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A projection of an efficient farm industry in southern Iowa 1959, 1980

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A PROJECTION OF AN EFFICIENT FARM INDUSTRY IN SOUTHERN IOWA 1959, 1980

by

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I. INTRODUCTION

A dynamic agricultural industry has brought many benefits and problems to the United States during the last thirty years. This period of rapidly changing technological and price conditions has induced serious disequilibrium in the use of farm resources (12, 29, 30). The farm industry has been adjusting rapidly (17, 31). The adjustments in resource allocation and farm organization, however, have not been fast enough or gone far enough to maintain a well balanced farm industry. Evidence suggests that the resource cost of producing current farm output is greater than necessary and that the industry is producing too much output relative to existing demand (14).

It does not seem unreasonable to assume that by 1980 the American people would like a farm industry that is reasonably well-adjusted to technological, market demand, and factor price conditions; an industry in which the earnings of labor and capital in farming are at parity with those of comparable resources in non-farm alternatives. What would be the characteristics of such a farm industry? This study was an attempt to identify and project the structural characteristics of an efficient farm sector in Southern Iowa consistent with long-run market equilibrium in 1980.

Economic efficiency is only one goal of farm policy and it is recognized that this goal may be in conflict with other goals of policy. But once an efficient farm sector is characterized, goals that may be competitive with economic efficiency can then be appraised more accurately in terms of the aggregate income sacrifice they entail.

The estimation of an efficient farm industry should perhaps have two sub-procedures. The first is organization under the assumption that maximum income will maximize welfare, i.e., all farmers are income maximizing. This is the assumption followed in this paper. The second phase would be a relaxation of the assumption of income maximization to conform with, or attempt a closer approximation of, the reality that farmers maximize utility by sacrificing some income for non-income goals.

Such an estimation of an efficient structure of agriculture in 1980 has implications much broader than the results of this study. It has implications regarding all institutional structures which are created as part of public and private agricultural policies which in turn are affected by the sociological and political setting of the country. If the goal of future agriculture efficiency is given high priority, and if a reasonable estimate can be made of the structure of an efficient agriculture, agricultural institutions could be shaped to ease the transition from the present situation to the desired future structure.

The area under consideration consisted of nineteen contiguous counties in the south-central part of Iowa designated as an economic subregion in the 1959 Census of Agriculture. This area was chosen because it is the low income area of Iowa and past studies have shown it to be the area of Iowa most in need of agricultural adjustment. It was also reasoned that if this analysis were to be extended, it would be safer to use methods and procedures developed on an area needing a large degree of adjustment than to use methods developed in a relatively well adjusted area.

Southern Iowa comprises only a small portion of the total resource commitments to, and output of, agriculture (36). However, the direction of needed adjustments in this area is probably similar to most agricultural areas of the country.

This study assumes that the technical and economic efficiency of agriculture is to be maximized subject to no noneconomic restrictions. It attempts to estimate the characteristics of the firm and the industry in southern Iowa in 1980 that fulfill these conditions. Implications of the results will be discussed briefly in the summary.

II. CHARACTERISTICS OF AN EFFICIENT FARM INDUSTRY

The overriding assumption throughout this study is that the efficiency of agricultural production should be maximized. The thesis problem is the identifications of the Southern Iowa farm industry's characteristics if the conditions of production and distribution efficiency are met. Maximum efficiency of production is desirable for if an increase in efficiency could be achieved, one of the following results would occur. More output will result from the same input, or the same output is possible from fewer resource inputs. Increased efficiency may also occur by adjusting the product mix within agriculture and between agriculture and other industries. If an adjustment of this nature is desired by the society, the value of the output will be increased. Any of these results imply the possibility of a change beneficial to the society.

There are three characteristics that form the broad criteria for economic efficiency in farm industry. These are: (1) total output produced at minimum factor cost, (2) output composition geared to relative product demand, and (3) optimum industry size insuring that the opportunity costs of all factors are covered (14). The specific conditions for maximum efficiency may be specified independently of the pricing system and are outlined in the following sections.

A. Conditions for Efficiency

1. Factor substitution

The marginal rate of substitution between inputs must be equal for all firms producing products with these inputs. Consider two farms producing corn. On farm A the marginal physical productivity of a unit of labor is 20 bushels of corn and the marginal physical productivity of a unit of capital is 10 bushels. On farm B the marginal physical productivity of both labor and ~~corn~~ capital is 10 bushels. The marginal rate of substitution between inputs is equal to the ratio of their marginal physical products. In this example the marginal rate of substitution of labor for capital on farm is two and on farm B it is one.

$$MRS^{A}_{LC} = \frac{MPP^{A}_{L}}{MPP^{A}_{C}} = \frac{20}{10} = 2 \qquad MRS^{B}_{LC} = \frac{MPP^{B}_{L}}{MPP^{B}_{C}} = \frac{10}{10} = 1$$

If a unit of labor is reallocated from farm B to farm A, corn yield on farm B is reduced by 10 bushels and the yield for farm A is increased by 20 bushels. This increases the industry's total yield by 10 bushels without additional units of input. Resources should be allocated to the firms where the marginal physical productivity (for producing a certain product) is the highest. Additional transfer of units of labor from farm B to A should continue until the marginal rates of substitution were equal for both farms. This procedure can be explained geometrically with the aid of the following diagrams.

Figures 1a and 1b show the marginal rates of substitution of labor for capital on farms A and B in the production of y bushels of corn. The slope of the isoquant y at any point is equal to the marginal rate of substitution of inputs at that point in the production of a given amount of product. In Figure 2, Figure 1b has been turned over 180

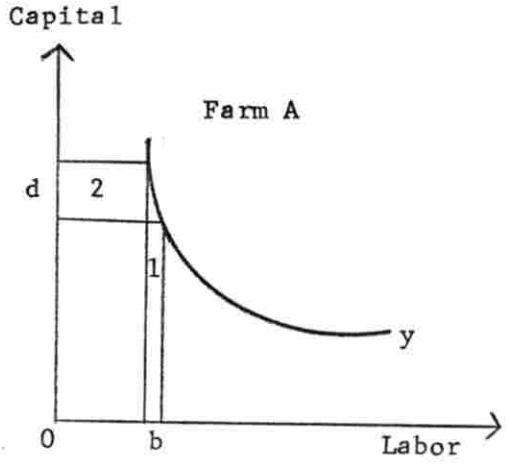

Figure 1a. Marginal rate of substitution, Farm A

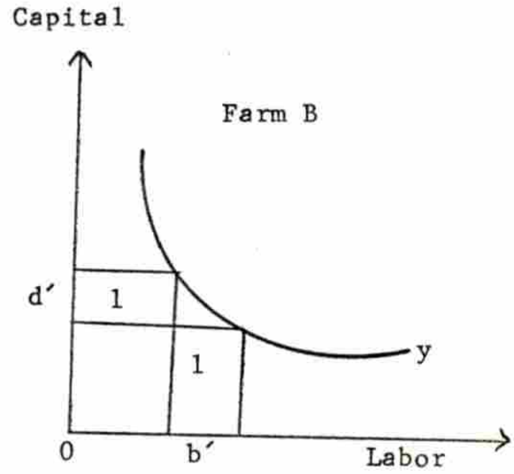

Figure 1b. Marginal rate of substitution, Farm B

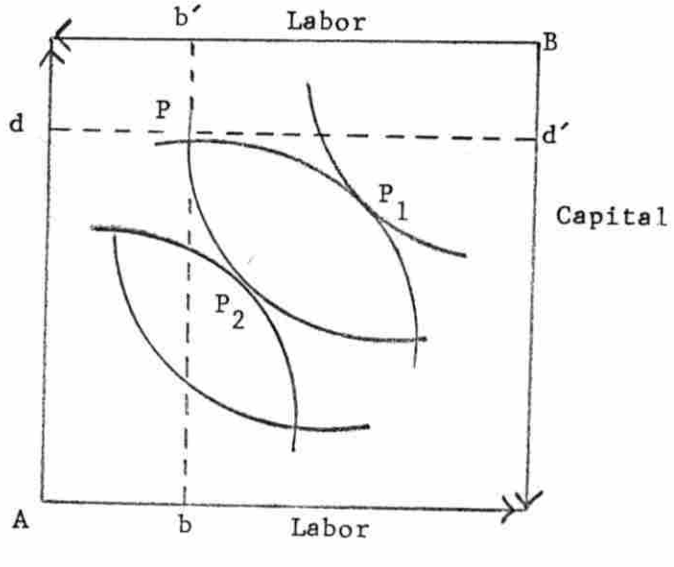

Figure 2. Inter-firm equality of marginal rates of substitution

degrees and superimposed on Figure 1a. It can now be seen that given the total combined resources of labor and capital on the two farms, total production can be increased by a reallocation of inputs between firms until the marginal rates of substitution between inputs is equal. The marginal rates of substitution are equal at points of tangency of the isoquants. A transfer of resources between the two farms could let them move from point P to P_1 or P_2 where an increase in total output is possible.

2. Factor-product transformation

A second condition requires the between firm equalization of marginal rates of transformation of factors into products. This means the marginal physical product of all inputs must be equal for all firms using the same inputs and producing the same product. In our previous example, the marginal physical productivity of labor was greater on farm A than on farm B. An increase of total production would result by allocating resources to firms where the marginal physical products were greatest. If the marginal productivities are unequal, factors can be transferred between firms and produce more of the product without the addition of inputs.

3. Product transformation in production

A similar condition must hold regarding the marginal rates of substitution between products on different farms. Each farm is faced by a production possibility curve the slope which depicts the marginal rate of substitution of one product for the other, given technology and resource assets. If one farm is more efficient in corn production than in raising hogs, and another farm is relatively more efficient in pork production, resource reallocation should take place to encourage specialization to the point where the marginal rates of substitution between corn and hog production are equal on both farms. Any other solution will result in less output from the same input of industry resources.

The achievement of inter-firm marginal equality in the factor-factor, factor-product, and product-product areas would insure the production of maximum output with given inputs or the production of a given output with a minimum input requirement. If these three conditions are satisfied, it is impossible to increase the output of one product without decreasing the output of another product or adding to the input of resources.

4. Output mix

From societies' view, the industry should produce the output that is wanted by the consumer sector. If efficiency is to be maximized, the least-cost output should also be the mix of products preferred by consumers. The equality of marginal rates of substitution between consumers of products produced is needed to accomplish this. If equality does not exist one consumer can be made better off without lowering the utility of another consumer by product transfer. To achieve these results the marginal rate of substitution between farm products in consumption must equal the marginal rate of substitution between farm products in production.

5. Industry size

The fifth condition to be met is that of establishing product-

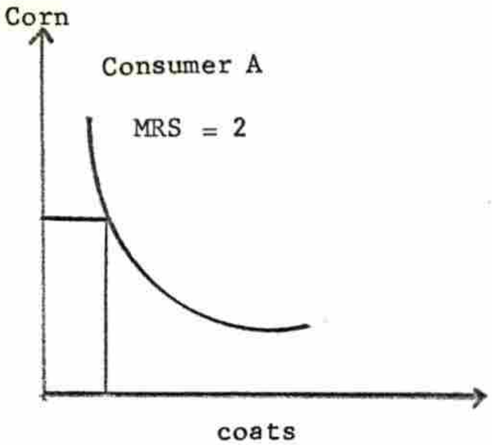

Figure 3a. Product substitution for consumer A

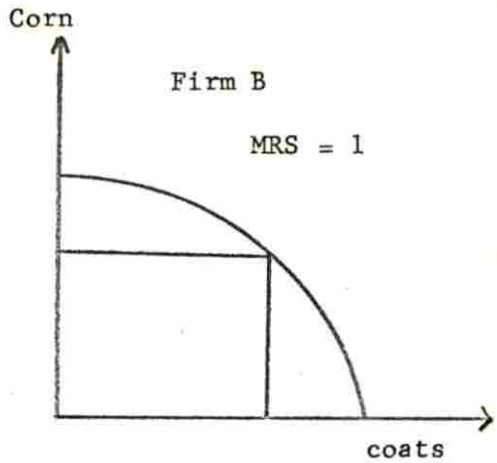

Figure 3b. Product transformation for firm B

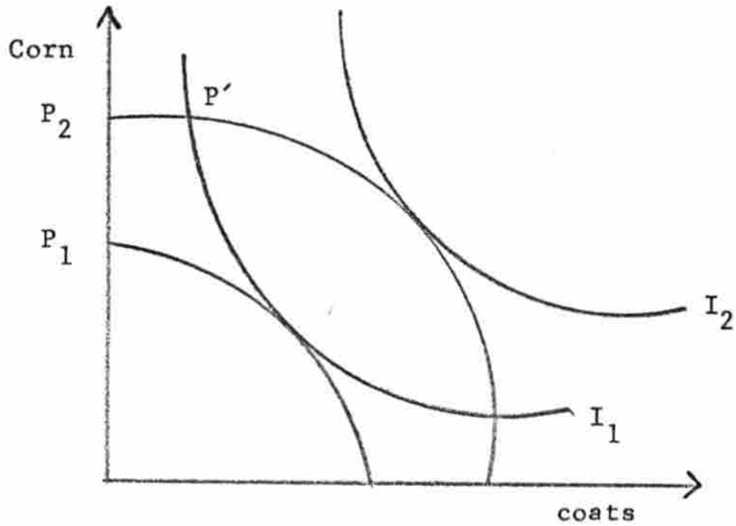

Figure 4. Consumer-firm equilibrium

product relationships between farm and non-farm products in production equal to the marginal rates of substitution of the farm and non-farm products in consumption.

Figure 3a is an indifference map of consumers and Figure 3b is the production possibility curve of producers. By superimposing Figure 3b on with Figure 3a in Figure 4 it can be seen that if the rates are not equal the possibility exists of raising the consumer to a higher utility level on a new indifference curve given existing production possibilities or the same level of utility can be generated by a lower input level. In either situation the possibility exists of attaining greater welfare levels. In reality no firm may produce both goods but substitutability of products exists by transfer of resources committed to production. This last condition would bring about optimal size of the industry.

6. Second order and total conditions

The simultaneous satisfaction of all of preceding marginal conditions is needed for allocative efficiency. At the same time it must be found that the marginal conditions of substitution between income and leisure are met and that inter-temporal equalization of marginal rates of substitution between resource control at different moments of time is satisfied. Together these constitute the set of necessary conditions for economic efficiency. But they are not in themselves, sufficient conditions. It is also required that all indifference curves in the equilibrium vicinity are convex to the origin and all transformation curves are convex to the origin. Without these second order conditions the necessary conditions might specify a minimum.

These maximum conditions could be stated in terms of the total conditions as follows: if efficiency is to be a maximum, it must be impossible to increase it by varying the output of any firm; by varying the amount of any product consumed by any consumer; or by varying the amount of any factor unit used to yield direct service to any individual (20).

B. Conditions Preventing Efficiency

Under a perfectly competitive system, the price and market systems would achieve the previously mentioned marginal conditions and the resultant static equilibrium consistent with the existing distribution of resources. In the first example, given perfect competition, the individual farm firm would maximize its profits by making the marginal rate of substitution between any pair of factors equal to the ratio of the factor prices. Because the prices of factors would be identical to all firms, the marginal rate of substitution between any pair of factors would be equal for any farm using both factors. In a basically similar manner, a perfectly competitive system would insure the satisfaction of all the marginal conditions. However, the impossibility of attaining perfect competition must be realized. Obstacles are present in the form of varying degrees of monopoly powers in firms buying from and selling to farmers although controversy exists concerning the effect of these monopolies. State and federal regulations may also indirectly prevent full competition from existing. External effects of production may cause a divergence in real costs from the costs effected by the competitive pricing system and because of this prevent the attainment of the competitive model.

The practical application of the preceding theoretical analysis in research is difficult to employ. The achievement of economic efficiency implies knowledge of marginal rates in both production and consumption areas. More important, the conditions have been presented as static equilibrium conditions and consideration of dynamic factors should produce caution in using these criteria in a dynamic world. Uncertainty also creates difficulty. Nonetheless, there appear to be no satisfactory alternatives to acceptance of the preceding marginal conditions of efficiency criteria.

That economic inefficiency exists in agriculture can be demonstrated by comparing the existing situation in agriculture with the conditions established as criteria of efficiency. The efficiency criteria have shown that if comparable resources are used in farm production, the return in these resources should be equal in all uses. This is not the case (7, 30). Similarly, the returns to comparable factors in farm and non-farm production should be equal. This condition is also not being met (2, 16).

It is emphasized that the problem of this study is not the attainment of perfect competition for the efficiency criteria may be attained under alternative methods of organizing economic activity. The question is to determine if efficiency exists in southern Iowa farms and if it does not exist what are the structural characteristics of the farm industry that will reasonably approximate the goal of economic efficiency. Alternatively, the problem could be expressed as measuring the costs involved if the farm industry is uneconomically organized.

III. PROJECTION PROBLEM

A. Ideal Projection Model

A projection, such as this study was concerned in making, is not a forecast of the situation that will exist sometime in the future. A projection is in essence a simulation; it may or may not be reasonable with the real world conditions. It is a procedure stating specific assumptions of the situation, particularly goals, and certain restrictions on the accomplishment of the goals. In short, a projection is an estimation of a future situation given certain exogenous data whereas a forecast would be an estimation of a future situation with the exogenous data evaluated at most likely values. The exogenous data of a projection need not be the most likely situation, but may be any situation desired by the projector as the environment of his analysis.

This distinction is very important in observing the results of this study. The reader must be aware of the assumptions and specific conditions upon which this projection is based. Adjustments of these stated conditions would alter the final results considerably.

This projection is built on the following assumption. Farm efficiency will be maximized. Agriculture is a small portion of the American economy and will continue to become an even smaller portion relative to the non-agricultural sector. Consequently, the long-run price to labor and capital (since these are mobile resources) to the agricultural industry will be determined outside of the farm industry. In other words the farm industry will have no price effect on the cost of these inputs. The price of land is considered to be generated within the agricultural sector. Since the demand of the non-agricultural sector for land is a relatively small component of total demand for land and tends to be very inelastic, the quantity of land available for agriculture can be assumed to be given. The opportunity cost of this land to the industry is essentially zero.

If, for the year 1980, it is possible to employ exogenous estimates of these costs of labor and capital to the agricultural industry, the amount of land available to the industry, the effect of advancing technology upon the total productivity of agriculture and upon the relative productivities of different inputs (this would mean knowing the production function), and the demand for agricultural products, an ideal projection model would yield determinate values for:

(V1) the level of farm product prices

(V2) the price of land to the firm

(V3) the amount of land input used by the farm

(V4) the amount of capital input used by the farm

(V5) the amount of labor input used by the farm

(V6) the number of farms

(V7) the level of farm product output.

Such a model could appear in equation form as follows:

(1) Demand for farm products = industry supply of farm products

(2) Industry utilization of land = K (firm demand for land)

(3) Industry demand for capital = K (firm demand for capital)

(4) Industry demand for labor = K (firm demand for labor)

(5) Industry demand for managers = K (firm demand for management) where K is the number of firms in the industry.

These five equations can be solved simultaneously, yielding a unique solution to the five unknowns. The assumptions necessary are those of a perfectly elastic supply of labor, management, and capital to the industry, and a perfectly inelastic supply of land which must be utilized. It is also assumed that each firm will employ only one unit of managerial input (or call it a different quality of labor). This assumption means that the number of managers will equal the number of farms and thus the industry demand for managers (Equation 5) will be equal to K.

The firms' demands for the different inputs and the firms' supply curves may be derived from the production function of the firm and are functions of the product price and the price of inputs. The five unknowns in the system of equations are:

(U1) the price of the output

(U2) the price of land

(U3) the amount of capital

(U4) the amount of labor

(U5) the amount of management units which is identical with the number of farms.

Once these values are known, the level of farm output may be obtained from the firms' production function. This model would identify an efficiently organized industry meeting the conditions specified in Section II. The reason the conditions would be met is that the firm demand curves for inputs (assuming income maximization) reflect the fulfillment of the marginal conditions for minimum cost of production. The simultaneous solution with supply and demand equalization insures the condition of correct industry size. For a realistic solution to the immediate problem of Southern Iowa, it would be assumed that the farm industry of the entire country was also being organized in the most efficient manner.

In solving our problem of simultaneous economic equilibrium of the firm and industry, the use of linear programing was considered. Discussion with staff of the Iowa State University Department of Economics led to the conclusion that this method, if possible, would require a prohibitive amount of time and resources. Consequently, the following procedure was developed which considered the problems of minimum cost of production and equilibrium output determination.

B. Actual Model

In order to simplify the problem, farm output was treated as a single product. In other words, the product mix problem was by aggregation assumed away, leaving the problems of determining the optimum level of output and the allocation of productive factors that would produce this output at minimum cost. The attempt is made to find the organization that will simultaneously provide for equilibrium of the farm and the industry. The specific goals are these: the determination of the total output necessary from the Southern Iowa area; the inputs of land, labor, and capital necessary to produce this output; the number of firms in the area; and subsequently the measurement of output and inputs per farm.

The model used had essentially six basic steps. The first was the identification of the characteristics of "well organized" farms under 1959 price, cost, and technological conditions. In other words, what were the committed resources, input combinations, and output levels on farms that were covering opportunity cost in 1959, or, as the data revealed, were coming closest to covering opportunity costs in 1959. It was assumed that if some farms were able to cover opportunity costs they were satisfying the marginal conditions expressed in the preceding section and consequently producing output at a minimum cost. The second step was the reorganization of the subregion's farming resources into these well-organized farms to approximate the minimum cost requirement in 1959. The third step was another reorganization to approximate the output level that would clear markets under the 1959 product demand conditions and also allow factor payments commensurate with their opportunity costs. At this point the results yielded an estimate of efficient agricultural organization in the region for 1959.

The fourth and fifth steps were trend projections of the 1980 farm product demand and farm resource productivity. The sixth and final step was a projection of the efficiently organized 1959 industry to 1980 with a third reorganization to approximate minimum cost and market-clearing requirements for 1980. Although the last step yielded determinate values for the desired answers, it was accomplished under the restriction that a certain amount of capital and labor would be used on each farm. This restriction appears to be reasonable when the process of farm disappearance is observed. As a farm is sold and the land area divided among neighboring farms, the labor and operating capital use on the disappearing farm are removed from agriculture and the remaining farmers used their original labor and capital inputs combined with the additional land input.

C. Limitations of the Model

There are several limitations to this model. The possibilities of errors are many and are found at all stages of the procedure. They start with a doubt of the reliability of data used and the question of estimating economic relationships such as fulfillment of marginal equalities within agriculture. There is also the problem of projecting the values of exogenous variables (labor and capital prices, total demand) from the non-agricultural sector. At many stages judgments had to be inserted, either by choice of restrictive assumptions or by choice of the values of exogenous variables. All steps of the procedure were subject to such errors. All errors will not accumulate, but uncertainty exists as to the direction the sum of them will take.

One possible alternative would be to make projections under different assumptions. This was done at some points, but it was preferred to take the most reasonable alternative in most cases. In cases where judgments were made, these are clearly stated and the reader can explore the alternatives if interested.

The greatest limitation to this model is its limited ability to achieve internal consistency among endogenous variables. The methodology does not permit the simultaneous estimation of all the endogenous variables. In this model the price of land is determined by using the residual as an estimate of the marginal value of the land input. This residual is determined by assuming an equilibrium price level for farm products. Clearly no consistent simultaneous solutions can be determined if the price of land is a function only of an arbitrary level of output prices. This problem is eased in the 1980 case where a strict assumption on the effects of technology is made concerning the marginal physical product of land.

Consequently, the point estimates generated by this projection are subject to many errors. However, the major interest should be not in the specific estimates themselves but in the general picture formed by these estimates. Certainly, policy makers should be concerned with the general trends. This discussion has warned against relying completely upon these results. It must also be mentioned that the results utilize existing information and to varying degrees of imperfection display the direction and magnitude of adjustments in the farming industry in Southern Iowa from 1959 to 1980 that are needed to satisfy the efficiency conditions.

IV. THE STUDY AREA

The nineteen counties (Figure 5) forming the study area for this thesis are generally considered to be the area of Iowa most in need of agricultural adjustment. As seen in the second section, the basic test of efficiency would be the determination of marginal equalities of inputs in all uses in the area and with alternative uses in other areas. However, in this section comparisons of "adjustment degree" is done in rougher terms of comparitive total resources and total resource returns. Trends present in Southern Iowa agriculture during the last ten years will be presented later in this section.

Inputs on Southern Iowa farms are considerably less than inputs on farms in other sections of Iowa. See Tables 1 and 2.

Table 1. Land use and value of land and buildings per commercial farm, by areas, 1959

	Value of land and buildings per farm[a]	Land use per farm[a]		
		Total land acres	Cropland harvested	Corn acres
Southern Iowa	35,085	243	121	53
North Central Iowa	71,163	215	176	97
State	50,372	194	131	71

[a]Source (35).

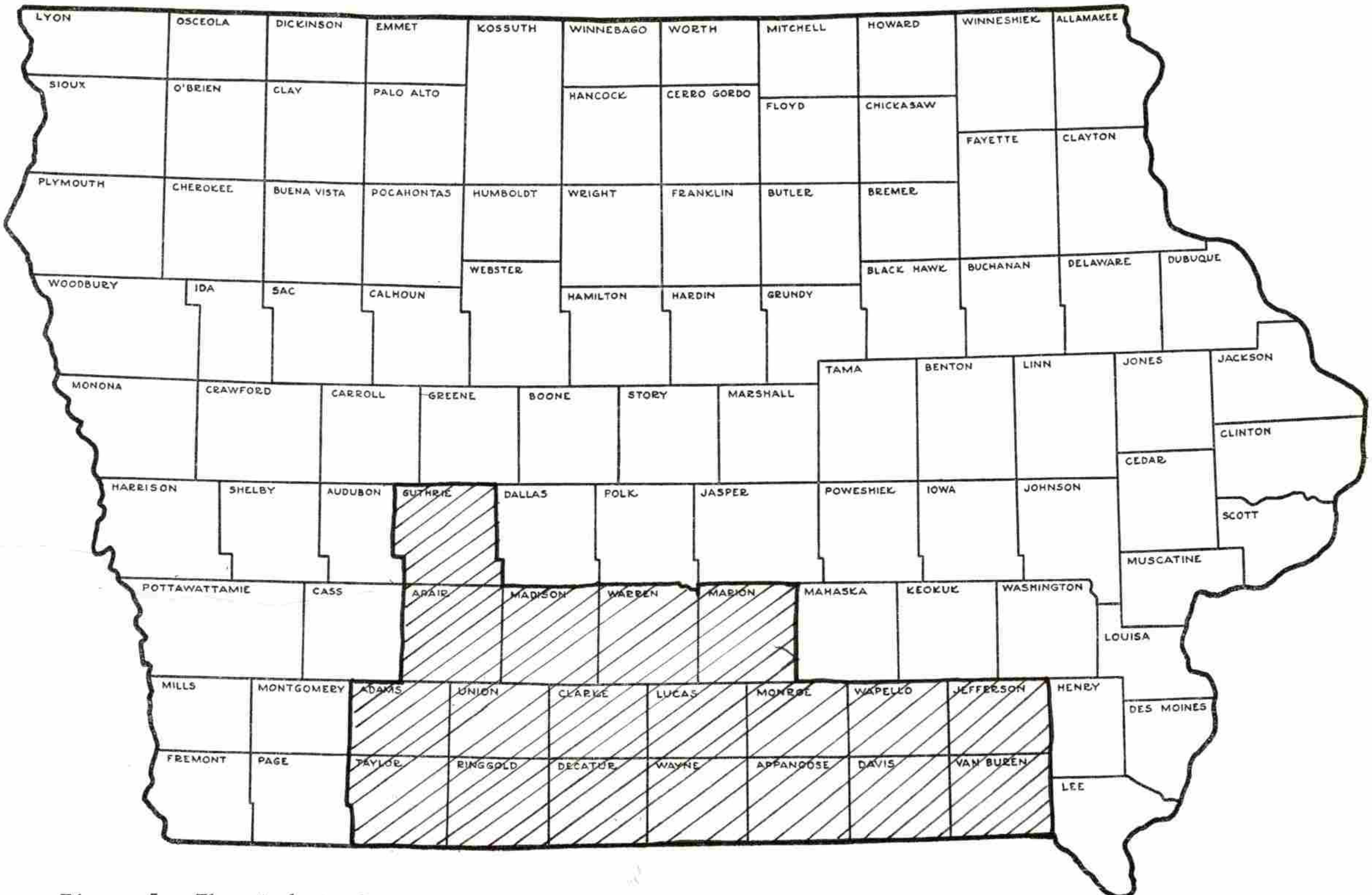

Figure 5. The study area

Table 2. Investment per farm in machinery and breeding stock, 1954[a]

	Value of implements and machinery	Value of breeding stock
Southern Iowa	3,327	2,496
Northwest Iowa	5,681	2,166
Non-southern Iowa	5,034	2,393
State	4,862	2,403

[a]Source (15).

Fertilizer is also used less extensively in Southern Iowa. In 1959 the study area used 1.8 tons of fertilizer per farm whereas North-central Iowa used 5.8 tons per farm and the state average was 3.8 tons per farm (35).

The fewer resources inputs used per farm resulted in the situation portrayed by Table 3. The gross value of farm products sold per farm in Southern Iowa was far below the gross value of sales in other areas. Net income per farm was also lower in this region.

Table 3. Gross value of products and net farm income, per farm, by areas, 1954[a]

	Gross value of farm products sold per farm	Net income per farm
Southern Iowa	4,610	1,774
Northwest Iowa	12,892	5,556
Non-southern Iowa	9,942	4,333
State	9,536	4,085

[a]Source (15).

These figures are not to imply that no adjustments have been taking place in Southern Iowa. From 1950 to 1959 the number of commercial farms in the area declined from 29,602 to 21,799 causing average farm size to increase from 188 to 243. This decrease in farm numbers was about twice as fast as the average rate for the state (15). Prospects for even more rapid change are evident from the increase in average age of farm operators from 47.5 years to 50.3 years. During this same period expenditure for hired labor decreased from $6,076,227 to $5,377,750 despite increased wage levels. Also evidence of an increasing reaction to modern commercialization was found by comparing changes in fertilizer use, feed purchases, livestock purchases, and the level of gross value of sales. These changes are enumerated in Table 4.

It is seen that although serious problems are evident in Southern Iowa agriculture, adjustment has taken place. This study proposes to examine the need for further changes commensurate with the efficiency criteria and to estimate the possible magnitude of these changes.

Table 4. Changes on commercial farms in Southern Iowa 1950-1959[a]

	1950	1959	% Change
Number of farms	29,602	21,799	-26
Avg. farm size	188	243	+29
Avg. age of farm operators	47.5	50.3	+5.9
Expenditure for hired labor	6,076,227	5,377,750	-11.5
Tons fertilizer per farm	.92[b]	1.81	+97
Feed purchases per farm	774	1,422	+84
Livestock purchases per farm	800	1,346	+68
Gross value of sales per farm	5,586	9,116	+63

[a]Source (33, 34).

[b]1954, all farms.

V. ESTIMATION PROCEDURE AND RESULTS

A. First Reorganization to Approximate the Minimum Cost Conditions in 1959

An important sub-procedure of establishing the minimum cost condition for agricultural output in 1959 was the identification of the characteristics of well organized farms under 1959 price, cost, and technological conditions. The procedure for this identification was basically one of finding farms presently organized in a manner enabling the desired minimum cost conditions of production.

A well organized farm was defined as a farm for which the excess of factor income over factor opportunity cost was maximized, or for which the excess of factor opportunity cost over factor income was minimized depending on the price conditions present in the industry. Factor income was defined as the total return to land, labor, and capital used in the farm firm. Factor opportunity cost was defined as the expected earnings of inputs if these input factors were used in non-farm production.

The 1959 census classification of commercial farms by economic classes I through VI was the starting point in the identification of the well organized farms. Iowa Farm Business Association records were sorted by gross value of sales into the census classes. If the business association farms were organized similar to the census farms, extensive use could reasonably be made of the census data. Also, rather than using data only from a few farms, the mean characteristics of the class of census farms that appeared to be the best organized would be used as the example of a well organized farm. Although this method may have limited the theoretical efficiency of the "optimal" farm, it gave a well organized farm that was definitely attainable by a large number of managers and also gave data from the entire population of such farms. Another advantage of establishing a relationship between farm business association farms and the census was that since census data is available for all areas of the country, an extension of this study to a larger geographic area would be feasible without developing new methods of data estimation.

The farm business association farms were sorted and found to possess characteristics similar to the census farms, see Table 5. The exception was class I where only one business association farm was available. There was then a basis for identifying the class of well organized census farms from the characteristics of the class of best-organized business association farms.

Estimates of the factor incomes and factor opportunity costs were prepared for each of the census classes of farms from farm business association farms of the comparable class. Incomes on the farms were observed in order to remove income derived from inputs not committed to the farm business. Adjustments were also made in factor incomes to account for abnormal prices of any major commodities. Because both cattle and hog prices display cyclical fluctuations, cattle and hog prices were adjusted in an attempt to reduce the effect that price fluctuations would have on factor income. The hog cycle that includes the year 1959 had a low point in hog numbers in 1957 and another low point in 1961. Consequently, the five year period 1957-1961 was used to determine average or

Table 5. Comparisons of mean values of selected characteristics of Farm Business Association Farms and values from census by economic class of farm for Southern Iowa

	Number of farms	Total acres	Crop acres	Value land and buildings	Inventories livestock[a]	Machinery value[b]	Total capital	G.V.S.
FBI	1	240.0	130.0	39,600	25,229	1,694	66,523	70,780
Census I	299	560.5	379.0	90,707	27,112	10,436	128,255	60,550
FB II	15	348.0	254.0	72,008	20,920	8,118	101,046	26,971
Census II	1,340	446.2	290.9	75,328	16,465	8,643	100,436	26,082
FB III	41	305.0	193.0	42,594	14,150	5,304	62,048	14,366
Census III	4,606	324.3	217.5	49,481	10,848	7,150	67,479	13,662
FB IV	15	204.9	117.5	23,364	7,834	2,911	34,109	7,774
Census IV	7,902	232.3	148.2	32,010	7,371	5,239	45,120	7,218
FB V	2	171.0	131.0	13,100	4,601	5,870	23,571	4,746
Census V	5,729	169.1	95.2	20,771	4,996	4,611	30,378	3,796
FB VI	2	120.0	69.0	8,400	2,598	1,500	12,498	2,149
Census VI	1,806	108.2	55.2	12,739	2,628	3,847	19,214	1,537

[a] Census livestock inventories computed as described in Appendix A.

[b] Census machinery value determined by procedure explained in Appendix B.

"normal" hog prices. The cattle cycle was more difficult to define since from a low point in 1958 inventories have been constantly increasing. For the study the corrected price of cattle was also assumed to be the average price of the five year period 1957-1961. Adjustments in prices were made by multiplying the 1959 income of these two products by a ratio formulated by dividing the five-year average price by the 1959 average price. For hogs this ratio was 16.52/13.80 or 1.197 and for cattle 22.80/24.70 or .923. The prices used were average prices received by farmers in Iowa (9).

The costs used in estimation of factor opportunity costs were as follows. The land cost was estimated at 4.5 percent of the 1959 value of land and buildings. The capital cost of operating capital was estimated at 6 percent of the capital invested in machinery, livestock, and necessary money needed to provide cash outlay for production expenses. The capital charge was adjusted for the length of time the money was tied up in the farm business. For example, the capital invested in a dairy cow is used the entire year, but the money invested in a fattening hog is returned after a few months. The firm was charged only for the length of time the capital was used. The length of time the investment was considered to be tied up is included in Appendix A. Hired labor was charged at the going wage taken from the census for monthly labor plus $40 a month to cover perquisites (35). The operator labor-management input was estimated from a regression equation developed in an earlier study comparing returns to labor-management in farming and in selected alternative occupations (16). From several alternatives presented in

Table 6. Factor costs, factor incomes, and adjustments on Farm Business Association farms in Iowa by Census classes, 1959

Class of farm	I[a]	II	III	IV	V	VI
Factor income[b]	12,108	7,696	5,244	3,906	3,467	1,388
Adjusted factor income[c]	7,539	9,661	6,373	4,416	3,467	1,369
Total factor cost	9,276	10,136	8,064	6,454	6,151	5,247
Factor income minus factor costs	-1,737	-475	-1,691	-2,038	-2,684	-3,878
Capital costs[d]	1,615	1,307	875	484	628	246
Land costs[e]	1,584	2,880	1,704	935	524	336
Labor costs[f]	6,077	5,949	5,485	5,035	4,999	4,665

[a]Unreliable sample, only one farm.

[b]Income due to farm committed resources only.

[c]Income adjusted of cyclical cattle and hog prices.

[d]Six percent of total capital committed to farm business.

[e]Four and one-half percent of value of land committed to farm business.

[f]Total of hired, family, and operator labor.

this previous study, the regression relating managers of farm supply companies in 1955 was selected because of its greater statistical significance. Based upon the criterion that the best organized farms were farms showing the largest positive or smallest negative difference between factor income and factor costs the Class II farms were determined to be the most efficient (see Table 6). On this basis the mean characteristics of the Class II farms were selected to represent the characteristics of the "well-organized" unit for Iowa Subregion 59 under 1959 prices, costs, and technological conditions.

Unfortunately, an insignificant sample of farms was available in the Class I category. It was also observed that under 1959 cost and price conditions, even the well organized farms failed to cover opportunity costs of the resources employed.

Once the Class II farms had been selected as the well organized farms, it was necessary to reproduce the characteristics of these farms from census data supplemented with other information. The input of land was measured by the census value of land and buildings. Operating inputs were estimated by several methods. For livestock capital input, prices were assigned to each type of livestock; the numbers were reported in the census. A value was computed and this value was adjusted by a multiplier representing the average proportion of a year's time the capital was tied up in each particular type of livestock. The adjusted value then was charged at the rate of 6 percent. These livestock figures are found in Appendix A. The census enumerates most classes of livestock, however, for valuation purposes further disaggregation was desirable. For this reason the county assessors records for these counties were used to break down certain classes of livestock by age (13).

To evaluate power and machinery inputs it was necessary to again use the farm business association record data. A statistically significant regression was found between capital investment in machinery and equipment and crop acres for the farm business association farms. This regression and resulting estimates are shown in Appendix B. This regression yielded a coefficient of correlation of .50 and a t value of 4.961 which is significant at the 1 percent level. This was used in estimating the mean value of machinery and equipment input for each class of census farm. Other capital inputs, whose value was a small percentage of total value, were estimated less rigorously from farm business association data. Estimates of labor input were generated mainly from the census data except for unpaid family labor which was estimated from farm business record data. The estimation procedure for labor inputs is completely outlined in Appendix C. Estimates of these structural characteristics were prepared for all farms to establish the situation existing in the total farm industry of this area. The development of these estimates is explained in Appendix D.

The first reorganization was aimed at satisfying the condition that the total output produced in the subregion be produced at the lowest possible opportunity cost. On the assumption that the census economic Class II farms most closely approximated the criterion of well organized units, it followed that on these farms the level of output was being turned out at the closest approximation to minimum factor cost. Thus, if all farms in the subregion were organized in a similar manner, the output of the subregion would be produced at the closest approximation to the minimum total opportunity cost permitted by industry price, cost, and technological conditions. So the following question was posed: Given the level of land input (measured in value terms to recognize quality variation) in the subregion, what would be the number of farms and the mean characteristics of farms if all units were organized as efficiently as the most efficient class of farms?

This reorganization to approximate minimum cost requirements was accomplished by taking the land base (in value terms) available for commercial farms and dividing by the mean value of land input for the group of "well organized" farms. This gave the number of well organized units possible on the given land base in Southern Iowa. By multiplying the number of farms by the mean characteristics of these well organized farms, the industry totals were derived. The number and organization of non-commercial farms were assumed to be constant.

The computations for this reorganization, based on the estimated characteristics of each class of farm as developed and/or taken from the census data, gave the results indicated in Table 7. The number of commercial farms would decline by 53 percent. Total labor input would fall by 31 percent and total input of capital would drop by 10 percent. However, the total volume of farm output would increase by 20 percent. This apparent parodoxical situation of greater output from fewer inputs is a result of the greater average efficiency of the remaining resources due to their more optimum combination. Although there is less total capital, there is a greater amount of capital investment for each person employed.

Changes per farm would be as follows: output up 158 percent, input of land up 120 percent, capital investment per man up 30 percent, land investment per man up 47 percent, input of labor up 48 percent and net factor income up 331 percent. The excess of factor opportunity cost over

Table 7. Selected characteristics before and after first reorganization to approximate minimum cost conditions under 1959 prices, costs and technology, commercial farms, census area Iowa 59

Characteristic	Before first reorganization 1959 actual	After first reorganization	Percent change
Number of farms	21,799	10,153	-53
Area totals			
Volume of farm output (1959 prices) (Mil.$)	153.5	184.2	+20
Input of real estate (1959 prices) (Mil. $)	764.8	764.8	0
Input of labor (man-months) (thousands)	287.9	199.0	-31
Input of operating capital (1959 prices) (Mil. $)	328.3	296.0	-10
Land in farms (thousands of acres)	5,290	5,290	0
Per farm			
Volume of farm output (1959 prices)	7,043	18,147	+158
Land acreage (acres)	243	521	+114
Input of real estate (1959 prices)	34,085	75,328	+120
Input of labor (man-months)	13.2	19.6	+48
Input of operating capital ($)	15,060	29,157	+94
Net factor income ($)	2,578	11,106	+331
Opportunity cost of labor ($)	4,488	8,343	+86
Opportunity cost of operating capital ($)	904	1,749	+93
Total opportunity cost of inputs ($)	6,926	12,482[a]	+80
Excess of factor income over factor cost ($)	-4,348	-1,376	-2,972[b]
Price of land per acre ($)	144	43[c]	-70

[a]Includes land charge based on 1959 actual price and a 4 1/2 percent rate of capitalization.

[b]Absolute decline in excess of factor cost over factor income.

[c]Residual return to land per acre of $1.95 capitalized at 4 1/2 percent.

factor income would decline from about $4,350 per farm to about $1,375 per farm. Under 1959 price conditions, normalized for cyclical effects in hogs and cattle, factor incomes, even on the well organized farms, failed to cover the opportunity costs of the resources employed.

B. Second Reorganization to Approximate the Output Level Condition in 1959

The first reorganization reduced both the aggregate resource cost of producing the total output and the resource cost per unit of output. But it also increased the subregion's total output. Thus, if it had occurred under 1959 conditions, it would have increased the national excess supply of farm products at 1959 prices. This excess supply has been estimated at 8.4 percent (32). The volume of farm output removed from markets by CCC would have increased and/or farm product prices would have declined. The second reorganization was aimed at bringing the subregion's proportionate share of national output into balance with demand at an output price that enabled factor earnings to meet factor opportunity costs and still retain the minimum cost of production condition.

For this reorganization, it was assumed that the adjustment in output would come via a decline in the amount of labor and capital used per unit of land, i.e., by extensification. The rationale for this assumption rests upon a comparison of the opportunity costs of land, labor and capital with their respective returns in farming under conditions of an excess supply of products. While it is reasonable to assume that the prices of labor and capital inputs are largely determined outside the farm industry, the same assumption is not realistic for land. On the assumption that resource owners attempt to maximize income, the long run supply of labor and capital inputs to the farm industry would tend to be perfectly elastic at prices equal to those existing in the non-farm economy. However, the supply of land to the farm industry is not perfectly elastic; on the contrary it is almost perfectly inelastic. Consequently its price is largely demand determined. Most of this demand originates in the farm industry and is influenced by the prices of farm products and the physical productivity of the land input in farm production.

The efficiently organized farm represented by the farms existing after the first reorganization should have a resource mix reflecting existing technological conditions and relative factor prices. These efficiently organized farms were producing output at minimum cost under the input prices present in the industry in 1959. But the total output produced by these farms exceeded the area's proportional share of the quantity that would clear markets at 1959 product prices. If this output were placed on the market, product prices would fall, and consequently returns to all factor inputs would fall. If owners of these factors were to maximize factor income, factors that could be transferred (labor and capital) would be withdrawn from agriculture production and enter non-agricultural employment. As factor inputs were withdrawn, farm production would drop. When farm production was reduced enough, farm product price would start to rise again until the quantity of farm products supplied equalled the quantity demanded. Land could not be withdrawn from the farm sector and the new equilibrium would combine the original quantity of land with reduced amounts of labor and capital. The marginal product of the fixed resource, land, would be lower and consequently its prices, which would be the marginal value product, would be lower.

In 1959 farm prices averaged 80 percent of parity (36). It was observed that even the well organized farms had factor incomes that were less than factor costs in 1959 (see Table 6). It was estimated that an increase to 83 percent of parity prices would bring factor incomes and factor costs into equality on the Class II farms. This need for the 83 percent of parity prices had also been discovered in the study comparing returns to factors in farming with returns from these same factors in the non-farm sector (16). In other words, if the farm industry had been well adjusted to market demands, factor prices, and known technology, markets for farm products would have cleared at a level of prices 3.8 percent higher than the actual level of farm product prices in 1959.

It is on this assumption of 83 percent of parity prices that the model limitation discussed in Section III enters into the computations. In a competitive industry the price of a factor input such as land would be the marginal value product of the input. Consequently raising the product price level would increase the value of land. But the farm industry was not in an equilibrium situation in 1959 as shown by the results of the first reorganization, the inability of farms to cover factor costs, and the excess production generated by the farming sector.

Because of this situation the equilibrium price of land was estimated as the residual after subtracting labor and capital opportunity costs from factor income rather than using the marginal value product as the measure of land value. This is equivalent to stating that land price is a function of an assumed product price level rather than being simultaneously determined with product price. However, once an estimation of equilibrium was available the two prices could be simultaneously determined. (This was done for the 1980 projection.)

From an estimate of the market-clearing quantity in 1959 and the assumption of a price elasticity of demand of -.25, an estimate was made of the 1959 market-clearing quantity at the 83 percent of parity level (1). The basis for the estimate of the market-clearing quantity was a recent Oklahoma State study (32). In essence, this work attempted to measure the excess supply of agricultural production by measuring the amount of production diverted from the market by CCC storage, diversion payments and overseas surplus disposal programs. Total output of the area in 1959 aggregated into dollar terms was about $153,500,000. The figure of 8.4 percent excess supply, determined for 1959 by Tyner and Tweenten, was accepted as a reasonable estimate of the excess supply of agricultural production. Under the assumption that all of agriculture was experiencing the same type of adjustment problem and that a similar adjustment was being made simultaneously across the nation, the market-clearing amount of production for the area at 1959 prices was determined. In order to allow the factors to earn their opportunity cost (which they had been unable to do) prices were raised from the 80 percent of parity of 1959 to 83 percent of parity. Using a price elasticity of demand estimate of -.25, another output adjustment was made allowing for the smaller production that would clear markets at the higher price. The resultant of these estimates was an estimate that production of about $140,200,000 would clear markets under existing demand conditions at prices equal to 83 percent of parity.

Based on farm record data for the 15 economic class II farms, a regression equation relating labor and capital input per unit of land value input (a measure of the degree of intensification) to output per unit of land value input was computed. The regression equation of $\hat{Y} = .049630 + 1.36855 X$ was estimated where $\hat{Y}$ equaled the output valued in adjusted dollars divided by the total land input measured in dollars and X equaled the capital and labor inputs valued in opportunity cost dollars divided by the total land input in dollars. This regression had an R^2 of .62 and was significant at the 5 percent level. This equation was used to estimate the output effects of different levels of extensification on well organized farms brought about by withdrawals of labor and capital. Based on the extensification regression and the assumption that the sub-region's share of the market-clearing level of national output remains identical to its present share, estimates were made of labor and capital withdrawals needed to produce the optimum level of output. Capital and labor withdrawal from agriculture was assumed to come about by whole farms. That is, as the land of an individual was divided and added to surrounding farms, the labor and capital employed on the disappearing farm were removed from agriculture.

In short the extensification regression determined the relationship of output per unit value of land with the intensity of capital and labor inputs combined with land. Since all the farms used in the regression were of the well organized class, any point on the regression line (assuming a definite statistical relationship existed) could be considered as a possible combination of land with labor and capital that would fulfill the minimum cost of output requirement. Production at varying degrees of input intensity might implicitly affect the product mix of the area, but in this study agricultural output was aggregated into dollar terms.

Given the extensification regression, the equilibrium output of the region, and the value of agricultural land in the region, the regression equation was solved to determine the total inputs necessary for producing the equilibrium output. Under the assumption of a given amount of total labor and capital inputs per farm, the number of farms in the subregion was determined. The value of land was computed from the residual of factor earnings after the opportunity costs of labor and capital were removed.

Using the new market clearing demand estimate, the regression equation was solved for the amount of labor and capital needed in the region to produce the equilibrium output.

$$\hat{Y} = a + bX$$

$$\frac{\text{Output}}{\text{\$ of land}} = a + b \left(\frac{\text{labor + capital}}{\text{\$ of land}}\right)$$

$$\frac{140,200,000}{764,800,000} = .049630 + 1.36855 \left(\frac{L + C}{764,800,000}\right)$$

$$\text{Labor + capital} = 74,500,000$$

Dividing this regional figure by the labor and capital inputs per farm (measure in opportunity cost dollars) yields 7,381 as the estimated number of commercial farming units in the region. With the figures then available the structural characteristics of the industry in Southern Iowa could be computed.

The resulting organization of Southern Iowa agriculture was an estimate of industry structure that supplied an amount of production that would clear markets at prices enabling the inputs to receive remuneration at prices comparable to those in the nonagricultural sector and would produce this output at minimum factor cost. The results of this second reorganization are displayed in Table 8.

The market-clearing reorganization reduced the number of farms in the subregion an additional 13 percent from the existing 1959 situation. The additional reduction in total labor input amounted to 19 percent and the reduction of capital amounted to 24 percent. These previous reduction percentages are measured from the original situation. The decrease in the number of farms compared to the first reorganization amounted to 27 percent.

Table 8. Selected characteristics after second reorganization to approximate market clearing conditions at 83 percent of parity relative farm prices and 1959 costs and technology, commercial farms, census area Iowa 59

Characteristic	Before first reorganization 1959 actual	After second reorganization	Percent change
Number of farms	21,799	7,381	-66
Area totals			
Volume of farm output (1959 actual prices) (mil. $)	153.5	140.2	- 8
Input of real estate (1959 prices) (mil. $)	764.8	764.8	0
Input of labor (man-hours) (thousands)	287.9	144.7	-50
Input of operating capital (mil. $)	328.3	215.2	-34
Land in Farms (thousands of acres)	5,290	5,290	0
Per farm			
Volume of farm output (1959 actual prices) ($)	7,043	18,999	+169
Land acreage (acres)	243	717	+195
Input of real estate (1959 prices) (thousand $)	34.1	103.2	+203
Input of labor (man-months)	13.2	19.6	+ 48
Input of operating capital (1959 prices) (thousand $)	15.1	29.2	+ 93
Net factor income ($)	2,578	12,969	+404
Opportunity cost of labor and operating capital ($)	5,392	10,092	+ 87
Residual return to land per acre ($)	-10.58	4.01	+ 14.59[a]
Price of land per acre ($)	144[b]	89[c]	- 38

[a]Absolute increase in residual return to land per acre.

[b]1959 actual price.

[c]Residual return to land capitalized at 4 1/2 percent.

Factor income per farm increased from about $11,100 after the first reorganization, to nearly $13,000. Factor income was large enough to cover the opportunity cost of labor and capital and leave a residual return of about $4 per acre for land. When capitalized at 4 1/2 percent, this gave a land price of $89 per acre compared with an average price for the subregion in 1959 of $144 per acre.

C. Third Reorganization to Approximate the Minimum Cost and Output Level Conditions for 1980

Having estimated the equilibrium organization of Southern Iowa agriculture in 1959, the projection of this organization was made. Before completing the third and final reorganization, several estimations of exogenous variables for 1980 were needed. The general procedure was that of projecting the well organized farms as units to 1980, allowing for changes in the mix of inputs. After determining the supply generated by these farms in 1980, an estimate of demand was made and the reapplication of the extensification procedure was used to again bring supply and demand into equilibrium. The specific sub-procedures of this projection are discussed in the following sections.

1. Input-output projections

The first of the necessary projections was the determination of the rate of growth of output due to advancing technology and the effect of this rate of growth upon the coefficients of the extensification regression. After experimenting with several methods of projecting 1980 output per unit of total input, it was decided that the most appropriate way of handling this projection was to assume three alternative levels of productivity growth and compute a third reorganization for each. To make these assumptions realistic in terms of historical experience, an estimate was needed for the rate of change of productivity of inputs on well organized farms in the subregion over a recent period. Estimates were prepared of inputs and outputs for the upper one-third of Southern Iowa Farm Business Association Farms, ranked on the basis of management returns (6, 10, 11, 26, 27, 28). This group of farms from the years 1948-50 to 1958-60 indicated that productivity of inputs on these farms increased at an annual rate of about 2 1/2 percent. This compared to a rate of about 2 percent for the entire farm industry (17). In both cases the estimates probably reflect an above-average weather effect. The industry rate of growth over the 1940-59 period averaged about 1.8 percent per year (17).

Since the amount of new technology and its effect on production during the next 20 years would be impossible to estimate with any accuracy, the study used the three alternative assumptions of 1 1/2 percent per year, 1 3/4 percent per year, and 2 percent per year as possible rates of change of output per unit of total input during the next 20 years. It was assumed that the increase in productivity could be attributed to capital and labor. This seems to be a reasonable assumption when the nature of the land input is considered. The productivity of land may rise, but this is due to the addition of other inputs which are essentially capital in nature, such as fertilizer and herbicides.

By assuming that all of the technological effect was due to increased efficiency of labor and capital, the technology increase would affect only the b-value of the extensification regression. The result of the different productivity increase rates is shown in Table 9. The 1959 slope of the regression line was 1.36855. Non-commercial farms were assumed throughout the study to have an annual productivity increase of 1 1/2 percent.

Table 9. Effect of different assumptions of productivity growth upon output and regression b-values

Annual rate of efficiency increase	1 1/2%	1 3/4%	2%
Total percentage increase, 1960-1980	34.7%	41.5%	48.6%
Resulting b-value	2.0658	2.2022	2.3456

The amount of land in this region available for farming in 1980 had been estimated at 5,602,880 acres (see Table 10) (21). The change in numbers of non-commercial farms was assumed to be a function of non-farm employment in the area which in turn was a function of urban population growth. Using this assumption, the number of non-commercial farms increased from 5,735 to 6,060. Assuming the structural characteristics of these farms remained constant, they totaled 421,147 acres leaving 5,181,739 acres for commercial farms.

The relative composition of agricultural inputs has been changing over time. It was assumed that such change would continue in the direction of more land and capital in relation to land because the effects of changing relative prices of these inputs and the differential effect of

Table 10. Estimates acres of farm land converted to nonagricultural uses during 1960-1980 in Southern Iowa[a]

	Southern Iowa
Urban expansion	1,550
Airport facilities	4,400
Highway use	16,860
Federal reservoir projects	47,900
State recreation areas	860
County Conservation Board recreation areas	8,650
Private recreation areas	5,700
Total farm land converted to nonfarm use	85,920

[a]Source (21).

technology upon input would continue to be the same type change as they have been in the past.

Using Farm Business Association records from well organized farms in this area, it was observed that from 1948 to 1960 land input per farm was increasing 1 1/2 percent per year, capital input was increasing 2 1/4 percent per year, and labor input was decreasing 1 1/2 percent per year. Land input remained relatively the same percentage of total inputs over this 12 year period while labor's relative percentage decreased considerably and capital's relative percentage increased.

Because the projection's starting point was a well-organized farm, there would be no "catching up" of adjustments to previous changes in prices and productivities of inputs. Several assumptions of the lag effect on previous adjustments were made. An initial projection of the resource mix on well organized farms in 1980 was based on rates of change in resource inputs on the well organized record-keeping farms in the area between 1948-50 and 1958-60 and assumptions about the proportions of the change that could be attributed to lag effects and response to technological and factor price change during the period. For land, it was assumed that three-fourths of the change in the input was a lag effect and one-fourth reflected response to current developments. For labor, 85 percent was assumed to be lag effect and 15 percent was assumed to be adjustment to current developments. For capital, the assumptions were one-third for lag effect and two-thirds for adjustment to current developments. After adjustment for lag, this procedure assumed that relative factor price changes and differential effects of new technology on factor productivities in the 1959 to 1980 period would be much the same as in the 1950's and that the factor mix on well-organized farms would continue to shift in the direction of more land and capital in relation to labor. Using the assumptions of differing lag effect on the adjustment of the input mix, the mix was projected to 1980.

2. Factor price projections

Opportunity cost prices for labor and capital for 1980 were projected from projections of increases in national average earnings of labor and capital. Projections of national inputs of labor and capital under full-employment conditions to 1980 have been prepared by Denison (4). Based on past trends in the relative factor shares in real national income and the projected level of real national income, projections were made of the absolute shares of labor and capital incomes in 1980. From these projections and Denison's projections of inputs, the changes in average labor and capital earnings over the 1959-80 period were computed. This provided a basis for adjusting the 1959 opportunity cost prices to make the 1980 values consistent with the projected increases in real earnings.

Using these exogenous estimates of gross national product in 1980 and the inputs of land, labor, and capital, the opportunity cost of inputs for 1980 were estimated. The results are as follows. Labor's share was expected to rise 2.2 percent; capital's share would decline 3.5 percent. These trends coupled with increased productivity result in a labor factor price 41 percent greater and a capital price 13.5 percent greater than those observed in 1959. These increased costs are on a per unit basis. The specific estimation is shown in Appendix E.

3. <u>Product demand projections</u>

To determine the demand for agricultural products in 1980 from Southern Iowa, two steps are necessary. First, total demand for agricultural products in 1980 must be estimated and second, the portion of this demand to be supplied from Southern Iowa must be determined. Different products and uses have varying elasticities of demand and the total demand curve reflects all of these components. Shifts in demand are brought about mainly by changing consumer income and population growth. According to Fox the latter is five times more powerful than increasing consumer income (5). The present study ignored the product mix problem by aggregating and measuring agricultural output into 1959 dollars. This procedure also reduced estimation errors which are more likely to accumulate when specific commodity demand changes are estimated. The quantitative effect of changing consumer income was taken from the USDA Land and Water Resource Report and the most recent census projections for 1980 were used to estimate this major determinate of demand (37, 2). The use of trends was the essential method that was used by the USDA and Census Bureau in determining these estimations.

The other major component of demand, exports, does not readily lend itself to extrapolation because of its present major reliance upon political conditions. The USDA Land and Water Resources Report was also used for establishing this demand component, but here the lower figure quoted was subjectively used because it was felt that the USDA was overly optimistic in their estimation (37).

Increases in demand for farm products from 1959 to 1980 were estimated separately for the different components. Population of the United States was expected to increase 43.6 percent. Per-capita consumption of farm products was expected to increase 2 percent due to increased per-capita income. Consequently, the volume of farm products utilized domestically was expected to increase by 44.5 percent. Demand for farm products for export was assumed to increase by 30 percent. The sum of these demand increases would provide an effective demand increase of 42.9 percent for farm products from 1959 to 1980. The demand estimation is summarized in Table 11.

It was assumed that the percentage share of total agricultural output produced in 1980 by the subregion under consideration remained

Table 11. Demand estimation

	1959	1980
Population index	100	143.6[a]
Domestic per capita consumption index	100	102.0[b]
Quantity of farm products utilized domestically index	100	144.5
Quantity of farm products for export index	100	130.0[b]
Total 1959 farm output in million $	34,583[b]	--
Total utilization (11.2% excess supply, 1959)[c]	30,710	43,877
Exports (11.2% of production)[b]	3,440 x 1.300	4,472
Domestic utilization	27,270 x 1.445	39,405
Total utilization index	100	142.87
Total utilization adjusted for price adjustment to 83% parity	30,422	43,467
Total utilization index at 83% parity	100	142.88
Equilibrium output So. Iowa in million $	141.7	202.5
Output non-commercial farms in million $	1.5	2.2
Output commercial farms in million $	140.2	200.3

[a]Source (3).

[b]Source (37).

[c]Source (32).

identical to the portion produced in 1959. This implicitly assumes that advancing technology will have no differential effects upon production among producing regions of the country and that changing tastes and consumer demands will not favor some regions to the detriment of other regions. Both of these assumptions are very strong and their relaxation might have major effects on the analysis. However, it is expected that the area under consideration would be an area where the effect might be relatively minor. The reason for this assumption being that although the topography of the area is not conducive to maximum use of some expected changes (large scale cropping equipment) the region may be producing a product (beef) that will be subject to increasing demand. These effects may be offsetting. Under the assumption that the region's share of national output in 1980 would remain at 0.60 percent of total output, equilibrium output would rise from $141,700,000 to $202,500,000 valued at 1959 dollars and 83 percent of parity prices.

The three productivity assumptions were applied to the initial projection of inputs in 1980 and a tentative set of estimates of total output was obtained for 1980. When these output estimates were compared with the 1980 projection of the subregion's proportionate share of needed national output, it was found that with the productivity expansion rate of 1.5 percent the quantity of output forthcoming fell short of the needed output at the 83 percent of parity price level. In the 1.75 percent case, output forthcoming exceeded needed output by a small margin. For the 2.00 percent case, the excess supply at 83 percent of parity prices was substantial.

In adjusting resources at this point, it was assumed that part of the disequilibrium would be reflected in product price changes and part would be reflected in a further reorganization of resources. The equilibrium product price level for 1980 was defined to be the price level at which the value of land determined by the residual method (using the extensification equation) equalled the marginal value product of land. As was stated previously, it was assumed that all increases in productivity were attributed to labor and capital. Therefore in this model the marginal value product of land is solely a function of output price. By successive reiterations, the resultant product price level in 1980 was found to be 1.04 percent of the 1959 product price in the 1.5 percent productivity increase case, .96 percent in the 1.75 percent case, and .92 percent in the 2.0 percent case.

The estimate of the price elasticity of demand was used to determine the output demand at the different price levels. The extensification regression with the new b-values was then applied to meet this demand under the minimum cost conditions of production.

The results of the third reorganization are found in Table 12. They suggest that most of the adjustment needed to achieve economic efficiency in 1980 reflects current imbalance in the farm industry. For example, in the 1.75 percent productivity expansion case, the projected number of commercial farms in 1980 was 7,007. The actual number of commercial farms in 1959 was 21,799. This is a reduction of about 68 percent. The second reorganization projection, however, shows that 66 of these 68 percentage points are associated with the adjustment to current market demand, factor price, and technological conditions. The increase in the amount of capital investment per farm appears to be the most significant change between the 1959 situation after the second reorganization and the 1980 estimated equilibrium.

Table 12. Selected characteristics, commercial farms, Census Subregion Iowa 59, 1959 actual, 1959 reorganized, and 1980 reorganized under alternative productivity growth assumptions

Item	1959 actual	1959 after second reorganization
Price (percent of parity)	80	83
Area total		
Number of farms	21,799	7,381
Volume of output (1959 prices) (mil. $)	153.5	140.2
Input of land (1959 prices) (mil. $)	764.8	764.8
Input of labor (thousand man-months)	287.9	144.7
Input of capital (1959 prices) (mil. $)	328.3	215.2
Land in farms (thousand acres)	5,290	5,290
Per farm		
Input of land (1959 prices) (thousand $)	34.0	103.2
Input of labor (man-months)	13.2	19.6
Input of capital (thousand $)	15.01	29.2
Land acreage (acres)	243	717
Factor income (thousand $)	2.57	12.97
Opportunity cost of labor (thousand $)	4.49	8.34
Opportunity cost of capital (thousand $)	.90	1.75
Opportunity cost of land (@ $89 per acre) (thousand $)	1.53	2.87
Excess of factor income over factor cost, labor, and capital (thousand $)	-4.35	0
Residual return to land per acre ($)	6.32	4.01
Price of land ($)	144[b]	
Capitalized @4 1/2 percent	--	89
Capitalized @ 5.25 percent	--	76

[a]Absolute change in excess of factor income over factor opportunity cost.

[b]Actual price.

Table 12. (Continued)

Item	1980 Commercial farms after third reorganization		
	Productivity growth assumption		
	1.5%	1.75%	2.00%
Price (percent of parity)	86.3%	79.7%	76.4%
Area total			
Number of farms	7,289	7,007	6,659
Volume of output (1959 prices) (mil. $)	198.3	202.3	204.3
Input of land (1959 prices) (mil. $)	746.2	746.2	746.2
Input of labor (thousand man-months)	135.6	130.3	123.9
Input of capital (1959 prices) (mil. $)	322.0	304.6	294.2
Land in farms (thousand acres)	5,182	5,182	5,182
Per farm			
Input of land (1959 prices) (thousand $)	102.4	106.6	112.0
Input of labor (man-months)	18.6	18.6	18.6
Input of capital (thousand $)	44.18	44.18	44.18
Land acreage (acres)	711	740	778
Factor income (thousand $)	16.67	16.09	16.10
Opportunity cost of labor (thousand $)	10.58	10.58	10.58
Opportunity cost of capital (thousand $)	3.09	3.09	3.09
Opportunity cost of land (@ $89 per acre) (thousand $)	2.85	2.96	3.12
Excess of factor income over factor cost, (thousand $)	.15	-.54	-.69
Residual return to land per acre ($)	4.21	3.27	3.12
Price of land ($)			
Capitalized @4 1/2 percent	94	73	69
Capitalized @5.25 percent	80	62	60

Table 12. (Continued)

Item	Percent change 1959 actual to 1980 1.75% case	Percent change 1959 second reorganization to 1980 1.75% case
Price (percent of parity)	--	--
Area total		
Number of farms	- 66	- 5
Volume of output (1959 prices) (mil. $)	+ 32	+ 44
Input of land (1959 prices) (mil. $)	- 2	- 2
Input of labor (thousand man-months)	- 55	- 10
Input of capital (1959 prices) (mil. $)	- 6	+ 44
Land in farms (thousand acres)	- 2	- 2
Per farm		
Input of land (1959 prices) (thousand $)	+214	+ 3
Input of labor (man-months)	+ 48	- 5
Input of capital (thousand $)	+194	+ 51
Land acreage (acres)	+205	+ 3
Factor income (thousand $)	+526	+ 24
Opportunity cost of labor (thousand $)	+136	+ 27
Opportunity cost of capital (thousand $)	+243	+ 77
Opportunity cost of land (@ $89 per acre) (thousand $)	+ 93	+ 3
Excess of factor income over factor cost, labor, and capital (thousand $)	5,240[a]	-455[a]
Residual return to land per acre ($)	- 48	- 18
Price of land ($)		
Capitalized @4 1/2 percent	- 49	- 18
Capitalized @5.25 percent	- 57	- 18

VI. SUMMARY AND CONCLUSIONS

This study has attempted to project the structure of Southern Iowa agriculture in 1980 that would result in an efficient organization of the farm industry. Under such an organization, the output supplied should be produced at minimum cost and should be able to clear the market at prices enabling the factor inputs to earn their respective opportunity costs. The projection was accomplished in three steps. The first, a reorganization of 1959 farms to achieve the minimum cost requirement of output. The second, a reorganization of well organized farms into more extensive units to bring the supply into line with effective product demand. The third step was the projection of the well organized industry to 1980.

The results show that to achieve economic efficiency the trends toward fewer and larger farms would need to continue. More capital and labor would be needed per farm, but total capital and labor inputs in the farm industry of this area would be reduced. At existing product prices, land appears to be overpriced in that opportunity cost returns to labor and capital cannot be covered on well organized farms. A lowering of land price would result in a greater amount of land combined with a given input of labor and capital in a manner indicated by the study.

Present governmental programs to alleviate or remove the farm problem have concentrated primarily upon reducing the land input. Without programs to reduce labor and capital inputs, the result has been an intensification of the production process with relatively more labor and capital being applied to each unit of land input. This intensification is just the opposite result of the extensification process of adjustment considered in this thesis. Present technology trends appear to be continually increasing the size, in acres, of the most efficient size farm firm. With programs restricting land use in effect, competition for land has added to other factors causing a higher price of land which has served as a brake on the adjustment of firms to the changing technological conditions. Agriculture in the study area has been adjusting and changing in the direction indicated by this study, but the rate of adjustment has been less than what would be needed to achieve an efficient farm sector in 1980 as estimated by this study. Figures 6 and 7 indicate the discrepancies between these two rates.

The most important aspects of the results are not the specific estimates, but the direction changes take and the approximate magnitude of these changes. In addition to the discussion of the preceding paragraph, there are several other policy implications. Credit institutions must be capable of meeting increased capital demands per farm. Conventional tenure arrangements must be adjusted to changing input mixes. Political and educational institutions must realize the implications of the possible changes in population of rural areas. The implication of the industry demand for entrants (new managers) under present adjustment rates (almost no demand) is that sociological changes such as the age distribution of the population may be quite large.

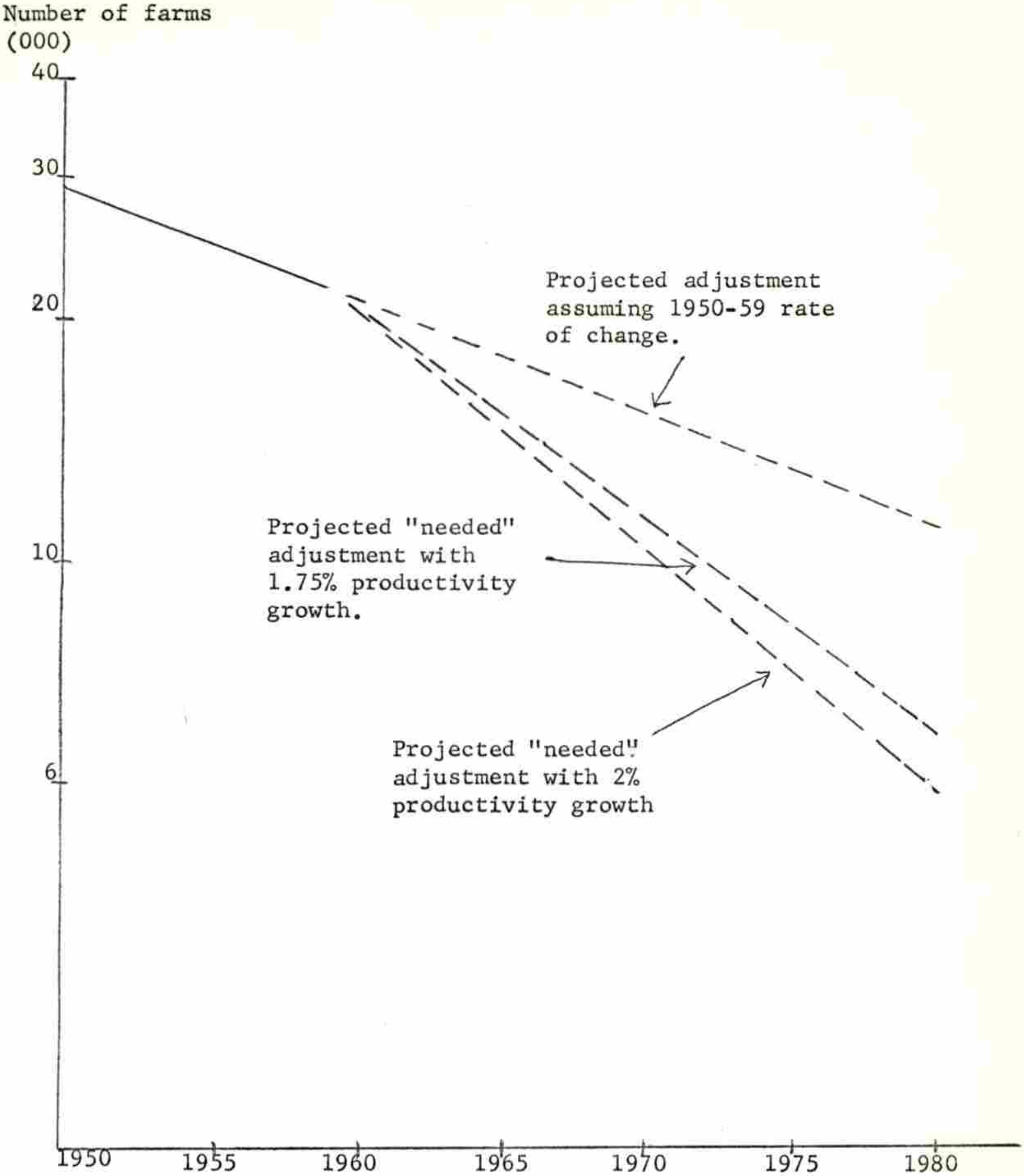

Figure 6. Number of commercial farms, 1950 and 1959 actual and 1980 projected, Southern Iowa.

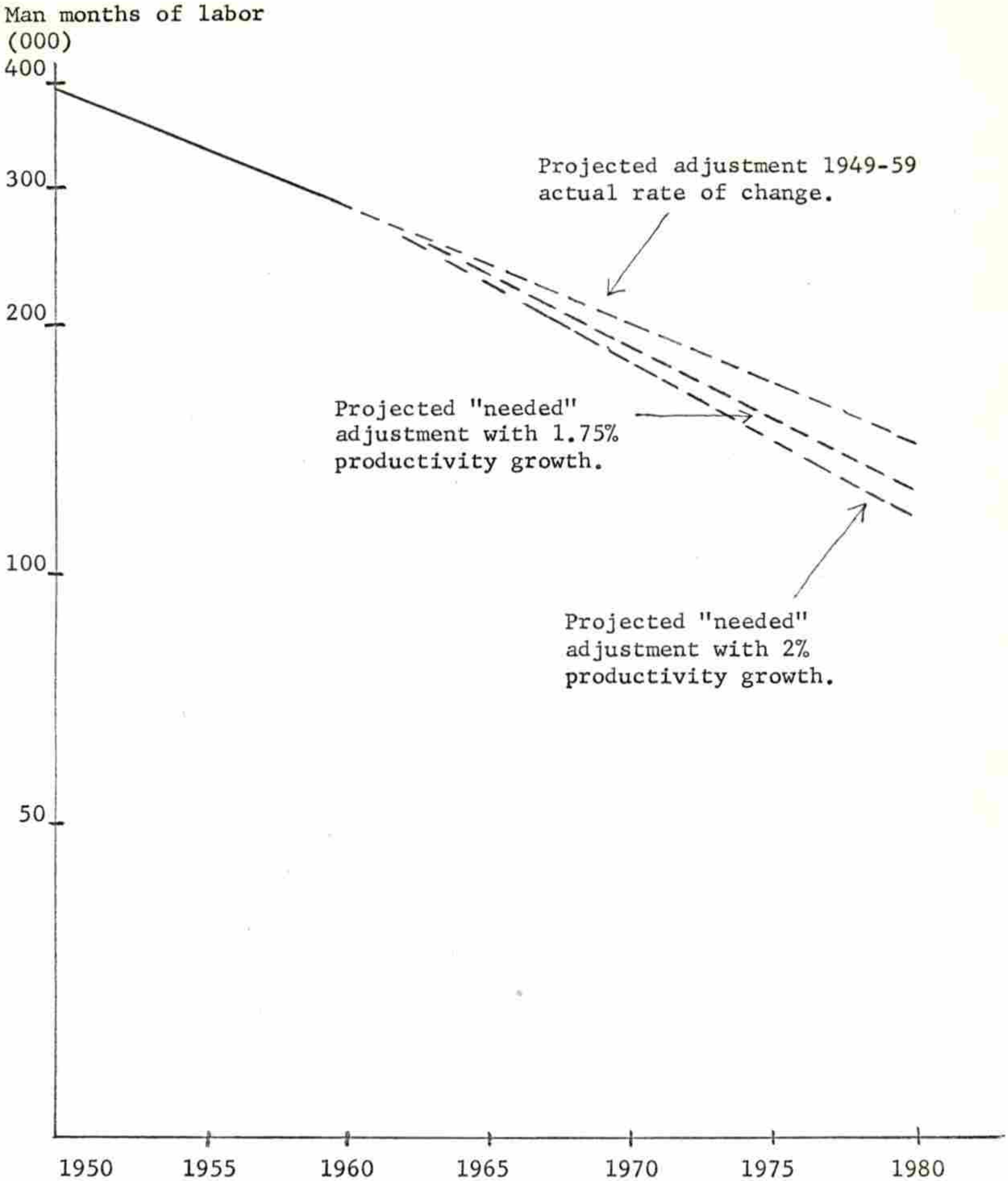

Figure 7. Man-months of farm labor, 1950 and 1959 actual and 1980 projected, Southern Iowa.

The study also implied that most of the structural imbalance is present in the contemporary situation and, abstracting from social costs, the most rapid adjustment possible should be encouraged.

Many unanswered questions were suggested to the author during the work. What are the adjustments necessary in other types of farming areas? What are the implications of extensification upon product mix? How will changing tastes and specific product demand elasticities effect the production during the next two decades? Would weather and other factors affecting uncertainty influence the results? These questions present possibilities of additional research and study.

The problem of the method of economic research into estimating simultaneous equilibrium in both a macro and micro setting was the greatest problem in this thesis. The author found no examples in the literature where a model had been designed to consider this problem. Perhaps inquiry into such a problem would yield the greatest benefit to future economic studies.

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IX. APPENDIX A: ESTIMATION OF LIVESTOCK INVENTORY VALUE

The procedure for obtaining livestock numbers on each class of farms was as follows. The figures for milk cows, beef cows, horses and mules, sheep over one year, sheep under one year, chickens, and hogs farrowed after June 1, 1959 were taken directly from the census worksheet (35). The census enumeration lists heifer and heifer calves as one class. Since the value of animals could vary greatly within each of these categories, a further breakdown was advantageous. To do this, county tax assessment records were used to break these classifications into age groups of over one year and under one year (13). Fully comparable categories show a downward bias of 15 percent in tax records. After adjusting for this bias, 63 percent of this class of cattle were estimated to be under one year of age. With hogs farrowed before June first, a similar procedure was followed to find the proportion of these hogs for breeding stock and the proportion for market. Fourteen and one-half percent were estimated to be breeding stock.

Estimated prices for the different types of livestock and the estimated part of the year the capital is tied up on different types of livestock are listed in the following table. Where applicable, prices were taken from the Iowa Farm Science magazine (9). Where this procedure was not reasonable, conversations with people acquainted with livestock prices were used as supplementary data. Total and average livestock numbers and values are listed in Table 14.

Table 13. Basic data for evaluating value of livestock on Southern Iowa farms, October 1959

	Wt.[a]	Price/cwt.	Price/head	Part of year on farm
Beef cows	1,100	16.40[b]	180.40	1
Milk cows	--	--	242.00[b]	1
Horses and mules	--	--	209.00[c]	1
Sheep under 1 year	60	18.70[b]	11.25	7/12
Sheep over 1 year	125	6.00	7.25	1
Heifers	700	22.70[a]	158.90	1
Heifer calves	300	28.00[a]	84.00	2/3
Bulls and steers	800	24.70[b]	197.60	2/3
Bull and steer calves	300	30.00[a]	90.00	2/3
Hogs farrowed after June 1	80		15.80[a,d]	7/12
Hogs farrowed before June 1 (breeding)	350	12.00[a]	42.00	1
Hogs farrowed before June 1 (feeding)	180	14.50[c]	26.10	7/12
Chickens	--	--	1.00	1

[a]Uhrig, William, Department of Economics, Iowa State University of Science and Technology. Ames, Iowa. Value of livestock. Personal communication. 1964.

[b]Iowa Farm Science (9).

[c]Kaiser, James. Department of Animal Science, Iowa State University of Science and Technology. Ames, Iowa. Value of horses and mules. Personal communication. 1964.

[d]$10 per head plus 14.5 cents per pound over 40 pounds.

Table 14. Total and average livestock numbers in Southern Iowa by economic class of farm

Class of farm	Milk cows[a]	Beef cows[b]	Horses and mules[a]	Heifers[c]	Heifer calves[c]	Steers and bulls	Bull and steer calves	Sheep over 1 year[a]	Sheep under 1 year[a]	Hogs over 6 months feeding[c]	Hogs over 6 months breeding[c]	Hogs under 6 months[a]	Chickens[a]
Total													
I	956	7,803	344	2,610	6,745	10,176	22,130	5,813	22,726	17,995	3,027	27,852	76,908
II	7,057	31,149	1,334	8,673	22,414	14,835	32,234	33,546	43,986	70,830	11,915	130,307	215,314
III	24,507	82,904	3,043	19,477	50,333	24,665	52,332	63,482	36,883	177,555	29,869	317,929	692,340
IV	35,079	94,826	4,284	22,370	57,810	21,450	46,645	88,294	46,645	225,357	37,910	344,718	933,460
V	20,410	47,720	3,455	12,056	31,154	9,839	21,396	54,835	24,830	83,520	14,050	134,830	522,005
VI	4,835	6,500	840	1,583	4,072	315	685	14,895	5,485	12,284	2,066	17,005	126,665
Average/farm													
I	3.20	26.10	1.15	8.73	22.56	34.03	74.01	19.44	76.01	60.18	10.12	93.15	257.22
II	5.27	23.25	1.00	6.47	16.73	11.07	24.07	25.05	32.83	52.86	8.89	97.24	160.68
III	5.24	17.73	.65	4.16	10.76	5.15	11.19	13.57	7.89	37.96	6.39	67.98	143.03
IV	4.43	11.98	.54	2.83	7.30	2.71	5.89	11.15	5.89	28.46	4.79	43.54	117.89
V	3.55	8.29	.60	2.09	5.41	1.71	3.72	9.20	4.31	14.51	2.44	23.43	90.70
VI	2.67	3.59	.46	.87	2.25	.17	.38	7.43	3.03	6.79	1.14	9.40	69.98

[a]U. S. Census of Agriculture, 1959 (35).

[b]Derived from U. S. Census of Agriculture, 1959.

[c]Derived from U. S. Census of Agriculture, 1959 (35) and Iowa State Tax Commission Report, 1960 (13).

X. APPENDIX B: ESTIMATION OF MACHINERY AND EQUIPMENT VALUE 1959

A linear regression relating crop acres to machinery and equipment investment on each farm was developed from the farm business association data. This regression was

$$\hat{Y} = 2723.4 + 20.35X$$

where Y is the investment in machinery and equipment and X is the crop acres. This regression was significant at the 1 percent level with an R^2 of .50 and t value of 4.961. This significant correlation was also found to exist in all other economic subregions of Iowa.

Table 15. Machinery investment on Southern Iowa farms by class of farm, 1959

Class of farm	I	II	III	IV	V	VI	Total
Rotated acres[a]	379.0	290.9	217.5	148.2	95.2	55.2	
Machine value/farm[b]	10,436	8,643	7,150	5,739	4,661	3,847	
Number of farms[a]	249	1,340	4,677	7,918	5,755	1,810	
Total machinery value	3,120,364	11,581,620	33,440,550	45,441,402	20,824,055	6,955,376	127,363,367

[a]Source (34).

[b]Computed on the basis of the regression equation $Y = 2723.4 + 20.35X$ where X is the rotated acres per farm.

XI. APPENDIX C: ESTIMATION OF OPPORTUNITY COSTS AND PHYSICAL AMOUNTS OF LABOR INPUTS

Three types of labor are used on farms, each requiring a different estimation method. These types are the operator labor-management input, hired labor and non-paid family labor. The estimation procedure must yield a physical measurement and a dollar measurement.

First consider the operator labor-management input. The physical input was estimated from census data given certain assumptions. The 1959 agricultural census divides farm operators by the number of days working off the farm. The divisions are 1-99 days, 100-199 days, more than 200 days, and no off-farm work. The following assumptions were made. If no off-farm work was done, the operator was charged with 12 months of work on the farm. If 1-99 days of off-farm work was done, the operator was assumed to have worked 10 months on the farm. In the 100-199 day range, the assumption was six months of farm work and if the off-farm work was greater than 200 days, the operator was charged for only one month of farm labor. After the total man-months of operator labor were computed in this manner for each class of farm, the estimations were compared to estimates by the U. S. Department of Agriculture and the U. S. Department of Commerce and found to be quite comparable for the type of farm most common in the Southern Iowa area (35, 36).

The basis for estimation of the opportunity cost of this type of input was a previous study by Kaldor, Beneke, and Bryant at Iowa State University relating returns from "well-organized" farms to returns in alternative occupations, specifically management of cooperative elevators, management of farm supply companies, and foreman in industrial employment (16). It was assumed that the traits required for managing a farm were similar to these other occupations. Consequently, these alternative occupations provided a basis for estimating opportunity cost for the farm operator. The comparisons to farm supply companies were used in this paper because of a greater statistical significance between salary and a weighted total of assets managed. The argument may be presented that an average farmer is not capable of reaching these alternatives but the talents necessary for the management of well-organized farms under present technology is considerable and in many respects more difficult than managing farm supply companies. The estimation technique was a linear regression equation of the form $\hat{Y} = 4543 + .0098X$ where $\hat{Y}$ equals the expected operator labor-management salary in dollars and X equals the weighted value of assets managed in dollars. The weighting of X was accomplished by adding the value of land operated to four times the value of machinery on the farm and six times the value of crop and livestock inventories.

The basis for estimating hired labor was also the census report. Because of seasonal use of hired labor, the figures in the census could not be directly used. The assumption was made that workers employed over six months as reported in the census were employed year round and were paid the average monthly wage reported in the census plus $40 per month to cover perquisites (34, 35). The census reported total expenditures on hired labor by class of farm and from this figure was subtracted the product of monthly workers multiplied by the monthly wage. This remainder was then divided by the weighted hourly wage of part-time labor to give the total hours of part-time labor hired. This was in turn divided by 210, which was the census figure for average hours worked per month by monthly labor (35). This gave us the man-months of part-time labor hired. The summation of full-time and part-time labor gave total months of hired labor.

The input of non-paid family labor was derived by again resorting to Farm Business Association Records. A regression of family labor on the weighted total of assets managed was used to establish a relationship between these characteristics. This regression was highly significant. The resulting estimates were again compared to the above mentioned USDA results. Family labor was arbitrarily charged at the rate of $175 per month reflecting generally a lower productivity than hired labor and no charge for perquisites.

Summation of total man-months of labor and opportunity costs over the three categories of labor was the last step in computing the labor estimates. Table 16 lists the results of labor estimation.

Table 16. Labor inputs on Southern Iowa farms, 1959, months

Type of labor	I	II	III	IV	V	VI	Total
Operator	3,211	15,813	52,379	85,241	55,735	15,835	227,214
Family	1,038	3,508	8,671	10,776	5,985	1,452	31,430
Hired, part time[a]	1,117	1,847	3,234	3,394	1,973	832	12,447
Hired, full time[b]	2,796	6,060	4,884	2,520	480	120	16,860
Total	8,162	26,278	69,168	101,931	64,173	18,239	287,951
Average/farm	27.3	19.6	14.8	12.9	11.2	10.1	13.2

[a]Working less than six months per year.

[b]Working more than six months per year.

XII. APPENDIX D: ESTIMATION OF EXISTING SITUATION

In order to estimate the changes required to produce output at minimum cost, estimates were needed of the existing situation of the region's farm firms. The census data and the records from farms in the area were used in a complimentary manner to derive the needed estimates. In most cases, farm business records were used to develop regression equations that could be applied to census data.

Production throughout this thesis has been measured from census data as the gross value of sales minus feed, livestock, and seed purchases plus the value of home used produce plus (or minus) inventory changes and corrections for cyclical price effects in hogs and cattle. The value of home used produce was estimated by the regression $\hat{Y} = 313.7 + 245.5 (\log X - 3.2)$ where X is the gross value of sales per farm (31). The estimates for operating expenses are listed in Table 17.

Table 17. Operating expenses on Southern Iowa farms by economic class of farm 1959

	Class I	Class II	Class III	Class IV	Class V	Class VI	Non-commercial	Class II after reorganization
Machinery expense[a]	2,817	2,299	1,807	1,478	1,109	951	805	2,356
Livestock expense[b]	424	350	322	305	297	290	193	350
Crop expense[c]	1,208	1,100	913	799	635	574	526	1,100
Taxes and insurance[d]	1,687	1,389	889	552	334	179	117	1,389
Machine depreciation[e]	1,925	1,742	1,540	1,456	1,336	1,253	1,188	1,742
Building depreciation[f]	272	557	240	182	156	125	125	557
Building repair[f]	203	182	168	128	46	21	21	182
Miscellaneous[f]	869	359	132	116	108	100	100	327
Subtotal	9,405	7,978	6,061	5,016	4,021	3,493	3,075	8,003
Feed purchases[g]	10,741	4,023	2,068	1,131	567	275	230	4,023
Livestock purchases[g]	22,443	5,485	1,683	648	352	137	161	5,485
Total	42,589	17,486	9,812	6,795	4,940	3,905	3,466	17,511

[a] Fuel and oil purchases and machine hire are taken from census (35). Repair was computed from regression $Y = 224.7 + .07415X$ where X is the crop acres per farm. Automobile expense for all farms was $200. The summation is the total recorded.

[b] Estimated from regression $\hat{Y} = 279.8 + .00752X$, X equals livestock inventory.

[c] Estimated from regression $\hat{Y} = 435.3 + 3.773X$, X equals crop acres.

[d] Estimated from regression $\hat{Y} = -67.4 + .0193X$, X equals value land and building.

[e] Estimated from regression $\hat{Y} = 860 + .102X$, X equals machine value.

[f] Average, farm business records.

[g] U. S. Census of Agriculture, 1959 (34).

XIII. APPENDIX E: ESTIMATION OF OPPORTUNITY COST OF INPUTS FOR 1980

The estimation of input prices for 1980 was based entirely on figures from The Sources of Economic Growth in the United States and the Alternative Before Us, by Edward F. Denison (4).

Denison found that constant percentage relationship has existed between national income and gross national produce (GNP) over time. Thus GNP figures and estimates for future GNP could be used for the estimation of future opportunity costs. The GNP for 1959 was multiplied by the relative shares of the major input classifications. The resulting number was divided by an index of total physical input for each of the three input classifications. This gave "total share per index input" for 1959.

The procedure was again computed for 1980 using Denison's estimates of GNP and total inputs. The relative shares for 1980 were estimated from past trends in income distribution. The projection procedure used was that of estimating the percentage change per year. The two points in time were compared to find the percentage increase over time in the total share of material income. The 1980 opportunities costs were estimated by the multiplication of the 1959 opportunity costs by the percentage increase to 1980.

Table 18. Estimating 1980 opportunity cost

	Labor	Capital	Land	Total
GNP 1959 in bil. $	455[a]	455[a]	455[a]	
Share 1959	.773[b]	.197[b]	.030[b]	1.000
	351.72	89.64	13.65	455.01
Index of input (physical)	1.000	1.000	1.000	
Share/unit 1959	351.72	89.64	13.65	
GNP 1980 in bil. $	877[a]	877[a]	877[a]	
Share 1980	.790[c]	.190[c]	.020[c]	1.000
	692.83	166.63	17.54	877.00
Index of inputs	1.397[d]	1.638[e]	1.000[f]	
Share/unit 1980	495.94	101.73	17.54	
Percent increase 1959-1980	41.0	13.5	28.5	

[a]Source (4,p. 261).

[b]Source (4, p. 30).

[c]Projection based on Denison (4, p. 30).

[d]Source (4, p. 37).

[e]Source (4, p. 152).

[f]Source (4, p. 89).