divided by the total input of services. The return to tenant and landlord, respectively, then is the average return for each $1 of resource services furnished by each whether these resources are labor, capital or land.

The "average method" of sharing production in proportion to the value of resource services gives the same result as the marginal method only under two conditions:

(1) The resources furnished by tenant and landlord must be either technical complements or substitute for each other at a constant rate. Unless one or the other of these two conditions holds true, not all units of labor, capital and land make the same contribution to production. If the two resources are technical complements, they must be combined in fixed and inflexible quantities, as 2 atoms of hydrogen and 1 atom of oxygen in a molecule of water. In this case there is no reason for considering them apart; they should be aggregated into a single category and "be considered as one."

If they substitute at constant rates, one can replace the other, but the contribution of each to production is always the same—regardless of the proportions in which they are combined. If they substitute at diminishing rates, however, the proportion in which they are combined makes a great difference in their contribution to production. One amount of labor

[17] The t value used here is a test between the elasticity or regression coefficient derived in the sample and the elasticity value which would have been necessary to give a marginal product equal to the particular rental rate, with the mean resource quantity used on the farms.

combined with $10,000 does not have the same productivity, with output constant at some specified level, as another amount of labor combined with $3,000. Hence, it should not be valued similarly when computing "relative contributions." The first month of labor used to replace capital may replace $2,000; the second month may replace only $1,200; and the third month only $500. Obviously this method cannot be applied, under diminishing substitution rates, in the same manner to farms which have different ratios of resources.

(2) Constant returns to scale must hold true. Under constant returns to scale, the productivity of every unit of a resource is the same as for any other unit. The marginal product is then the same as the average product. This fact can be illustrated by the two simple equalities below. The average product (A) per unit of resource is the total product (P) divided by the total units of resources (X) as in (1) below:

$$A = \frac{P}{X} \tag{1}$$

The marginal product (M) is the elasticity of production (e) multiplied by the ratio P/X as in (2) below:

$$M = e\,\frac{P}{X} \tag{2}$$

Constant returns to scale hold true only when the elasticity figure (e) is equal to 1. Hence, under constant returns to scale ($e=1$), the righthand side of equation (2) becomes 1 P/X, or simply P/X. M is then equal to A and the two methods of allocating shares to landlord and tenant will give the same results. Also, the sum of the shares to each will then equal the total farm product.

However, in case e is not equal to 1 (each exponent on the X's in the production function equations of previous pages is an e), the "average method" will not give the same result as the "marginal method." Also, the total farm product will not be equalled by the sum of the landlord and tenants "computed shares." The elasticities (the exponents) may be less than 1 for the individual resources furnished by landlord or tenant. Imputing a share to each equal to the quantity of the resource by the marginal product of the resource, then, will have this effect: The total farm product will not be exhausted by the sum of the shares to the landlord and tenant.

This last principle can be illustrated by the simple equations below. In (3) we define a situation in which the elasticity (e) of production is less ($<$) than 1. The elasticity of production (the e or exponent on the X's in previous equations) is equal to the percentage change in resources used. Hence, when ΔP means "change in total farm production," P means total farm production, ΔX means change in quantity of resources used and X means total quantity of resources used. Then $\Delta P/P$ is the percentage change in production and $\Delta X/X$ is the percentage change in resources. Thus the elasticity coefficient can be

$$e < 1 \tag{3}$$

$$e = \frac{\Delta P}{P} \Big/ \frac{\Delta X}{X} \tag{4}$$

$$\therefore \frac{\Delta P}{P} \Big/ \frac{\Delta X}{X} < 1 \tag{5}$$

defined as in (3), and equation (3) is the equivalent of equation (5). From (5) we are able to derive (6) and (7). Equation (7) indicates that if we multiply

$$\frac{X}{P}\,\frac{\Delta P}{\Delta X} < 1 \tag{6}$$

$$\therefore X\,\frac{\Delta P}{\Delta X} < P \tag{7}$$

the quantity of the resource (X) by its marginal product ($\Delta P/\Delta X$), the resulting quantity or product will be less than ($<$) the total product (P) because the elasticity (5) is less than 1.

If the elasticity figure had been greater than ($>$) 1, the sum of the shares of the product computed by the "marginal product" method would exceed P, the total product with an elasticity equal to 1, the shares computed by the "marginal product" method will just equal the total product; the "marginal product" method also will give the same results as the "average product" method.

The elasticities (or e values) derived in the samples all differ from 1, as indicated by the exponents on the X's of the previous production function equations. Hence, it is known that the two methods of imputing shares will not give the same result. It is also known that the total product will not be exhausted if tenant and landlord shares are computed on the basis of the "marginal product" method. Accordingly, the following procedures are used in the empirical analysis which follows:

First, the dollar value of all inputs or resource services furnished by landlord and tenant has been computed. These values have been added and the two ratios X_t/S_a and L_l/S_a have been computed, where S_a is the sum of the dollar value of all resource services for the total farm, X_t is the value of resource services furnished by the tenant and X_l is the value of resource services furnished by the landlord. The total product, in dollar quantities, of the farm (P) has then been broken down into the two ratios above.[18] The resulting absolute shares are then compared with the income which landlord and tenant actually received under share and cash leasing arrangements. This step is an analysis of the outcome under the "average method" of imputing shares.

Second, the quantities of the resource services, furnished separately by tenant and landlord, have been multiplied by their mean marginal products. The sum of the quantities are then determined for the farm as a whole and denoted as S_m. The "computed share" of P for the tenant then is

$$\frac{(\Delta P/\Delta X_t)\,(X_t)}{S_m},$$

[18] The tenant's "computed share" of P is thus $(P)\ (X_t/S_a)$. The "computed share" of the landlord is $(P)\ (X_l/S_a)$ for this "average product" method.

while the computed share to the landlord is

$$\frac{(\Delta P/\Delta X_l)\,(X_l)}{S_m}\ .$$

This method is used later as a "modified marginal product" method of imputing shares to landlord and tenant.[19]

DATA USED

The data used in the analysis which follows are for all farms in the 1951 northern and southern Iowa samples. While not all of the farms included in these samples are rented, the objective of this section is to test imputed shares for alternative leasing arrangements. These arrangements can be tested against the product of any farm which might be rented under alternative leases. Hence, the procedure is to take all farms in the sample and compute the share which would go to the leasing parties if the farm were rented under one of the standard leasing arrangements.

The procedure used in testing shares on all sample farms, whether owned or rented, gives results which are almost identical for share-rented farms in northern Iowa. (The analysis was not made for southern Iowa since the standard errors for the elasticity coefficients were relatively great, and several of the regressions were not significant at the 30-percent level of probability.) Hence, only the analysis for all sample farms is used (a) to avoid presentation of two sets of results which are almost identical and (b) because the elasticity coefficients are significant at low probability levels. The leasing arrangements used in the following analysis are those found to exist in samples of rented farms.

A second reason why all farms are used is that the static economic tenet stating that shares should equal the marginal product of resources refers to the marginal productivity of resources for all farms—not just to rented farms. In other words, the marginal return of a particular resource may be high or low on one rented farm; yet it may be the marginal productivity coefficient on farms far removed from the particular farm which has the "final effect in determining shares which are related to marginal products." For this reason, comparison of marginal productivities on "all farms" with rental shares is more meaningful than comparison of only marginal products for rented farms. Even then the "universe examined" may be too restricted to illustrate properly any "central tendencies."

PROPORTIONS IN WHICH PRODUCTION AND RESOURCE SERVICES ARE SHARED ON CROPS

Table 6 shows, for the 1951 samples in northern and southern Iowa, the proportions by which crop-share tenants and landlords shared production and values of resource inputs on crops. Expenses have been computed by adding (1) the actual cash expenses, including depreciation, plus (2) the market value of the services furnished by each party. The value of labor was computed by multiplying the months of labor used on crops by the monthly wage rate without board. The value of land and buildings was computed by multiplying the capital value of these two classes of assets by the long-term interest rate.[20] The figures on expenses or values of resource services thus represent the annual inputs or contributions to farm production. The figures are based on a sample of 60 farms in northern Iowa and 54 farms in southern Iowa.

The modal shares of crops paid as rent to landlords are identical in the two samples; mean shares are similar. The shares of the annual inputs or expense of resources are also highly similar. The only difference between the two areas is the proportion of cash inputs (X_3 in the equations on previous pages) on crops. This difference results mainly because less fertilizer is used on the southern Iowa farms. The proportion of all expenses paid by the landlord is changed accordingly, since fertilizer is a fairly large expense shared by the landlord in northern Iowa.

ABSOLUTE VALUE OF RESOURCE SERVICES AND INCOME FOR TENANT AND LANDLORD ON CROPS

Table 7 has been computed for all farms in the 1951 sample, regardless of whether they were owned or rented. The figures in this table have been computed by multiplying the mean shares for share-rented farms (table 6) by the production and expenses (values of resource services) of all farms in the samples. The results indicate the proportions of inputs and outputs which would be represented by tenant and landlord if all farms in the sample were

[19] The total product, P, is divided into these two proportions, in a manner similar to that outlined for the "average product" method in footnote 18.

[20] The monthly wage rate, computed as a mean for the year, was $191.10. The interest rate used was 5 percent.

TABLE 6. MEAN AND MODAL SHARES OF PRODUCT AND EXPENSES RECEIVED OR PAID BY THE LANDLORD, 1951 NORTHERN, SOUTHERN IOWA SAMPLES FOR CROP-SHARE LEASES.

Item shared	Northern Iowa		Southern Iowa	
	Mean per-cent	Mode per-cent	Mean per-cent	Mode per-cent
Products:				
Corn	50	50	50	50
Oats	43	40	44	40
Soybeans	45	50	47	50
Flax	41	40	0	0
Hay	($6.10)	0	($4.91)	0
Expenses or values of resource services:				
Machinery expenses*	2	0	2	0
All other cash inputs on crops	44	xx	37	xx
Land	100	100	100	100
Labor	†	0	†	0
Buildings	100‡	100	100‡	100

*Includes custom hire of machinery. This is the main machine item shared by the landlord.
†Less than 1 percent.
‡A few tenants paid some building repairs, but the total for the rented sample was less than 1 percent.

TABLE 7. MEAN VALUE OF RESOURCE SERVICES AND MEAN VALUE OF CROP PRODUCTION FOR LANDLORD AND TENANT PER FARM, 1951 NORTHERN AND SOUTHERN IOWA SAMPLES.*

Item	Total dollar value for: Tenant	Landlord	Farm total
Northern Iowa			
Machine expenses ($)	1,573	25	1,598
All other crop capital expenses ($)	570	253	823††
Crop, land and buildings ($)	†	3,054	3,054
Labor ($)	1,815	‡	1,815
Total value per farm ($)	3,958	3,332	7,290
Percent of total (%)	54.3	45.7	100
Southern Iowa			
Machine expenses ($)	1,044	26	1,070
All other crop capital expenses ($)	238	139	377††
Crop, land and buildings ($)	†	1,240	1,240
Labor ($)	1,662	‡	1,662
Total value per farm ($)	2,944	1,405	4,349
Percent of total (%)	67.7	32.3	100
Value of crop production			
Northern Iowa			
Value of crop production ($)	4,535§	4,016**	8,551
Percent of total (%)	53.0	47.0	100
Southern Iowa			
Value of crop production ($)	2,438§	2,339**	4,777
Percent of total (%)	51.0	49.0	100

*These farm totals and shares for landlord and tenant are based on all farms in the 1951 northern and southern Iowa samples. In other words, the quantities representing means for the farms, with regard to tenure, have been broken down into the mean proportions of costs and production found on share-rented farms in the two areas. The 60 share-rented farms in northern Iowa and 44 share-rented farms in southern Iowa provide the mean shares by which production and inputs for all farms are shared. The figures in the table show the contributions which would be made by, and the return which would be received if, all farms were rented under the typical crop-share lease.

†Figure not shown because building expense is only infrequently paid by tenant.

‡Figure not shown because labor expense is only infrequently paid by landlord.

§Includes value of hay, less cash rent paid to landlord for these items.

**Includes only cash rent paid by tenants for hay and not value of hay produced.

††Taxes are not included since the resources upon which they are levied, rather than the tax, represent the service going into the physical production process.

to adopt the typical share lease of the areas. As mentioned previously, these figures have been computed on the basis of all farms in the sample so that the "average product" method of imputing incomes might be compared with the "marginal product" method. It is the comparison of sharing methods, applied to actual farm situations, which is important, rather than a comparison between tenure groups.[21]

The tenant's share of the expenses or resource services is 54.3 percent of the total annual input for northern Iowa. It is 67.7 percent for southern Iowa.[22] This difference arises mainly because the contribution of the land input is relatively smaller in southern than in northern Iowa. The landlord not only furnishes fewer acres per farm for crop production, but each acre also has a lower physical productivity and makes a smaller value contribution to total farm production. Even if the value contribution of crop and pasture land is totaled for southern Iowa, the sum is less than the value contribution of cropland alone in northern Iowa.

In view of these differences, it appears doubtful if sharing arrangements should be as similar for the two areas as is shown in table 6. Or, if similar arrangements are to be used for inputs or expenses, it perhaps is economically unrealistic that the shares of crops should be as homogeneous as shown in table 6.

"AVERAGE PRODUCT" METHOD OF IMPUTING SHARES

Table 7 shows that the share of crop income going to tenant and landlord is quite similar to the share of resource services provided by each. The tenant receives 53 percent of the crop income and furnishes 54.3 percent of the crop expenses. However, the two shares are considerably different in southern Iowa. The tenant receives 53 percent of crop income but furnishes 67.7 percent of crop services.

The data in table 7 provide the basis for allocating shares to landlord and tenant on the "average product" basis. If the "average product" method of imputing income is considered, the rental share in northern Iowa is "in line," considering the variance of the data, with the value of resource services furnished by each party. This is not true for southern Iowa. Some adjustment in shares of product or expense would need to be made if the "average product" method of sharing were the actual goal. However, there are reasons why shares and products need not correspond in a particular area.

The proportions of resources furnished and the shares of products received by tenants and landlords would need to be equal only if the "average product" method of allocating shares were the single force entering into rental prices. However, the "average product" method is mainly an empirical device whereby tenant and landlord might obtain an overall picture of their business structure and sharing arrangements.

Other economic forces of the market also effect rental rates or prices. One of these forces is the supply of labor relative to the demand for it. It is known that the size of the farm population and the working force relative to the cropland area in southern Iowa are greater than for northern Iowa. This relatively greater supply of the labor resource acts to bid up the rental share or prices. Higher rental rates, which leave a smaller residual for labor return, may cause some of the surplus of labor to move into nonfarm industries where its productivity is greater than in farming. To the extent that this facet of economic organization is expressed in the higher shares of product relative to inputs in southern Iowa, the differentials between southern and northern Iowa need not have negative connotations. Differentials in rental and expense ratios simply act to bring the supply of

[21] This procedure was followed since significant elasticity coefficients were not obtained for the sample of share-rented farms in southern Iowa and because economic equilibrium causing market prices of resources and marginal value product of resources to approach each other relates to all farms, rather than rented farms alone.

[22] With slight exceptions due to "weighting of input items," these proportions are nearly identical with those derived for the samples of share-rented farms in the two areas. This is an obvious fact since the shares of product and expenses on the share-rented farms were used in computing those for "all farm samples."

TABLE 8. RESOURCE SHARES AND PROPORTIONS OF PRODUCTIVITY VALUES REPRESENTED BY TENANT AND LANDLORD RESOURCES WHEN SHARES IMPUTED TO RESOURCES ARE BASED ON MEAN MARGINAL PRODUCTS.

Resource	Tenant			Landlord			Total farm
	Units	Marginal product ($)	Units × marginal product ($)*	Units	Marginal product ($)	Units × marginal product ($)†	Units × marginal product ($)
			Northern Iowa (1951 sample)				
Cropland	xx	xx	xx	167	46.83	7,820.61	7,820.61
Labor	9.5	68.04	651.78	xx	xx	xx	651.78
Capital	2,168	0.65	1,409.20	278	0.65	180.70	1,589.90
Total	xx	xx	2,060.98	xx	xx	8,001.31	10,062.29
Percent of farm total	xx	xx	24.6	xx	xx	75.4	100
			Southern Iowa (1951 sample)				
Cropland	xx	xx	xx	115	33.08	3,804.20	3,804.20
Labor	8.7	48.05	418.03	xx	xx	xx	418.03
Capital	1,421	1.32	1,875.72	164	1.32	216.48	2,092.20
Total	xx	xx	2,293.75	xx	xx	3,020.68	6,314.43
Percent of farm total	xx	xx	36.3	xx	xx	63.7	100

*Column 1 multiplied by column 2.
†Column 4 multiplied by column 5.

labor, capital and land resources into line with each other and to cause them to be used for the products which consumers desire.

If the higher rental shares in southern Iowa result because of the relative surplus of labor, higher rental rates which cause more of this labor to move to other localities or to other industries are consistent with the best use of resources.

SHARES OF CROPS IN PROPORTION TO MARGINAL PRODUCTS

The "modified marginal products" method is used in table 8 as a basis for calculating shares of income. If crop production were to be shared in proportion to the marginal products of landlord and tenant resources, the share would be 75.4 percent to the landlord in northern Iowa and 63.7 percent in southern Iowa. These proportions result if the marginal productivity of each resource (at its mean) is multiplied by the mean quantity of the resource and the sums are calculated in the manner outlined earlier.

The "sum of the productivities" is $10,006 in northern Iowa (table 8), while the actual value of crop production is only $8,551 (table 7). The respective figures are $6,314 and $4,777 in southern Iowa. The "sum of productivities" exceeds the actual product because the total elasticity is greater than 1 for the production function equation of both areas. (The sum of the elasticities or exponents for crop production in northern Iowa is $0.076 + 0.912 + 0.165 = 1.153$. The sum is $0.088 + 0.795 + 0.393 = 1.176$ for southern Iowa.) Hence, an inequality of the nature outlined at the beginning of this section exists.

The largest proportion of income is imputed (under the "modified marginal product method") to the landlord's resource because the elasticity coefficient of land is so high. That is, the marginal productivity of land does not decline by relatively large amounts up to the mean.[23] In contrast, the marginal productivity for labor declines rapidly because the elasticity coefficient is only 0.076 for northern Iowa and 0.088 for southern Iowa. Elasticity coefficients are much lower for capital services than for land in both areas.[24]

The imputational shares computed under the "modified marginal product" method are vastly different from shares established under existing leasing customs. Therefore, it is doubtful that the method: (1) can be applied effectively, (2) would be acceptable as a basis for allocating the total farm product or (3) has close relationship to the relative market demand for various resources. However, while it does not appear to be a useful or feasible method of allocating shares to tenant and landlord, the "marginal product" method has one thing in common with the "average product" method. Both methods indicate a greater share of the total farm product for the tenant in southern Iowa than in northern Iowa. Under existing arrangements, the actual share to the tenant is lower in southern than in northern Iowa. If the "average product" method were used, the southern Iowa tenant would get 67.7 percent of the crop income, and the northern Iowa tenant would get 54.3 percent. If the "modified marginal product" method were used, the shares to the tenant would be 36.3 percent in southern and 24.6 in northern Iowa.

LIMITATION OF MARGINAL PRODUCTIVITY ANALYSIS IN IMPUTING SHARES

The marginal productivity analysis applied in this study has limitations mainly of three kinds. One kind

[23] All marginal productivities in this study are calculated at the mean input of resources (see footnote 15).

[24] If each unit of resource were allocated its own marginal product (rather than the marginal product of the mean resource unit), the proportion of the "sum of productivities" going to tenant resources would be greater. This is true because the "first" units of tenant resources (i.e., labor and the largest part of the capital) have a much higher productivity than the "mean" unit. Land does not have a similarly high marginal product for the "first" units as compared to the "mean" units. However, computation of all of the quantities would require an enormous quantity of time and resources. The magnitude of the marginal product of one unit of one resource will differ depending on all other possible quantities of the remaining resources.

of limitation deals with problems in estimation of coefficients and need not be explained here.[25]

The second limitation deals with the use of marginal productivity coefficients in imputing shares of total farm production to tenant and landlord. Few production function estimates are likely to give production elasticities which total exactly 1. Thus, the "marginal product" method will always give absolute shares for tenant and landlord which total more than the actual product. There is no basis for specifying that this "surplus" or "deficit" should fall to the tenant alone, the landlord alone or that it should be shared in any particular way. However, landlords and tenants can and should use marginal approximations in their budgeting and planning. These marginal quantities can be estimated simply as expected additions to returns from additions to inputs or costs supplied by both parties. Considering additional returns and costs, marginal shares can be calculated to show whether a new practice or resource input is profitable to both parties. The calculations also can be used for changing shares to make new practices or inputs profitable.

A final limitation of the study deals with aggregation of inputs and stratification of samples. This study has been in terms of a single, broad category of capital services. For detailed analysis which may show how the productivity of particular forms of capital resources (i.e., fertilizer, machinery, conservation materials, etc.) are affected by various leasing arrangements, samples are needed which allow much more detail in stratification. The over-all sample needs to be broken into strata such as: (a) farms which do and those which do not share resource contributions in the same proportion as production; (b) farms which do and those which do not use the same shares for different crops; (c) farms which do and those which do not have leases for various periods of time or which contain different provisions for compensation; and (d) tenants who have similar amounts of capital or who are or are not related to the landlord. By stratifying farms on the basis of criteria such as these, greater differentials in productivity may be uncovered than in this study where farms operated under leases were simply grouped into broad strata by lease types.

[25] For details of these limitations in estimation, see: Heady, Earl O. Productivity and income of labor and capital on Marshall silt loam farms in relation to conservation farming. Iowa Agr. Exp. Sta. Res. Bul. 401.