THE USE OF FUNCTIONAL ANALYSIS IN EVALUATING THE OPERATIONS OF MICHIGAN ELEVATOR-FARM SUPPLY BUSINESSES

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THE USE OF FUNCTIONAL ANALYSIS IN EVALUATING THE OPERATIONS OF MICHIGAN ELEVATOR-FARM SUPPLY BUSINESSES

By

ARTHUR J. PURSEL

AN ABSTRACT

Submitted to the College of Agriculture of Michigan State University of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

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ABSTRACT

The purpose of this study was to obtain estimates of the marginal productivities of the resources used in the operations of Michigan elevator-farm supply firms. It was anticipated that these estimates would provide useful aids to elevator owners and managers, boards of directors, management consultants, research and extension personnel in analyzing the effects of proposed reorganization and expansion programs.

The real product of the country elevator is service and the empirical measure of this service is gross margin. A Cobb-Douglas type production function was employed to determine the marginal value productivities of the inputs used in performing this service. This is an exponential equation which is linear in logarithms. The regression coefficients are determined by the method of least squares.

The marginal value product of each input category was then determined by the following formula: $MVP_{X_i} = \frac{b_i \, E(Y)}{X_i}$ or the antilogarithm of the $\log b_i + \log E(Y) - \log X_i$, where $E(Y)$ is the gross margin obtained when X_i is the amount of that input used in the estimating equation, and b_i is the regression coefficient of X_i.

The data used in estimating the marginal value productivities were obtained from the financial records and a personal interview with the managers of 34 selected Michigan elevator-farm supply firms. An effort was made to select firms

which were typical in terms of the products sold. Considerable range with respect to the proportions of inputs used was desired in order to reduce the inter-correlation between inputs and hence to assure greater reliability of the estimated regression coefficients. This in turn increases the accuracy of the marginal value products derived from the function.

The returns to each category of inputs for the "typical" organization were found to be $.320 for the labor ($X_1$), $.179 for inventory and accounts receivable (X_2), $1.696 for direct operating expenses (X_3), and $2.68 for investment in machinery and equipment (X_4). The gross margin was estimated to be $83,674 when the geometric mean amounts of inputs are used.

The marginal value product of labor is not significantly different from its marginal factor cost, therefore, it was concluded that this input should not be increased. It was believed that increased quality is a more appropriate goal with respect to labor. It was concluded that the inventory and accounts receivable category should not be increased because its MVP was approximately equal to its MFC. The lack of a measuring device which would simultaneously measure the interrelated factors of level, composition and rate of turnover makes it difficult to evaluate inventory adequately.

The two adjustments which seem most advisable are: (1) increase the expenditures on direct operating expenses while holding all other inputs constant, and (2) to increase direct operating expenses and the amount of investment in machinery

and equipment, in least cost combinations. However, the case for the latter adjustment is not strong when machinery and equipment have a reservation price of 20 percent. The first adjustment is primarily an increase in utilization of existing facilities because operating expenses are those which vary with the physical volume of products handled by the firm. The fact that a high rate of liquid capital accumulation is obtained substantiates the case for this adjustment. Liquid capital accumulation is thought of in terms of traditional accounting procedures and is net profit plus the depreciation charge.

It must be recognized that the country elevator is a merchandising firm as well as a producing firm, therefore, the instigation of the proposed adjustments must also be accompanied with management practices which will increase the quantity of services demanded from the firm.

A measurement of the demand for a given firm's services indicates that it is relatively elastic. Therefore a major means of increasing the utilization of capacity is to cut unit gross margins and consequently increase total gross margin.

Approved by Vernon L. Sorenson

Major Professor

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Responsibility for errors which may be present in the completed work belongs to the author.

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CHAPTER I

INTRODUCTION

Objectives and Methods Used. The major objectives of this study are (1) to measure the returns to various input and investment categories used in selected Michigan elevator-farm supply firms and (2) to estimate the effects of varying resource combinations on returns to these input categories. This study is concerned with the problem of efficient resource use in the operation of country elevators.

Probably the major problem in the operation of elevator-farm supply businesses is determining the quantities and proportions of resources which are most likely to maximize net operating profit. However, country elevators are merchandising firms as well as producing firms. Therefore market complementarity among products is also an important factor in determining the profitability of these businesses.

Elevator owners and managers, boards of directors, management consultants, and marketing firm research workers are continually faced with the question "Will it pay?". Generally, this question is of concern when a reorganization or expansion program is proposed. It was hoped that results of this study would offer guides useful in analyzing the effects of proposed reorganization and expansion programs.

Theoretically, the conditions of maximum profit are met, when the marginal value product of each input is equal to its

marginal factor cost. The most logical procedure in adjusting a firm to a more nearly optimum economic position is to increase the use of those inputs which yield the greatest returns.

Cobb-Douglas analysis is used to obtain estimates of the marginal value products of major input and investment categories employed in the production of market services by the firms studied. While Cobb-Douglas functions have been used in analyzing farm firms, very little use has been made of this method in analyzing firms which market the products of agriculture and furnish the necessary production items for farms.[1/]

The operating relationships and the nature of the production function for a country elevator are discussed in Chapter II. A brief discussion of the Cobb-Douglas function and a review of past studies in which this function has been employed is also given in Chapter II.

Chapter III deals with four major items. The first of these is the fitting of the function and a statistical evaluation of the results; second, the computation of the marginal value products; and third, ratio comparisons of net operating profits to net fixed assets and replacement values. The fourth item considered is a short-run and long-run adjustment in the factors of production and the changes in net operating profit as a result of these adjustments.

1/ Recently two studies have been completed at Kansas State College on resource returns and productivity coefficients for grain elevators in Kansas.

Chapter IV deals primarily with an analysis of the differences between estimated and actual operating returns [2]; and secondly, with a further comment on the operating structure of the country elevator.

General conclusions and recommendations obtainable from the analysis are given in Chapter V.

The Sample. Data were obtained from financial records of the firms analyzed and from a personal interview with the manager of each firm. Several major criteria were established in selecting the sample.

An effort was made to select firms which were typical of the elevator-farm supply business in Michigan - typical in the sense that the products sold and merchandised by these firms are essentially the same. Organizations with an unusual product mix were not included in the sample. Those with exceptionally low dollar volume (below 200,000 dollars) and those primarily of the feed store variety were excluded from the sample. Considerable range with respect to the size of business and the proportions of inputs was desired in order to assure greater reliability of the estimated regression coefficients.

Elevators operated by chain organizations were not included because of the overlapping accounting and managerial services employed. A partial exception to this rule was

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2/ Actual operating returns is an index of marketing services which eliminates the difference in absolute unit gross margins taken by the firms studied.

made in the case of elevators associated with Farm Bureau Services. However, this was not considered a serious error because of the decentralized accounting and management procedures practiced by Farm Bureau Services. Originally financial records and interviews were obtained from 42 country elevators, however, due to insufficient information it was necessary to reduce the number studied to 34.

CHAPTER II

THE ANALYTICAL FRAMEWORK

Operating Relationships. The elevator industry plays an important role in Michigan agriculture by meeting a large portion of the marketing and distributing needs of the farming community. Elevator-farm supply firms are assembling points for the movement of grain through the marketing system and into the hands of the consumer. The country elevator is also a major distributor of items required in the production of field crops and livestock products

These firms handle processed and unprocessed grain. The greater proportion of processed grain is derived from the elevator's custom feed grinding and mixing operation, while a smaller proportion is obtained from retailing "complete" feed mixes. Feed supplements are added to a high percentage of the processed grain handled. Most of these supplements take the form of protein additives such as soybean, linseed, cottonseed meals and/or prepared commercial protein supplements. Other feed ingredients such as salt, antibotics, and liquid molasses are also added to the processed grain.

Unprocessed or merchandised grain is sold to three major classes of buyers: (1) terminal grain elevator companies, (2) other country elevators, and (3) farmers.

In classifying the market service output of the firms studied, unprocessed grain, processed grain, and service income are grouped into a single category. The guiding principle,

in grouping these products is the high degree of complementarity existing between them. The greater the degree of interrelationship between products, the more reason for aggregating them into the same category.3/ This principle was also used in grouping the many other items handled by country elevators into the sideline category.

The firm which provides a farmer with those commodities needed in livestock production is very apt to obtain that same farmer's saleable grain. In this respect, feed and merchandised grain operations are complementary in the market.

The sources of service income for the country elevator are: (1) custom grinding and mixing of livestock feed, (2) handling, trucking and storing grain, and (3) cleaning and treating grain for seed. Service income, as the above list indicates, is primarily derived from grain handling and processing operations. Vertical integration of service operations with both processed and merchandised grain leads to a greater volume in either or both enterprises. In this respect service operations exhibit both technical and market complementarity with processed and merchandised grain. Technical complementarity exists because some of the facilities used for service operations may be used for grain processing and merchandising. Market complementarity exists because grain merchandising and processing volume may be increased as a result of providing

3/ Richard Phillips, Managing for Greater Returns in Country Elevator and Retail Farm Supply Businesses, Published by Farmers Grain Dealers Association of Iowa (Cooperative) Des Moines, Iowa, pp. 34 and 35.

the service.

Technical complementarity between unprocessed and processed grain is greatest in what might be called the dual-purpose plant, because part of the same facilities are used in handling grain as are used in processing feed. The seasonal nature of grain harvests and livestock feeding, makes this type of operation possible. Technical complementarity between these two activities permits higher utilization of machinery and equipment, and consequently absorbs idle capacity. Dual-purpose facilities provide operational flexibility and reduce risk caused by shifts in the composition of the grain volume handled by the firm. It is apparent that an increase in the total volume of grain (processed and unprocessed) handled may lead to competition for the available facilities. This competition is not serious in those firms primarily merchandising oats and wheat, because these grains are harvested at a time of the year when feed volume is lowest. However, if the firm in question merchandises large quantities of corn a competitive relationship could exist, because corn is normally harvested and sold when the feed business is at or near peak volume.

A partial answer to the competitive relationships existing in the dual-purpose plant, is separation of grain and feed facilities. If the facilities are separated, the firm can handle a greater total volume of business. Separate facilities permit handling harvest-time runs, and at the same time enable the firm to maintain its feed volume. However, an expansion program

of this type requires increased investment in fixed facilities, more specialized employees, and consequently the necessity of increased sales volume.

The question now presents itself as to when grain and feed facilities should be separated. It is extremely difficult to give a concrete or empirical answer to this question. The factors which must be considered are: (1) the present sales volume in feed and grain, (2) the seasonal nature and type of grain production in the trading area under consideration, and (3) the potential increase in grain volume that might occur as a result of increased capacity. If all these questions can be answered with a reasonable degree of accuracy, it would then be necessary to make a comparison of the costs relationships for each method. Upon completion of the cost analysis, management would have a guide to the decision of whether to separate the feed and grain facilities.

The Market Service Output of the Firm. The relationship between merchandised grain and processed grain has been discussed in physical terms, however, it is impossible to devise a physical index which will measure all the products handled by these businesses.

Sideline items run the gamut from fertilizer to print feed bags, out of which farmers' wives make aprons. In conjunction with the profit motive, the purpose of sidelines is to increase competitive effectiveness and make use of idle capacity. Idle capacity may be labor, plant facilities, or

managerial ability. Sideline operations absorb idle capacity and provide an opportunity to gain additional grain volume from the same farmers who purchase sideline items. In this respect, sideline items and grain are complementary to each other.4/

A substantial proportion of the elevator's operating income is derived from services which are not associated with the purchase and sale of a commodity. A service is also performed in handling and distributing the many products bought and sold. The sale value of any commodity is composed, in part, of the value of market services performed in handling, storing and processing. These services are similar to those performed independent of the purchase and sale of commodities. The services performed in these two ways then, represent a homogeneous output of the firm. The dollar value used to measure these services is the gross margin derived from each activity carried on by the elevator. The average gross margin for the 34 elevators studied was $98,564.

The following table shows the average percentage of gross margin derived from each source of gross margin.

Table I. Percentage Each Source of Gross Margin is of the Total Gross Margin

	Merchandised Grain	Processed Grain	Fertilizer	Seed	Petroleum	Farm Supply	Service Inc.
Percentage	18.08	20.09	6.56	5.71	10.08	17.23	22.25

4/ Joel Dean, Managerial Economics, New York: Prentice Hall, Inc., pp. 119-120.

Table I indicates that grain operations are the primary sources of service revenue for these firms. The gross margin derived from merchandised grain, processed grain and other service associated with grain operations is 60.4 percent of the total gross margin. The proportion of gross margin obtained from these three sources is also a fairly constant percentage amongst the different firms. Only nine of the firms obtained less than 50 percent or more than 80 percent of their gross income from grain operations. In other words, 25 of the 34 firms studied derived from 50 to 80 percent of their total gross margin from grain operations.

Nature of the Production Function for the Elevator-Farm Supply Business. In the previous section commodities handled by the country elevator were classified into two primary categories. In the next few paragraphs a justification will be developed for measuring the output of an elevator-farm supply firm as a homogeneous set of market services.

The commodity inputs can be specified as:

(1) Z_1 = grain (2) Z_2 = sideline items

The total value of output when measured to include the value of both the commodity and market services is:

$$Q_1 = F\left[(Z_1), X_1, \ldots, X_n\right]$$

$$Q_2 = F'\left[(Z_2), X_1, \ldots, X_n\right]$$

The commodity inputs (Z_1 and Z_2) are identities with the physical outputs and X_1 to X_n are the inputs incorporated with the commodities in the marketing operation. The value change

between the commodity inputs and commodity outputs arises to the extent that non-commodity inputs (X_1, ...,X_n) add value through the incorporation of market services with the commodity. Since there is an identity between the commodity inputs and the output in both a physical and value sense, it appears irrelevant to include the commodities handled as a part of the output of a marketing firm such as the country elevator. If this premise is accepted, service is the real product of the elevator-farm supply business and the financial measure of this service is gross margin which includes the difference between the purchase and sale value of commodities handled, and direct charges for service performed without the purchase and sale of commodities. The value product for the elevator, then, could be stated as follows:

$$Y = \sum_{j=1}^{d} Z_j(P_{1j} - P_{2j}) + Q = F(X_1, X_2, X_3, X_4 | X_5,....,X_n) + U.$$

where Y = index of marketing services in dollars as measured by adjusted gross margin. Z_j = physical quantity of commodities purchased and sold. P_{1j} = price of a particular product sold, P_{2j} = price of a particular product purchased, j = 1 to d, and Q is service revenue obtained independent of the buying and selling of commodities. X_1 through X_4 are the amounts and/or values of each variable input used in obtaining gross margin, X_5,....,X_n are fixed, while U represents the variations in actual gross margin from the functional relationship. These variations are assumed to be randomly and normally distributed.

Gross margin is derived from many sources. These are aggregated into a single output category. Grain and sideline operations, as was the previous categorization of all the sources of gross margin, are complementary to each other for essentially the same reasons, that processed grain and merchandised grain are complementary to service operations, as well as to each other. Market complementarity stems from the relation between grain volume and the ability to provide a complete or "full" line of production items needed by farmers.

To use gross margin as the index of marketing services, it is necessary to make certain computations in order that the index will have the same meaning for all firms. This is necessary to obtain comparable interfirm comparisons of the value of market services performed. All firms must be placed on an equal basis in the sense that any differences in the absolute unit gross margins due to competitive relationships, location factors and managerial policy are eliminated. The computation of the index is illustrated in the next chapter.

In producing marketing services certain inputs are required. These are categorized as follows:

X_1 = Labor

X_2 = Inventory and accounts receivable

X_3 = Direct operating expenses

X_4 = Investment in machinery and equipment

$X_5, \ldots, X_n$ = Unstudied factors of productions which are held constant

Labor (X_1) is measured in man months of productive labor. This category includes all labor time except that devoted to management and bookkeeping tasks.

Inventory and accounts receivable (X_2) is the average monthly inventory, plus the average monthly accounts receivable. This is used as a measure of the liquid capital necessary to operate.

Direct operating expenses (X_3) are the expenses which vary with the volume of business done by the elevator. Such things as power, telephone expense, and hired trucking are included in this input category.

Investment in machinery and equipment (X_4) is the replacement value of machinery and equipment in the elevator. These values are engineering estimates obtained from Michigan Millers, the agency which insures the physical facilities of these firms.

($X_5,\ldots,X_n$) the effects of these factors on the dependent variable (Y) are fixed at a specific level.

Rules for Input Categorization. One of the major difficulties encountered in carrying out this study was categorizing the inputs in such a way as to gain a reasonable degree of independence between the input categories. The proportions of individual inputs within a category should be in least cost combinations to be meaningful from an economic standpoint.

Johnson[5] presents the following rules as guides to be used in categorizing inputs which have a meaningful relationship to value of output in analyzing farm businesses. These rules appear to be applicable in categorizing the inputs used by country elevators.

(1) One reasonable rule for grouping inputs into categories is to group good complements together and good substitutes together, measuring the complements in terms of "sets" and the substitutes in terms of the common denominator which makes them good substitutes.

(2) Sets of complements and sets of substitutes can be grouped into the same category very conveniently if the sets are complementary to, or substitutes for, each other.

(3) The converse of the above two rules follows: Input categories defined should be neither good substitutes nor good complements for each other.

Johnson[6] further states that the above rules have the following advantages: (1) the input categories so defined ordinarily turn out to be the categories which managers have recognized and named. (2) Managers ordinarily recognize substitutes and have a name for them which recognizes the common

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5/ Glenn L. Johnson, "Classification and Accounting Problems in Fitting Production Functions to Farm Record and Survey Data", Resource Productivity, Returns to Scale and Farm Size. Edited Earl O. Heady, Glenn L. Johnson and Lowell S. Hardin. pp. 90-91.

6/ Ibid., p. 91.

denominator. (3) Concentrates the analysis on the real problems faced by managers. The real input combination problems are not concerned with combining substitutes and complements, but, rather with combining categories of inputs which are neither perfect substitutes nor perfect complements to each other.

There are also certain accounting procedures that should be followed in grouping individual inputs into categories. It is necessary to put cash expenditures and investments in fixed facilities in separate input categories or the marginal value products will have little meaning as guides for obtaining optimum adjustment. MVP's for cash expenditures would be underestimated, and the MVP's for investments would be overestimated, if the two types of inputs were in the same category. This condition arises from the expected returns on different types of inputs.

Cash expenditures are made on items that are generally consumed within one period of production. Therefore, it is necessary that the product resulting from these expenditures have a value at least as great as the cost of the input. On the other hand, investment items are usually consumed over several periods of production, consequently, the return should be high enough to cover that portion of the asset used in one production period. Maintenance expenditures and depreciation should be eliminated from the input categories, then the marginal value product can be determined for the investment category

and equated against a marginal factor cost determined by the management. The marginal factor cost would include depreciation, insurance, repairs, taxes, interest, and perhaps a subjective cost for risk.

Theoretical Background. The theory guiding the empirical part of this study is the theory of static production economics. This body of theory is deduced from the law of diminishing returns under a set of static assumptions which state the conditions necessary to maximize profits. "The law of diminishing returns holds that (except in very special instances) the addition of a variable input to fixed inputs results first in total returns which increase at an increasing rate, second in total returns which increase at a decreasing rate, and third in total returns which decrease with increases in the variable inputs".2/

Optimum Combinations of the Factors of Production. In applying the economizing principles to the factors of production there are two questions of primary concern. They are: (1) optimum or most profitable combination of the factors to use and (2) the optimum amount of all factors to use.

The general equation or expression for a production relationship between total gross margin or the index of marketing services and the factors of production, labor, accounts receivable and inventory, direct operating expenses and capital

2/ Bradford & Johnson, Farm Management Analysis, p. 113.

investment, plus an indefinite number and amount of fixed factors would be:

$$Y = F(X_1, X_2, X_3, X_4 | X_5, \ldots, X_n).$$

This is a production function and may be thought of as a definite relation between gross margin (Y) and a set of input variables $(X_1,\ldots,X_n)$. The index of gross margin (Y) depends simultaneously upon the factors $(X_1,\ldots,X_4)$ in some definite way when the factors $(X_5,\ldots,X_n)$ are held constant.[8/]

In the operation of a country elevator the manager is primarily interested in maximizing profit. It follows from the law of diminishing returns, that profit will be increased as long as the marginal value product[9/] of any factor of production exceeds its marginal factor cost.[10/]

This concept is illustrated in the following profit equation with gross margin dependent upon direct operating expenses (X_3) and investment in machinery and equipment (X_4),

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8/ Ibid., p. 122.

9/ Marginal value product is the change in the value of the total product (gross margin) as a result of using an additional unit of input.

In terms of calculus:

$$MVP = Y \cdot \frac{\partial P_Y}{\partial X_i} + P_Y \cdot \frac{\partial Y}{\partial X_i}$$

Where: Y = Original output

P_Y = New price of Y

10/ Marginal factor cost is the change in the total cost as a result of using another unit of input.

In terms of calculus:

$$MFC = X_i \cdot \frac{\partial P_{X_i}}{\partial X_i} + P_{X_i} \cdot \frac{\partial X_i}{\partial X_i}$$

X_i = Original input

P_{X_i} = New price of X_i

with labor (X_1) and accounts receivable and inventory (X_2) held constant at an arbitrary level and with ($X_5,\ldots,X_n$) assumed fixed.

(1) $\pi = P_Y Y - P_{X_3} X_3 - P_{X_4} X_4 - C - F.C.$ [11/]

when differentiated with respect to X_3 and X_4.

(2) $\frac{\partial \pi}{\partial X_3} = MVP_{X_3(Y)} - MFC_{X_3}$

(3) $\frac{\partial \pi}{\partial X_4} - MVP_{X_4(Y)} - MFC_{X_4}$

The conditions for maximizing profit are met, by setting equations (2) and (3) equal to zero and solving them simultaneously. Interaction between the factors necessitates a simultaneous solution so that the profit maximizing conditions (1) what combination of X_3 and X_4 to use and (2) how much of X_3 and X_4 to use, are satisfied.

The Cobb-Douglas Production Function. The use of this function was originated by Cobb and Douglas in a study concerned with statistically testing the marginal productivity theory of distribution. The function was used to measure the effects of labor and capital on gross national product. The function in the power form was $P = bL^kC^{1-k}$. It was fitted by least squares regression and was linear in logarithms. The restriction that the sum of the regression coefficients be equal to one was imposed upon the function, thereby assuming

11/ C = the arbitrary amount of X_1 and X_2 used times their respective prices.

constant returns to scales.[12] It was later demonstrated by Durand, that the assumption of constant returns to scale could be statistically tested by the F test of variance.[13] Increasing returns to scale are present, if the sum of the coefficients or exponents is greater than one, decreasing returns if the sum is less than one and constant returns to scale when the sum is equal to one. Thus, the function never reaches a maximum and can not handle two or more production stages simultaneously. The function has constant elasticity throughout, which means that least cost combinations of two inputs will be in the same proportion at successive levels of output. Another disadvantage, as the function is used in this study, is that it must intersect the Y and X axis at Y = O. H. O. Carter has developed certain modifications which do away with these disadvantages.[14]

However, there are several advantages to this function which make it a useful tool for determining the marginal value products of input categories. In logarithms the function is linear and easily fitted to empirical data by the method of least squares. It takes the following form when fitted in

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12/ Charles W. Cobb and Paul H. Douglas, "A Theory of Production", American Economic Review, Supplement XVIII, pp. 139-165.

13/ David Durand, "Some Thoughts on Marginal Productivity with Special Reference to Professor Douglas' Analysis," Journal of Political Economics (XLV), pp. 740-758.

14/ H. O. Carter, "Modification of the Cobb-Douglas Function to Destroy Constant Elasticity and Symmetry", Resource Productivity Returns to Scale and Farm Size. Edited by Earl C. Heady, Glenn L. Johnson and Lowell S. Hardin. pp. 168-174.

logarithms:

$$\text{Log } Y = \log a + b_1 \log X_1 + - + b_n \log X_n.$$

When transforming into natural numbers it is necessary only to place the coefficients in the exponent position. It gives immediately elasticities of the product with respect to the factors of production and permits the phenomenon of decreasing marginal returns to come into evidence without using too many degrees of freedom. If errors in the data are small and normally distributed, a logarithmic transformation of the variables will perserve the normality to a substantial degree. Even if errors are not normally distributed and not independent the best linear estimates will still be provided by the method of least squares.15/

Applications of the Cobb-Douglas Technique. Considerable work has been done in fitting value productivity functions to cross sectional data of farm firms. In most of these studies the Cobb-Douglas function has been used in determining the marginal productivities of input and investment categories. One of the first studies of this type was that of Tintner and Brownlee who fitted a production function to farm record data.16/ Earl Heady used a random sample of Iowa farms in an analysis measuring the returns to the factors of production.17/

15/ Gerhard Tintner, "A Note on the Derivation of Production Function from Farm Records", Econometrica XII, No. 1, January, 1944, pp. 26-44.

16/ Tintner and Brownlee, "Production Functions Derived from Farm Records", Journal of Farm Economics, Vol. 26, 1944.

17/ Earl Heady, "Production Functions from a Random Sample of Iowa Farms", Journal of Farm Economics, Vol. 28, 1946.

In a series of progress reports at the University of Kentucky Johnson used a purposive sample in fitting value productivity functions to farm data.[18] In the more recent past several studies of this type have been done at Michigan State University. R. V. Wagley, in 1953, determined the marginal value productivities of input and investment categories on a purposive sample of Ingham County Michigan farms.[19] C. Beringer used a multi-equation model in determining the marginal productivities of input categories for 27 Illinois dairy-hog farms.[20]

While many empirical studies have been made to analyze the economic efficiency of resources on farm firms, only recently have the analytical techniques of production economics been employed to study resource use in agricultural marketing firms. Within the last year two studies have been completed at the Kansas Agricultural Experimental Station on the elevator industry in that state. The first of these studies is entitled, "Resource Returns and Productivity Coefficients in the Kansas Cooperative Grain Elevator Industry".[21]

18/ Glenn L. Johnson, "Sources of Income on Upland McCracken County Farms", 1951, Progress Report No. 2. Kentucky Agricultural Experimental Station.

19/ Robert V. Wagley, "Marginal Productivities of Investments and Expenditures, Selected Ingham County Farms, 1952". (Unpublished Master Thesis, 1953), Michigan State College, 1953.

20/ Christoph Beringer, "A Method of Estimating Marginal Value Productivities of Input and Investment Categories on Multiple Enterprise Farms", Unpublished Ph.D. Thesis, Michigan State College, 1955.

21/ Paul L. Kelley, Henry Tucker, and Milton L. Manuel, "Resource Returns and Productivity Coefficients in the Kansas Cooperative Grain Elevator Industry", Technical Bulletin 84, Agricultural Experimental Station, Kansas State College, October 1956.

The second study is entitled "Resource Returns and Productivity Coefficients in Central and Western Kansas Country Elevators of Modern Construction".[22/]

In the first study the Cobb-Douglas function was employed to estimate the productivity of resources used in 215 cooperative elevators in Kansas for the 1949 wheat crop year. The variables were classified as follows:

Y = Value of output in dollars

X_1= Labor services in dollars

X_2= Operating expense services in dollars

X_3= Capital services in dollars

The value of output (Y) is sales plus ending inventories less beginning inventories less purchases plus income from storage, grinding, commission and other miscellaneous income. Patronage refunds and recovery on accounts previously charged off were excluded. (X_1) labor services was defined as salaries of managers and office help, wages of plant workers, commissions paid, directors' fees and employees' pensions. (X_2) other operating expenses were defined as office supplies, plant supplies and other incidentals essential to elevator operations. (X_3) capital services included repairs, water, light and power, telephone and telegraph, gas and oil, depreciation, rent and railroad lease expense. Taxes on property, capital stock taxes, corporation taxes, insurance, interest, auditing expense,

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22/ Paul L. Kelly, John H. McCoy, Henry Tucker, and Virve T. Altan, "Resource Returns and Productivity Coefficients in Central and Western Kansas Country Elevators of Modern Construction, Agricultural Experimental Station, Kansas State College, March 1957.

licences and bonds, legal expense, bank service charges and bad debts were excluded from the function.[23/]

Functions were first fitted to data stratified by three risk areas of the state - Western, Central and Eastern Kansas. Secondly the data of the same firms were sorted by degrees of diversification to determine whether the more diversified plants were more productive in the use of various resources.

The results showed that in general labor had been optimally allocated among the area and diversification alternatives. Capital services were substantially more productive than labor services in this industry. Capital services, on an area basis, appeared to have been optimally allocated. However, on a diversification basis capital services in the medium stratum were more productive than in either low or high diversification groups. The analysis, in general, indicated that the firms studied exhibited constant returns to scale.[24/]

In the second study a sample of 22 elevators was drawn from a suspopulation of western and central Kansas elevators with licensed storage capacity of 95,000 or more bushels and of uniform type of construction. The subpopulation was stratified into four size groups. Elevators in each stratum were picked at random with proportion allocation. Data for the 1951 wheat crop year were collected by personal interview and from office records. Cobb-Douglas production functions

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23/ Kelley, Tucker, Manuel, op. cit., p. 46.

24/ Ibid., p. 40.

were fitted to sidelines, storage and grain merchandising operations as well as for total plant operation.[25] The classification of variables was essentially the same in both studies.

Estimated marginal productivities, measured at the geometric means of output and inputs, showed that efficiency could have been increased in sidelines and total plant operations by adding labor inputs relative to operating expenses and capital service inputs, and in storage by increasing operating expenses and capital services relative to labor. Tests of interfunction differences in marginal products indicated that transfers of resources between elevator activities would not have increased total economic efficiency. Constant returns to scale were indicated in grain merchandising and total plant functions. Increasing returns to scale were indicated in sidelines and storage activities.[26]

25/ Kelly, McCoy, Tucker, Altan, op. cit., p. 1.

26/ Ibid., p. 2.

CHAPTER III

FITTING THE FUNCTION

Computation of Index of Marketing Services. The data collected from 34 elevators was summarized to determine the gross income and the amount of each input or investment category used in obtaining gross margin. Gross margin was then converted to an index of marketing services by eliminating any differences in absolute unit gross margin that occurred between firms. A weighted average unit gross margin was computed for every commodity and item sold by the elevators. The actual unit gross margin times the quantity sold was calculated for each firm, this figure is the total gross margin obtained from that product. These figures were then summed and the total divided by the sum of the quantities sold, to obtain the weighted average unit gross margin. The weighted average unit gross margin was then remultiplied by each firm's quantity to get the index value of marketing service for that commodity or service. The individual index values were then summed to get an aggregate value for the index of marketing services. Lack of information on the number of bushels of grain handled and warehoused, necessitated the use of actual gross margin values for these services. This was not considered a serious error because of the small percentage of total marketing services that these items represented. An example may help to clarify the computation of the aggregate

value of the index of marketing services.

The following table shows the type of data obtained from the questionnaire that was answered by the managers of the firms studied. A check on the total gross margin computed from questionnaire data was made (not index of marketing services) for each firm by a comparison with the total gross margin[27] indicated in the operating statements. The comparison revealed that in certain incidences discrepancies did exist. These discrepancies were due to inaccurate answers to questions on returns obtained from merchandising grain. Since nearly all of the firms aggregate individual grain margins into a single account, it was impossible to determine in which grain or combination of grains the discrepancy had occurred. It was possible to determine however, that about 85 percent of the total error occurred in nine firms. The index of marketing services for these nine firms was adjusted by adding or subtracting the difference between questionnaire data and operating statement figures. Upon completion of this adjustment an aggregate discrepancy of only $14,056 or approximately .43 percent was not accounted for.

Statistical Results and Evaluation. The method used in fitting the Cobb-Douglas function was least squares multiple regression and correlation. The normal equations were solved to calculate the regression coefficients and their respective

27/ This is total gross margin adjusted to exclude non-operating income such as patronage dividends, rent revenue, etc.

Table 2. Example: Computation of the Index of Marketing Services*

	Corn				Feed				
Firm	(1) Quantity in Bushels	(2) Unit Gross Margin	(3) Total Gross Margin	(4) Index Value (1) x .06	(5) Quantity in Tons	(6) Unit Gross Margin	(7) Total Gross Margin	(8) Index Value (5) x $10	(9) Total Index Value
1	100	$.08	$ 8.00	$ 6.00	10	$10	$100	$100	106
2	200	.05	10.00	12.00	12	8	96	120	132
3	150	.06	9.00	9.00	8	13	104	80	89
	450		$27.00		30		$300		

*1. Columns (1) and (5) are the quantities of corn and feed handled by each firm.
2. Columns (2) and (6) are the unit gross margins that each firm obtains from corn and feed.
3. Column (3) is the quantity of corn handled (1) times the unit gross margin (2) and equals total gross margin from corn.
4. The sum of column (3) divided by the sum of column (1) equals the weighted average unit gross margin for corn.
5. Column (4) is the weighted average unit gross margin of corn times the quantity handled (1) by each firm.
6. Column (7) is the quantity of feed handled (5) times the unit gross margin (6) and equals to gross margin from feed.
7. The sum of column (7) divided by the sum of column (5) equals the weighted average unit gross margin for feed.
8. Column (8) is the weighted average unit gross margin of feed times the quantity handled (5) by each firm.
9. Column (9) is column (4) plus column (8) or the total index value.

standard errors were determined.[28/]

The regression coefficients and their respective standard errors were found to be:

Labor $b_1 = .387980 \pm .123377$

Inventory and Accounts Receivable $b_2 = .163434 \pm .083167$

Direct Operating Expenses $b_3 = .269722 \pm .090065$

Machinery and Equipment Investment $b_4 = .187699 \pm .090447$.

All the regression coefficients were positive and less than one. This indicates that additional increments of each input will increase gross margin, but that additional increments of any one input, with the other inputs fixed at a specific level, will increase gross margin at a decreasing rate.

The equation obtained for predicting gross income is as follows:

$$\text{Log } \hat{Y} = 1.339103 + .387980 \log X_1 + .163434 \log X_2 + .269722 \log X_3 + .187699 \log X_4.$$

The sum of the regression coefficients is 1.006835, indicating that there is slightly increasing returns to scale. However, the sum of the regression coefficients does not differ significantly from one. Therefore, it was not concluded that these firms had increasing returns to scale.

The coefficient of multiple determination (R^2) is .87. This means that 87 percent of the total variance in the logarithms of the dependent variable (gross income) is associated with the independent variables. To test the reliability of

28/ See "Computational Methods for Handling Systems of Simultaneous Equations" by Joan Friedman and Richard J. Foote, Agriculture Handbook No. 94, USDA, AMS, Nov. 1955.

the coefficient of determination, the F test of variance was employed.[29] The F value obtained from the test was 48.0619 or well beyond the upper .001 point, thus making $R^2_{Y \cdot X_{1,2,3,4}}$ clearly significant when tested against zero.

Thirteen percent of the variance in Y is not explained by the independent variables. It can be assumed that this difference is caused by such factors as management, quality of labor, competitive factors, percent utilization of capacity and possibly certain other unmeasured elements. The assumption used regarding the influence of variation in the unmeasured factors about their means on gross income is that they are randomly and normally distributed.

The logarithm of gross income at the geometric mean (G) was estimated to be 4.92259, the antilog of which is $83,674.00 dollars. The standard error of estimate ($\bar{S}$) was .048879. Under conditions of random sampling and given the same business conditions that existed in 1955, 32 percent of the time the logarithm of gross income would be expected to be greater or smaller than 4.92259 $\pm$ .048879. In dollar values the gross income in two out of three times, on the average, would be within the range of 74,767 to 93,642 dollars.

29/ Frederick E. Croxton and Dudley J. Cowden, Applied General Statistics, (New York; Prentice-Hall, Inc.) p. 733. The formula used in determining the F value was:

$$F = \frac{R^2_{1.234--m} \div (M-1)}{(1 - R^2_{1.234--m}) \div (N-m)}$$

Computation of the Marginal Value Products. The next step in evaluating the results of the regression and correlation analysis is to compute the marginal value product (MVP) for each input category for the "usual" or "typical"[30/] firm.

The following table gives the data required in computing the MVP.

Table 3. "Usual" Organization and Estimated Marginal Value Product of 34 Elevator Farm Supply Firms in Michigan, 1955.

Input Categories	Quantity of Input	Log of (G) Input	b_i	Log of b_i	Log of Gross Income	MVP*
Labor (X_1)	101.3	2.00581	.38798	9.58881-10	4.92259	$320.32
Inventory & Accounts Receivable(X_2)	$76,194	4.88192	.16343	9.21333-10		.179
Direct Operating Expense(X_3)	$13,305	4.12402	.26972	9.43091-10		1.696
Replacement Value of Machinery & Equipment(X_4)	$58,697	4.76862	.18770	9.27346-10		.268

* $MVP_{X_i} = \frac{b_i(E)Y}{X_i}$ = antilog of log b_i + log (E) Y - log X_i.

The regression coefficients (b_i) are used directly in computing the marginal value products. Therefore, it is necessary that the coefficients be reliable. One method of testing the significance of these coefficients is to test them against the null hypothesis of zero.

30/ The term "usual" or "typical" is used to mean the elevator farm supply firm having the geometric mean amounts of inputs used in the production of gross margin.

The regression coefficient (b_1) of labor (X_1) was significantly different from zero at the one percent level. The regression coefficient (b_2) of inventories and accounts receivable (X_2) was significantly different from zero at the 10 percent level. The regression coefficient (b_3) of direct operating expenses (X_3) was significantly different from zero at the one percent level and b_4 of total replacement value of machinery and equipment (X_4) was significantly different from zero at the five percent level.

An alternative method of testing the regression coefficients and one which seems more realistic in determining the optimum combination of inputs, is to test the b_i's determined by the regression analysis, against a minimum b_i which will yield an MVP_{x_i} equal to the MFC_{x_i}. This is computed by setting MVP_{x_i} equal to the MFC_{x_i} and fixing E(Y) and X_i at their respective geometric mean values and solving for the minimum b_{x_i} algebraically.

Labor (X_1) was priced by dividing the mean value of the cost of labor by the mean amount of labor.[31/] Inventory and accounts receivable (X_2) was priced at several different levels. The reason for doing this was that the cost of carrying these two items in an elevator varies considerably. The cost of carrying inventories includes interest, depreciation, losses, taxes, and risk. The elevator industry generally considers 12 percent per annum as the total cost of carrying an inventory.

31/ Labor is measured in man-months, which is one man's labor for a month.

The cost of accounts receivable as determined by Dunn and Bradstreet[32] for country elevators varies from 6 to 24 percent. The major difference between the cost of inventory and accounts receivable is bad debt loss. The cost of direct operating expenses (X_3) is equal to actual outlays. The cost of machinery and equipment was computed at three different levels. One level was computed at a depreciation rate, a higher level for depreciation and repairs. A still higher level was computed to provide for depreciation, repairs and the normal return that it probably would take to induce businessmen to invest money in new machinery and equipment.

The following prices were used in determining minimum b_i values.

Labor	$311.50 per month
Inventory and accounts receivable	$ .05
	.09
	.12
	.18
Direct operating expenses	$ 1.00
Machinery and equipment	$ .10
	.15
	.20

The following table indicates the minimum b_i values. The difference between the b_i^* and the estimated b_i is then measured in terms of the standard error of the estimated b_i.

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[32]

Table 4. Comparison Between the Estimated b_i and the b_i^* Necessary to Equate MVP_{x_i} and MFC_{x_i} for the 34 Elevator-Farm Supply Firms Studied in Michigan.

Input or Investment Category	"Usual" Organi-zation	M.F.C.	Estimated b_i	$6b_i$	b_i^* Necessary to Return Min. MVP	$b_i - b_i^*$	$\frac{b_i - b_i^*}{6b_i}$	Area Under Normal Curve
Labor (Man months)	101.3	311.50	.38798	.12338	.37955	.00843	.06832	.054
Inventory & Accts. Rec. (Dollars)	76,194	.05	.16343	.08317	.04580	.11763	1.41443	.843
		.09			.08244	.08099	.97387	.670
		.12			.10990	.05353	.64369	.480
		.18			.16490	-.00147	-.01763	.014
Direct Operating Expt. (Dollars)	13,305	1.00	.26972	.09006	.16000	.10972	1.21825	.777
Machinery & Equip. (Dollars)	58,697	.10	.18770	.09045	.07057	.11713	1.29500	.805
		.15			.10590	.08180	.90438	.634
		.20			.14110	.04660	.51520	.394

This in turn indicates the probability of the b_i occurring, if the estimated b_i^* is the true population regression coefficient.

The standard error of the regression coefficients is determined by the range of the data, size of sample and the inter-correlation occurring between variables. Relatively high inter-correlation between variables reduced the reliability of the coefficients. Such influences are reflected in the standard errors of the b's and, hence; in the reliability of the marginal value products. Relatively high inter-correlations between two variables may cause an overestimation of one of the b's and an underestimation of the other b. In an attempt to reduce inter-correlation, the rules outlined in the previous chapter for input categorization were followed. The sample was also selected in such a manner as to give substantial range to the proportions of inputs used.

Even through these precautions were taken, it can be seen from the following sample correlations that considerable inter-correlation was exhibited between certain sets of the variables.

$r_{12} = .78135$ $\quad r_{23} = .57798$ $\quad r_{34} = .49220$

$r_{13} = .76459$ $\quad r_{24} = .63096$

$r_{14} = .64308$

Observation of the above values indicates that x_1 and x_2, and x_1 and x_3 show the highest degree of correlation. However, the rest of the variables exhibited a substantially smaller

degree of correlation. In either set of the variables indicating a higher degree of correlation the estimated b's could be higher or lower than the true regression coefficients. If bias exists in the regression coefficients it would be reflected in the marginal value products.

The only regression coefficient which yielded an MVP below the minimum return was the accounts receivable and inventory input category. This occurred when the category was priced at a reservation price of 18 percent; however, the regression coefficient was within the 68 percent confidence interval.

On the basis of outside information and experience the returns to labor and direct operating expenses did not differ too much from expectations. Generally in these businesses an excess amount of labor is used relative to the utilization of machinery and equipment. Therefore, the returns to labor are barely enough to cover the cost of labor, while the returns to direct operating expenses are relatively high. The most logical adjustment by which to increase gross margin is to increase the proportion of direct operating expenses relative to the amount of labor used.

It is extremely difficult to determine the returns on inventory and accounts receivable without an empirical analysis. The interrelated factors of composition, level and rate of turnover make it difficult to evaluate inventory. Accounts receivable are also difficult to evaluate because of the many types of credit policies which prevail in the feed and grain industry.

The returns to machinery and equipment are generally considered low because of the excess capacity needed to handle harvest runs and seasonal livestock feeding peaks. However, the marginal value product calculated in the empirical portion of this study indicates that an increase in the proportion of machinery and equipment investment relative to other inputs may increase total gross margin.

From the results of the above analyses it appears that the usual organization of the Michigan elevators is not in serious maladjustment except for direct operating expenses. The regression coefficient of direct operating expenses is significantly higher (at the 75 percent level) than the b_i^* necessary to return a minimum MVP, indicating that more of this input can be used.

An adjustment in machinery and equipment investment may increase the returns of the typically organized elevator although the case for this type of an adjustment with a reservation price of 20 percent is not strong. The high returns to direct operating expenses indicates that these plants are operating at something less than full capacity. It would then appear that if these firms desired to increase gross margin, efforts should first be made to expand output in existing facilities.

Ratio Comparisons. An alternative method of analyzing the returns of these firms is to make certain ratio comparisons with the aggregate results of the functional analysis. The

mean estimated gross margin (G) as determined by the functional analysis was $83,674. The total operating expenses including depreciation, measured at the geometric mean is $76,823. By subtracting total operating expenses from gross margin, the net operating profit is $6,851.

When this value is compared to net fixed assets, we have a significant measure of the earning power of present investment in plant facilities. The average net fixed assets of the 34 elevators studied in this survey was $69,502. Net operating margin as a percentage of net fixed assets is 9.857 percent. Another meaningful financial measure is the return on the replacement value of buildings, machinery and equipment. This measure is a useful indication of the ability of these firms to rebuild and modernize their physical plants. The replacement values of buildings, machinery and equipment used are appraisals that Michigan Millers Mutual Insurance Company use as a basis for insuring these firms. Replacement values for trucking equipment were taken directly from balance sheet data on total investment in trucking equipment. It was necessary to use this data because inadequate information on numbers and types of trucking equipment made it impossible to compute the cost of new trucking equipment.

It is necessary to make certain qualifying assumptions, when ratio comparisons are made with replacement values. These assumptions are:

1. Rates of depreciation will remain constant though the total depreciation charge may change.
2. Property taxes will remain constant.
3. All operating expenses exclusive of depreciation will remain constant.
4. Dollar volume of business will remain constant.

It is necessary to adjust total operating expenses by the increase in depreciation, which will result from using replacement values. The average total replacement value of buildings, machinery and equipment is $143,197 for the 34 elevators. This amount plus $10,746, the average investment in trucking equipment, gives a total average replacement value of $153,943 for all fixed assets. The depreciation rate applied to the investment in buildings, machinery and equipment is 5.7313 percent. The rate applied to trucking equipment investment is 20.1586 percent.[33/] The adjusted total depreciation is $10,373.00, hence total operating expenses increased from $76,823 to $79,638. When adjusted total operating expenses are subtracted from the gross margin derived from the functional analysis, the adjusted net operating margin is $4,036.

The average investment over a period of years would be approximately one-half of the replacement value of fixed assets, or $76,971.50. Net profit divided by the average investment

33/ These rates are computed on the basis of 24 elevators, inadequacies in balance sheet data made it impossible to compute an average rate based on all of the 34 elevators surveyed.

over a period of years gives a measure of the net return on investment in plant facilities. This percentage is 5.24. To get an indication of the total returns to investment in fixed assets, it is necessary to add depreciation to net returns. The total return on average investment over a period of years would be 18.72 percent, when fixed facilities are priced at replacement values. Experience indicates that a return of 15-20 percent on the average investment in fixed facilities is reasonable in the operation of elevator-farm supply firms. The above return of 18.72 percent is probably enough for the average firm to replace its present facilities, but it is unlikely that this is a high enough return to carry out any extensive expansion program.

Short-Run Adjustment. The ultimate purpose of this study was to provide reference points to make judgments on alternative economic organizations of elevators and to serve as guides in reorganizing these firms. The estimated regression coefficients were believed reliable enough, to warrant their use in estimating gross margin and marginal value products for different combinations of inputs.

As a preliminary to a suggested reorganization, consideration is first given to the effect on gross margin and the marginal value products of increasing the input which has the highest rate of return. A reorganization based on this criteria will be referred to as a short-run adjustment.

The input having the highest rate of return is direct operating expenses. Direct operating expenses have previously been defined as those expenses which vary with the volume of business done by the firm. Greater amounts of this input result in increased utilization of plant capacity.

Experience indicates that one of the major economic problems in country elevators is excess capacity. Capacity is defined as the bushels of grain or tons of feed, that a feed and grain elevator can handle in a given period of time. Due to the seasonal nature of grain and bean harvests and the resulting necessity of handling these commodities in a short period of time, it is necessary to maintain unused capacity during certain parts of the year. This also is true to a lesser degree on feed processing facilities.

The average plant studied in this survey utilized only 9.32 percent of its grain capacity and 48.95 percent of its feed handling capacity.[34/] While these are only rough estimates, they do give an indication of capacity used.

When direct operating expenses are increased from $13,305 to $27,250, a better than two fold increase is obtained in the utilization of plant facilities. These results apply only if the commodity mix is not changed from the average values

34/ Percent utilization of grain facilities is based on rated grain handling capacity for a 101 day period at eight hours per day. It was believed that the normal grain handling period is approximately four months in length.
Percent utilization of feed facilities is based on rated feed handling capacity for a 305 day period at eight hours per day. Some feed business is done nearly every day of the year, however, there are seasonal fluctuations.

included in the sample. The following table shows the effects on the marginal value products when the above mentioned increase in direct operating expenses is made and other inputs are used in the "usual" amounts.

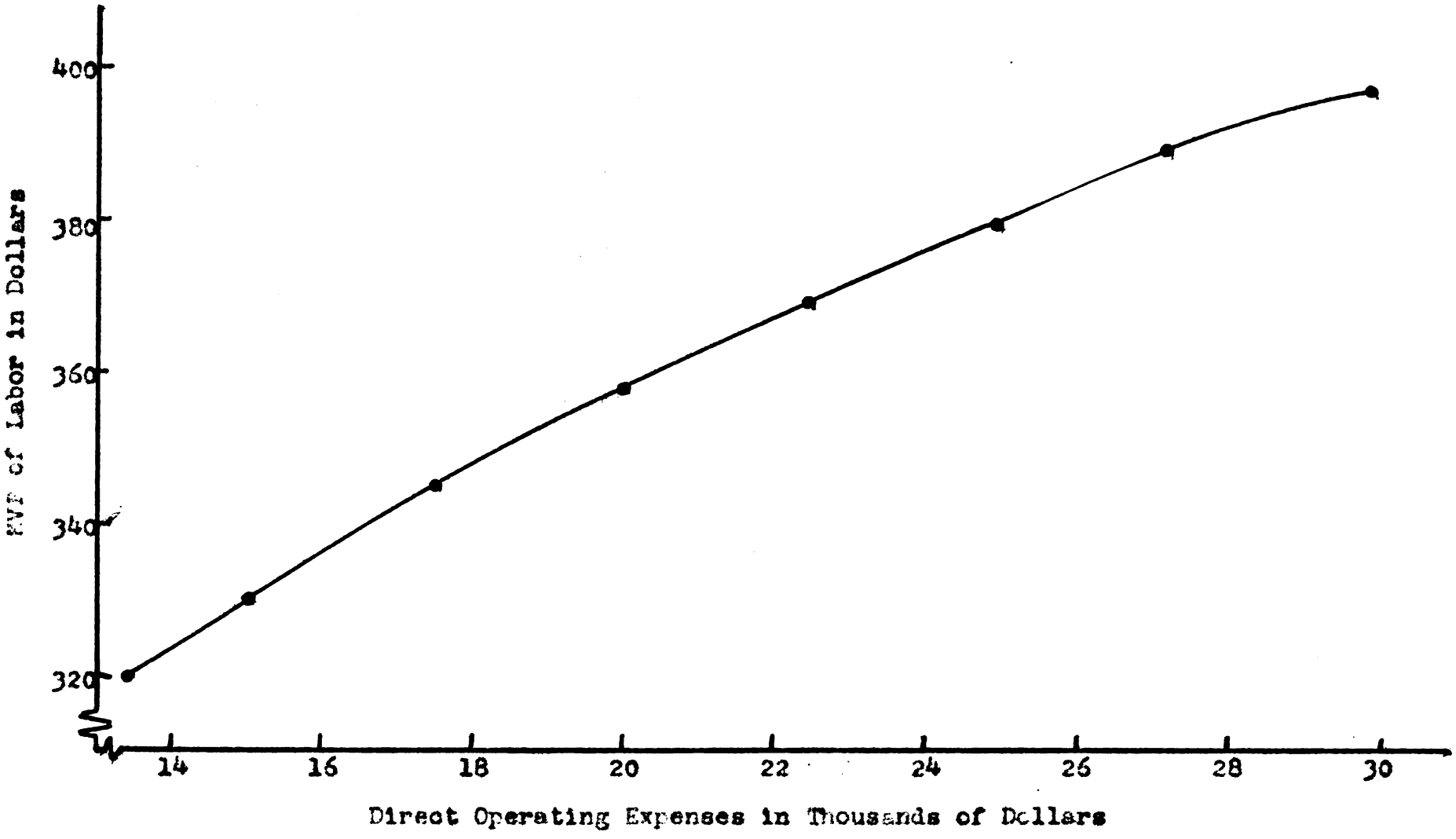
Table 5. Changes in MVP's for the "Typical" Organization Resulting from Increasing Directing Operating Expenses from $13,305 to $27,250.

Input Category	Quantity of Inputs	Original M.V.P. (Dollars)	New M.V.P. (Dollars)
Labor in Man months (X_1)	101.3	320.32	388.64
Inventory and Accounts Receivable (X_2)	$76,194	.179	.217
Direct Operating Expenses (X_3)	$27,250	1.696	1.004
Investment in Machinery and Equipment (X_4)	$58,697	.267	.324

The estimated gross margin increased from $83,674 to $101,517 as a result of increasing the amount of direct operating expenses (X_3) to the point where the $MVPx_3 = MFCx_3$. This causes the MVP's of the three other factors of production to increase substantially. Figure 1 illustrates the change in the MVP of labor when the "usual" amounts of all inputs except direct operating expenses are used in deriving gross margin. The MVP of the marginal unit of labor increased from $320.32 to $388.64.

It would seem that the next question to be answered is the effect on net operating profit as a result of the short-run adjustment. It should be recognized that profit is the

Figure 1. Effects on the MVP of Labor for the "Typical" Organization Resulting from Increasing Direct Operating Expenses from $13,305 to $27,250



consequence of using all the factors of production. However, the elevator operator is most concerned about the absolute magnitude of net operating profit and the rate of return it represents on investment in fixed assets. Estimated net operating profit increased from $6,851 to $10,749 with the above short-run adjustment. In estimating the net profit after the short-run adjustment was made, the increase in direct operating expenses was added to the geometric mean of total operating expenses. This total was then substracted from the estimated gross margin derived from making the adjustment. The rate of return on net fixed assets increases from 9.86 to 15.46 percent or an increase of 56.95 percent.

Long-Run Adjustment. Another suggested reorganization is a long-run adjustment when two or more variables are changed simultaneously. The high rate of return on direct operating expenses and investment in machinery and equipment, indicates that increase in amount expended on these two factors of production, could enhance the gross margin of country elevators.

In determining an organization which would be nearer optimum adjustment, several trial combinations of different amounts of X_3 and X_4 were made, while X_1 and X_2 were used in the "usual" amounts. The amounts of X_3 and X_4 used in the trial combinations were determined by an "expansion" line obtained by proportionate increases in X_3 and X_4. The line is a path which represents successive points of tangency between iso-value product curves and iso-cost curves. It is partly

determined by the nature of the production function and partly by the relative prices of the two inputs. It should further be remembered that the expansion line indicates the most profitable proportions in which to combine direct operating expenses and investment in machinery and equipment, to derive various levels of gross margin. The following figure shows the expansion line (C.P) with direct operating expenses priced at one dollar per unit and machinery and equipment investment included at a reservation return of 20 percent.

A 100,000 dollar iso-value product curve has been superimposed upon the expansion line. The iso-cost line which is tangent to the iso-value product curve at point (A) represents an annual cost of $36,700.

The investment in machinery and the equipment is $75,000. The annual cost of X_3 is $21,700 while the annual cost of X_4 is $15,000.

As can be seen from the point of tangency between the iso-value product curve and the iso-cost line the selected points representing different amounts of X_3 and X_4 are also points of optimum combination. The following MVP's of X_3 and X_4 at the trial points 1, 2, 3, and 4, show the effects of the law of diminishing returns, when part of the measured inputs, (X_1 and X_2) are fixed at a specific level.

Table 6. Changes in the MVP of X_3 and X_4 as a Result of Increasing the Expenditures on Direct Operating Expenses and Machinery and Equipment Investment.

Trial	Estimated Gross Margin	MVP Direct Operating-Expenses	MVP Machinery & Equipment
1	90,110	1.41	.28
2	111,392	1.09	.22
3	116,722	1.03	.21
4	119,025	1.01	.20

After exploring the effects of increasing the amount of X_3 and X_4 used, as dictated by the expansion line, a proposed reorganization was developed. The proposed organization was to use labor (X_1) and accounts receivable and inventory (X_2) in the "usual" amounts, while direct operating expenses (X_3) and machinery and equipment investment (X_4) were increased to the point where the MVP's of X_3 and X_4 were approximately equal to their respective MFC's.

The estimated gross margin of the proposed reorganization is $119,025. The resulting MVP's are shown in the following table, (7).

While the marginal factor cost of all the input categories are not equated with the minimum marginal value products, it is evident that the proposed reorganization is nearer optimum adjustment than the "typical" organization. The reorganized firm does not have the MVP of all inputs equated with their respective MFC's. No attempt is made to equate these

Figure 2. Trial Combinations of Direct Operating Expenses (X_3) and Machinery and Equipment Investment (X_4)

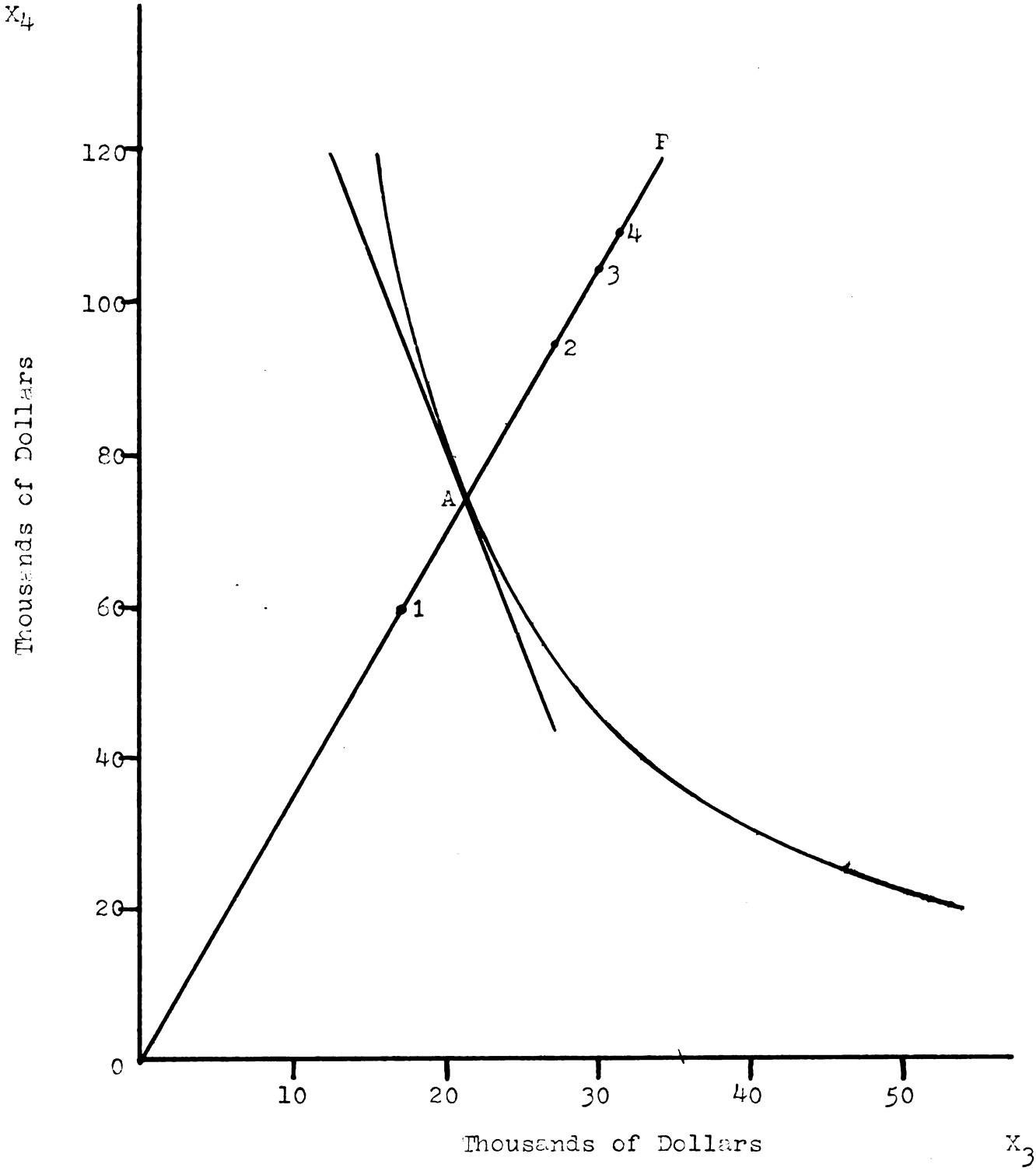


Table 7. Changes in MVP's for the "Typical" Organization Resulting from Increases in Direct Operating Expenses and Investment in Machinery and Equipment.

Input or Investment Category	Quantity Used	Original MVP	New MVP
Labor (X_1)	101.3	320.32	455.66
Inventory and Accounts Receivable(X_2)	76,194	.179	.255
Direct Operating Expenses (X_3)	31,750	1.696	1.011
Investment in Machinery and Equipment (X_4)	110,000	.267	.203

values for all factors because increasing returns to scale prevents attaining the high profit point. Further, on the basis of experience and judgment it is believed that the other two inputs should not be increased. With reference to labor it was believed that having more qualified employees was a more appropriate goal than increased amounts of labor. Therefore, it was concluded that labor inputs should not be increased in attempting to increase gross margin.

Due to the complications involved in evaluating the accounts receivable and inventory category, it was believed that this input category should not be increased. Most of these complications arise because the three interrelated factors of level, composition, and rate of turnover make it difficult to evaluate inventory adequately. In order to provide the surrounding farming community with the required items it is necessary for elevator-farm supply firms to maintain a certain level and

composition of inventory. Certain items such as feed, fertilizer and hardware normally turnover several times every year. On the other hand, a wheat or bean inventory may be stored for a considerable period of time. Due to inadequate measuring devices for handling all these factors, it is impossible to make accurate measurements.

Effects on Net Profit and Operating Capital of Increasing Direct Operating Expenses and Investment in Machinery and Equipment. It should again be emphasized that profit is a residual value derived from using all the factors of production. As a result of increasing the amount of direct operating expenses and machinery and equipment investment, net operating profit was increased substantially over the net operating profit derived from the typically organized elevator-farm supply firm. However, profit was not as great as it was when the short-run adjustment was made. This was due to the increase in depreciation, which resulted from the increased investment that was incurred in the long-run adjustment. The procedure in estimating the net operating profit was the same as was used in estimating net operating profit for the short-run adjustment. The same rates of depreciation[35/] were applied to the estimated investment in building machinery and equipment and trucking equipment, as was used in the

35/ 5.7313 percent on investment in building, machinery and equipment. 20.1586 percent on investment in trucking equipment.

short-run adjustment on the returns to replacement values.[36]

The increase in depreciation plus the increase in direct operating expenses was added to total operating expenses calculated at the geometric mean. This total was then subtracted

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36/ With investment in machinery and equipment being only a part of the total investment in the physical facilities, it is necessary to estimate what the total investment in all plant facilities will be if the investment in machinery and equipment is expanded. To estimate what the total investment will be, a correlation and regression analysis was computed to determine the degree of relationship that existed between machinery and equipment investment, and total investment in all facilities. Total investment in all facilities priced at replacement value represented the dependent variable and investment in machinery and equipment priced at replacement.

$R = .919008$
$R^2 = .8445757$
$S = .105659$
$\sigma_r = .080474$
$\sigma_b = .097757$
$T_b = 12.361762$

The predicting equation was:
$\log \hat{Y} = - .588544 + 1.208447 \log X_4$.
$\hat{Y}$ = estimated total investment.
X_4 = investment in machinery and equipment priced at replacement value.

The results indicated a significant relationship existed between total investment in all plant facilities and investment in machinery and equipment. Therefore, the predicting equation was believed reliable enough to be employed in determining what total investment in all physical facilities would be, if machinery and equipment was set at a specific level.

The specific level at which investment in machinery and equipment should be set, is theoretically determined by increasing the amount of this input used, to the point where the $MVP_{X4} = MFC_{X4}$. The theoretical termination point for increases in direct operating expenses would also be where the $MVP_{X_3} = MFC_{X_3}$.

from the estimated gross margin derived from the long-run adjustment. The estimated gross margin from increasing direct operating expenses to $31,750 and machinery and equipment to $110,000, was $119,025. The estimated total operating expenses are $109,201 which when subtracted from estimated gross margin leaves an estimated net operating profit of $9,824.

Net operating profit as a percentage of average investment in fixed assets, priced at replacement values, over a period of years is 6.1703 percent. Estimated total investment priced at replacement value was $318,943, which would make the average investment over a period of years equal to approximately one-half of this, or $159,471.50. To get an indication of the total returns to the investment in fixed assets, net operating profit plus depreciation were taken as a percentage of the average investment in fixed assets. This was 19.64 percent.

The net operating profit is not as great with the long-run adjustment as with the short-run adjustment where in the latter case total depreciation is based on the present investment in facilities. However, when replacements values are used in pricing facilities in all situations a comparison of the accumulation of liquid capital can be made. The importance of the concept of liquid capital accumulation lies in the fact that the rate of accumulation relative to total investment determines the firm's ability to maintain and modernize its

physical plant and provide a return on investment.

The following table shows the absolute amount and rate of liquid capital accumulation, when facilities are priced at replacement values.

Table 8. Accumulation of Liquid Capital when Facilities are Priced at Replacement Values.

	Geometric Mean	Short-Run	Long-Run
Net Profit	$ 4,036	$ 7,934	$ 9,824
Depreciation*	10,373	10,373	21,492
Total Returns	14,409	18,307	31,316
Total Replacement Value	153,943	153,943	318,943
Average Investment over Period of Years	76,971	76,971	159,471
Accumulation rate on Investment over a Period of Years	18.72	23.78	19.64

* Rates of depreciation: 5.73 on buildings, machinery and equipment
20.16 on trucking equipment

It is seen from the above table that the greatest absolute amount of accumulation occurs in the long-run situation. However, the rate of accumulation is highest in the short-run situation. This further substantiates the case for increasing the utilization of existing facilities rather than constructing new facilities.

CHAPTER IV

ANALYSIS OF RESIDUALS

Several of the firms analyzed had an index of marketing services which deviated a considerable amount from the value estimated by the function fitted to the data. Explanation of these deviations requires an individual analysis of each firm. To determine which firms should be analyzed the standard deviation of the logarithm residuals was computed. The standard deviation was determined to be ± .0786. There were five firms which had a positive residual greater than this value and five firms which had a negative value larger than - .0786. It was believed that an empirical analysis could be based on averages of the groups and that further explanation of the individual firms which deviated radically from the average of the groups would be given.

Product mix, utilization of capacity, competition, volume handled, and quality of inputs are the five major factors assumed to be affecting the degree to which a given firm deviates from the function fitted to the data from the 34 elevators studied.

The quality of inputs used is related to the caliber of management operating an elevator. It is impossible to measure these factors related to management directly, but it is possible to develop indirect measures of their effects on gross margins. The two prime examples are the quality of personnel and the quality of machinery and equipment employed.

Probably more of the personnel employed in a country elevator perform management tasks than in most other businesses, because much of the work to be done is of a non-routine nature. It is desirable for key employees in the feed grinding and mixing department to have considerable knowledge of feed concentrates and supplements so that they can aid farmers in the development of balance feed rations. The key employee in the grain department should be able to determine the grade of a specific lot of a grain so that the manager of the elevator and farmers are able to conclude a mutually satisfactory transaction.

The productivity of labor is closely related to the quality of machinery and equipment in an elevator. A firm that has relatively modern machinery and equipment which is synchronized will probably obtain more business relative to its competitors. Plant layout will enhance the productivity of labor in two ways: (1) it enables the employees to handle a greater physical volume of production in a given time period, and (2) decreases the change over time required for each customer.

The first factor examined was the product mix or the sources of gross margin for the firms in the positive and negative residual groups. These figures were compared to each other and to the average for the 34 elevators studied (Table 9). Substantial differences existed in four sources of gross margin.

Table 9. Comparison of the Sources of Gross Margin.

	Merchandised Grain	Processed Grain	Farm Supply	Service Income
Ave. 34 firms	18.07	20.09	17.24	22.25
Ave. 5 positive residual	20.22	19.58	12.35	28.00
Ave. 5 negative residual	14.48	32.63	17.05	21.45

The five firms with large positive residuals, obtained a greater percentage of total gross margin from merchandised grain and service income relative to the average for the 34 firms and to the average of the five firms with negative residuals. The five firms with the large negative residuals obtained a greater percentage of total gross margin from processed grain and farm supply relative to the group with large positive residuals. The negative group also obtained a greater percentage of total gross margin from processed grain and farm supply relative to the group with large positive residuals. The negative group also obtained a larger percentage of total margin from processed grain than the average for all firms and obtained about the same percentage from farm supply. In themselves these figures do not mean too much, but when they are related to the percent utilization of grain capacity and feed capacity they give an indication of the reasons for the direction of the residuals (Table 10).

Table 10. Comparison of Capacity Utilization.

	Percent Grain Capacity Used	Percent Feed Capacity Used
Ave. 34 firms	26.81	52.85
Ave. 5 positive residuals	41.31	67.53
Ave. 5 negative residuals	19.00	52.97

This table shows that the five firms with positive residuals utilized 22.31 percentage points more of their grain capacity and 14.56 percentage points more of their feed capacity than the five firms with negative residuals. These five firms on the average also utilized a higher percentage of grain and feed capacity than the average of all firms. One firm in this group utilized an exceptionally low percentage of its grain capacity; the reason for the large positive residual is partially due to the high percentage of gross margin derived from petroleum products, which is a high mark-up product. In general, the basis for partial explanation of the large positive residual is indicated by the high percent of total gross margin from merchandised grain in coordination with greater utilization of grain facilities. The inverse relationship is also a partial explanation of the large negative residual. The group with negative residuals, derived a larger percentage of gross margin from processed grain but had lower utilization of feed processing capacity than the group with positive residuals. This implies that these firms were not doing a large enough volume in the product which was the largest source of gross margin. However, it could also indicate that the firms with negative residuals were not doing enough total business relative to those firms with positive residuals or to the average of all firms.

In an attempt to see if those firms with negative residual were not doing enough total business, actual gross margin (Y_a), index of marketing services (Y_c), and estimated index

of marketing services ($\hat{Y}$) are compared in Table 11. These comparisons indicate the relationship between the price of market services and the total volume of business done by these firms. Price competition and volume handled are highly interrelated because both greatly affect the magnitude of total gross margin. This means that the management of a country elevator must have some idea of the elasticity of demand for its services. If demand is relatively inelastic, total gross margin will be decreased if price is reduced.[37] If demand is relatively elastic a decrease in price will increase total gross margin. While the exact demand schedules for the services sold are not know, it still is possible to use the concepts involved to develop a better understanding of the direction and magnitude of the deviations for the productivity function.

The average $\hat{Y}$ for the group with negative residuals was $1,450 under the average $\hat{Y}$ for those firms with positive residuals. This indicates that the amount of inputs used by these firms was not radically different from the group with positive residuals. Therefore, it appears that partial explanation of the residual is related to the price-volume relationships confronting these elevators.

The index of marketing services (Y_c) was computed to eliminate differences in unit gross margin and for all practical purposes eliminate the effects of price competition

37/ Actually unit gross margin is reduced and the selling price is cut by the amount of this reduction.

Table 11. Comparison of Y_a, Y_c, and $\hat{Y}$

	Y_a	Y_c	$Y_a - Y_c$	$\hat{Y}$	$Y_c - \hat{Y}$
Ave. 34 firms	96,956	96,543	+ 413*	94,959	+ 1,584**
Ave. 5 positive Res.	99,543	103,937	- 4,394	75,312	+28,625
Ave. 5 negative Res.	69,560	58,202	+11,398	73,312	-15,660

* This difference is due to the 14,056 dollar aggregate positive error between Y_a and

** This difference is due to a positive bias created by converting the logarithm estimates into natural numbers.

between these firms. Stiff price competition, relative to the average firm studied, is indicated when Y_c is subtracted from Y_a and the resulting difference is negative. The inverse is true when the difference is positive. The inverse relationship between $Y_a - Y_c$ and $Y_c - \hat{Y}$ is an important indication of the elasticity of demand for the services offered by a country elevator. The difference between Y_a and Y_c shows what change will occur in total gross margin when price differences occur between firms, while the difference between Y_c and $\hat{Y}$ is an indication of the volume differences on total gross margin. Based on the functional relationship developed for the 34 firms analyzed a negative difference Y_c and $\hat{Y}$ would indicate a deficiency in the physical volume handled by the firm in question for the amount of inputs used.

A comparison of the difference between Y_a and Y_c for each of the groups points out very conclusively that this is the situation, because Y_c eliminates price differences (in the sense of unit gross margins), thus a true picture of the

physical volume differences is shown. Comparisons of the average Y_c for the two groups shows that the firms with positive residuals have an average of $45,000 more gross margin, than the firms with negative residuals. Comparisons of the Y_a between the two groups shows that the difference is only $30,000. Roughly $11,000 of this $15,000 change occurred in the group with negative residuals, which indicates that these firms are attempting to maintain total gross margin by increasing unit gross margins, rather than striving to increase physical volume. This further indicates that demand for a given elevator's services is relatively elastic, hence the total gross margin will increase when unit gross margins are decreased.

One firm in the group with positive residuals had a positive difference between Y_a and Y_c, however, this same firm had a large positive difference between Y_c and $\hat{Y}$, which in turn offset all the positive difference between Y_a and Y_c and leaves a substantial positive difference between Y_c and $\hat{Y}$. This firm is in an extremely advantageous competitive position, because it is simultaneously able to take a wider margin on services sold and have a large physical volume of business. This same firm utilized 62.21 percent of its grain capacity and 97.11 percent of its feed capacity.

All firms in the group with negative residuals had negative differences between Y_a and Y_c. This indicates that these firms have a lesser degree of competition than the average for all firms studied. This could result from localized

gentleman's agreements or the actual lack of effective competition in the area. In light of the large positive residuals for those firms which operate with lower margins it would appear that these firms are in error by not cutting unit gross margins. Greater volume rather than high margins appears to be the more appropriate objective if management desires to increase the profitability of the organization.

A Further Comment on the Operating Framework of the Michigan Country Elevator. There are many factors, other than those empirically analyzed in this study, which affect the profitability of a country elevator. While there was no apparent relationship with the residuals computed in the previous section, it was believed that a description of these factors could help to explain the business operating framework of the country elevator. Credit availability, pricing policies, competitive practices of competitors, how these practices are met, advertising and promotional schemes are all factors which affect the gross margin of these firms.

When the managers of these firms were asked under what conditions they needed operating capital in the last two or three years, 20 of the 34 managers indicated a need for capital to meet seasonal demand. Six managers said that there was no need for seasonal operating capital and eight did not reply to the question or said that there was a need for long-term investment capital. Ten managers said that short-term capital for meeting seasonal demand would have increased gross margin.

The reason given most often for the need of short-term capital was to take advantage of pre-season discounts on fertilizer and other farm supplies. Only one manager indicated short-term capital would be used for financing grain purchases. When check against a question which asked if the managers held grain for higher prices only five indicated that they had followed this practice.

Seven managers said that capital for investment in facilities was needed, five of these same managers had also indicated a need for short-term capital. The answers to this question were not consistent with a later question which asked what new products and services should be added. Thirty of the thirty-four managers indicated that new lines could profitably be added to the firm's present lines. The following are the types of new lines that the managers said were needed: (1) bulk feed and fertilizer delivery equipment (2) feed and molasses mixing equipment, (3) grain handling and storaging facilities. It is apparent from the above list that the new lines would require intermediate or long-term capital. Many managers indicated that having the above facilities would put them on a more equal basis with their competitors.

Practices employed by competitors which were most troublesome to the managers interviewed may be summarized into four major classifications: (1) price cutting, (2) not discounting sufficiently on damaged or wet grain, (3) cutting trucking

charges, and (4) liberal credit terms.

The managers said they met these practices by providing better services, high quality products and the advantages of a cooperative in some cases. A somewhat more complacent answer was that they "tried to do the best possible under the circumstances".

Pricing policies also depend upon the competitive structure facing the individual firm, however, products which can be differentiated will be priced by different methods than those products which cannot be differentiated in the farmers' mind. The following table shows a summary of pricing methods for certain items sold by country elevators. The sum of each column does not equal 34 because more than one method of pricing a given commodity was employed by part of the firms studied.

Table 12. Method of Pricing, Number of Firms and Percentage Using Each Method.

Method of Pricing	Grain	Per cent-age	Feed	Per cent-age	Other Farm Supplies	Per cent-age	Ser-vices	Per cent-age
Buyers or suppliers sug-gested mark-ups	8	19	4	10	13	26	2	6
Meet competition	25	58	11	27	20	41	27	75
Base on estimated cost	8	19	24	60	15	31	6	16
Try to beat competitors	2	4	1	3	1	2	1	3
	43		40		49		36	

The methods of pricing grain and services indicates that there is a high degree of competition in these two items. This is expected in a homogeneous commodity such as grain. Services, generally speaking, are very much the same regardless of the firm, therefore, it is to be expected that a substantial degree of competition exists in this item.

The above table indicates that feed is a product which can differentiated to a considerable extent. This is primarily due to "complete" feed mixes and brand name protein supplements which can be differentiated on a quality basis.

The methods employed in pricing other farm supplies exhibit considerable variability. Items such as fertilizer have experienced considerable price competition in the last few years, almost to the extent of price wars in certain areas of the State. Seed corn and legume seeds on the other hand, may be differentiated on a quality basis, hence suppliers suggested mark-up or margins based on estimated cost may be used as the predominant pricing methods.

Advertising and other promotional schemes are not used to any great extent in the elevator business. Probably the major reason for this is that the country elevator primarily merchandises farm production items and these do not lend themselves to the emotional appeal which can be created for such products as new automobiles, clothes and other consumer items.

Thirty-two of the 34 firms studied advertised, however, the total amount spent was only $42,303. About 41 percent of this amount was spent on newspaper advertising, 15 percent was used for direct mail advertising and 5 percent was spent on radio and T.V. advertising. About 10 percent of the total amount spent on advertising was for calls on farmers and 29 percent was spent for all other promotion. Nearly all of this 29 percent was donations to community organizations such as F.F.A., Junior Farm Bureau, 4-H and churches.

CHAPTER V

SUMMARY AND CONCLUSIONS

In this study a Cobb-Douglas type production function was employed to determine the productivity of the different resources used in 34 selected Michigan elevator-farm supply firms in 1955. The primary objectives were to measure the returns to various resources used in country elevators and to estimate the effects of varying resource combinations on gross margin as measured by an index of marketing services. The secondary objective was to obtain estimates of the returns to fixed assets based on present valuations and on replacement costs. It was hoped that these estimates would offer useful tools to the management of country elevators concerned with proposed reorganization and expansion programs.

A discussion on the operating structure of the Michigan country elevator and the nature of its production function showed that the real product of the country elevator is service and that the measure of this service is gross margin.

When measured at the geometric mean of inputs, it was found that the productivity of direct operating expenses and machinery and equipment was considerably greater than labor or accounts receivable and inventory. It was then concluded that an increase in the amounts of direct operating expenses and fixed assets would lead to a more nearly economic optimum. Slight increasing returns to scale were evidenced in the

function fitted, therefore it was not possible to reach an economic optimum in the sense that the marginal value product of each input was equal to its respective marginal factor cost.

A proposed reorganization based on increasing direct operating expenses, the input which yielded the highest return, was investigated. This is primarily an increase in the use of the firm's capacity, because direct operating expenses are those expenses which vary with the physical volume of products handled by the elevator. It appears to be a very reasonable proposal in light of the fact that only about 50 percent of the feed grinding and mixing capacity of these firms was used and only about 26 percent of the grain capacity was utilized.

By increasing direct operating expenses to the point at which the marginal value product was equal to the marginal factor cost, gross margin was increased by $17,843. As a result of the increase in gross margin, net profit was increased from $6,851 to $10,749.

A long-run adjustment, in which direct operating expenses and investment in machinery and equipment were increased in least cost combinations was also investigated. This adjustment increased the estimated gross returns from $83,674 at the geometric mean of inputs to $119,025, however, increased depreciation as a result of expanding the physical plant cause the net operating profit to be only $9,824.

The net operating profit is not as great with the long-run adjustment as with the short-run adjustment where in the latter case total depreciation is based on present investment in facilities. When replacement values are used in pricing facilities in all situations the net profit decreases in both the "usual" organization and the short-run situation, however, the rate of liquid capital accumulation is highest in the short-run situation. This means that the immediate concern of these firms should be one of increasing the utilization of present facilities rather than investing in new facilities.

It must be remembered that elevator farm supply firms are merchandising as well as producing firms. Therefore, an instigation of the proposed reorganizations will not necessarily increase returns unless management takes action which will increase the quantity demanded of the firm's services.

Firms which deviated substantially from the function fitted to the data were analyzed to determine the cause of the deviation. In general, those firms with large positive residuals obtained a higher percentage of total gross margin from merchandised grain and utilized a greater percentage of their rated capacity relative to the average for all firms or those with negative residuals.

A comparison of actual gross margin indicated in the operating statement (Y_a), index of marketing services (Y_c), and estimate of the index of marketing services ($\hat{Y}$) indicated that the demand for a given firm's services is relatively

elastic. Therefore, a major objective of management should be to increase volume by decreasing the price of its services in order to obtain a greater total gross margin.

APPENDIX

Table 13.

	Man-Months Productive Labor (X_1)	Average Monthly Accounts Receivable and Inventory (X_2)	Direct Operating Expenses (X_3)	Replacement Value of Machinery and Equipment (X_4)	Index of Marketing Services (Y)
1	117	93415	22739	48382	87571
2	40	26280	4722	33737	34652
3	192	122929	7400	43078	72724
4	83	96031	17383	49346	78767
5	66	55986	11216	41851	52554
6	90	71512	10190	61302	63580
7	42	26392	10468	23657	30371
8	252	153906	21814	67596	130984
9	132	98790	14439	66934	88186
10	108	95859	19769	130655	103611
11	252	131887	27140	91852	191291
12	137	92471	14812	76785	107098
13	51	35504	8191	31945	37796
14	100	77459	10835	67172	62476
15	52	37436	12479	18445	46577
16	52	38658	10581	25000	43079
17	46	20399	5909	40658	39508
18	164	101462	17811	41840	151947
19	120	78889	22314	47500	81198
20	336	190095	44428	97017	260457
21	106	59683	19389	100482	118705
22	166	80323	21552	110100	116998
23	180	65099	16454	86997	159929
24	50	33850	5686	72821	57485
25	82	206697	7038	65524	84191
26	76	28447	8934	53101	44240
27	54	45097	7394	48862	54626
28	77	49545	14519	58227	77964
29	114	106236	8553	61562	87371
30	148	214027	33383	77797	168804
31	84	65701	8785	34553	83749
32	240	188415	44058	165738	218755
33	162	277114	18402	99475	147427
34	72	143454	6067	105537	77790

Table 14. Components of Gross Margin and of Each Input Category

Gross Margin (Y)						
Merchandised Grain	Processed Grain	Fertilizer	Seed	Petroleum	Farm Supply	Service Income

Input Categories			
Labor (X_1)	Inventory and Accounts Receivable (X_2)	Direct Operating Expenses (X_3)	Investment in Machinery & Equipment (X_4)
Productive Man Months	Average monthly inventory plus average monthly accounts receivable	Electricity Machinery Gas, oil, grease Freight expense Hired trucking Office supplies Interest on loans for inventories Warehouse supplies Telephone and telegraph Discounts and exchanges Advertising Collection expense Traveling expense Sales tax Cash over or short	Replacement Value of Machinery and Equipment

Table 15. Computation of Marginal Value Products

	Input Category	Quantity of Input	Marginal Value Product
X_1	Labor	101.3 months	320.32
X_2	Inventory & Accounts Receivable	$76,194	.179
X_3	Direct Operating Expense	13,305	1.696
X_4	Replacement Value of Machinery & Equipment	58,697	.268

$$MVP_{X_i} = \frac{b_i\ (E)\ Y}{X_i} = \text{antilog of } \log b_i + \log (\bar{Y})\ Y - \log X_i$$

MVP_{X_1} = 9.58881-10 + 4.92259 - 2.70581 = 2.50559 = Antilog 320.32

MVP_{X_2} = 9.21333-10 + 4.92259 - 4.88192 = 9.25400-10 = .179

MVP_{X_3} = 9.43091-10 + 4.92259 - 4.12402 = .22948 = 1.696

MVP_{X_4} = 9.27346-10 + 4.92259 - 4.76862 = 9.42743-10 = .268

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CONFIDENTIAL CONFIDENTIAL

Questionnaire on Elevator-Farm Supply Businesses

The information asked for on this questionnaire is for research purposes only. It will never be divulged in such a manner that the information can be identified with your business.

Name of Business _____ Date _____

Address _____ Michigan
Post Office County

GENERAL INFORMATION

Kind of Ownership
Individual proprietor _____
Regular Corporation _____
Cooperative Corporation _____

How large a trade territory do you cover (miles in each direction)
East _____
South _____
West _____
North _____

EMPLOYMENT RECORD

How many full time employees do you have exclusive of the manager _____?

How much seasonal hiring did you do last year? _____

_____

_____

Can you give a job classification for each individual you employ as asked for in the table below? If one individual works at two jobs, for example, if an office employee waits on customers, or if a mill man drives truck part time, please estimate the time spent on each job as closely as possible.

Classification of jobs by individuals

Employee and Department	Time employed in months	Duties	Salary
Feed			
1	_____	_____	_____
2	_____	_____	_____
3	_____	_____	_____
4	_____	_____	_____
5	_____	_____	_____
6	_____	_____	_____
7	_____	_____	_____

Employee and department	Time employed in months	Duties	Salary
Grain			
1			
2			
3			
4			
5			
6			
Truck drivers			
1			
2			
3			
4			
5			
Bookkeeping			
1			
2			
3			
4			
5			
Other			
1			
2			
3			
4			
5			
6			

Managers Name _____. Do you operate on a straight salary _____ or on a salary plus commissions or a bonus _____.

What is the basis for payment of commissions or bonuses if any _____
_____.

How much of the salary item in the operating statement of your audit represents a payment to you for management _____.

Do any other employees receive commissions or bonuses. If yes, explain _____
_____
_____

What percent of managers time is spent:

1. Waiting on customers _____?
2. Buying grain or beans _____?
3. Doing clerical work _____?
4. Studying markets, attending meetings, learning about feeding or fertilization practices, studying past operating records otherwise acquiring information needed for management decisions _____?
5. Other activities _____?

FARM PRODUCTS MARKETED

Product	Quantity bought	Cars shipped	Cost of sales	Average mark up taken
Beans (navy)				
Corn				
Oats				
Wheat				
Barley				
Soybeans				
Other				

FARM SUPPLIES SOLD

Supplies	Units sold	Sales	Cost of sales	Mark up taken	Average price rec'd
Gasoline					
Tractor fuel					
Kerosene & fuel oil					
Lubrication oil					
Feed					
Seed					
Fertilizer - high					
low					
Coal					
Other farm supplies					

	Receipts	Charge
Receipts from services rendered:		
Grain and seed treating and cleaning		
Grinding and mixing		
Warehousing (Storage)		
Trucking		

MONTHLY STATEMENT OF INVENTORIES AND ACCOUNTS RECEIVABLE

Month	Accounts receivable	Inventories
January		
February		
March		
April		
May		
June		
July		
August		
September		
October		
November		
December		

Marketing inventories include wheat and other grains, poultry, eggs, etc. Farm supply inventories include feed, seed, fertilizer, farm machinery, miscellaneous farm supplies, etc.

BORROWING DURING LAST FISCAL YEAR
(List each loan separately)

Loan No.	1	2	3	4	5
Term of loan in months					
Source (type of lender)					
Purpose (oper., cap., etc.)					
Security (mort., etc.)					
Method of repayment					
Maximum amount outstanding during fiscal year					
Amount outstanding at close of year					
Interest rate					

How much did you owe on trade accounts payable during seasonal peak operations?

Spring _____ Fall _____

What is the maximum amount which you can borrow on a seasonal basis from banks, patrons, relatives, etc.? _____

KIND OF ADVERTISING OR FARMER RELATIONS USED

Method	Frequency	Expenditure
Newspaper advertising	_____	_____
Direct Mail	_____	_____
Radio or T. V.	_____	_____
Call on farmers	_____	_____
Other	_____	_____
_____	_____	_____
_____	_____	_____

Under what conditions in the past 2 or 3 years have you been hard pressed for capital?

_____

_____

Could you have increased your volume if you had had additional operating capital this past year? Yes _____ no _____ How much _____.

Explain _____

_____

_____

Do you feel that at the present time you should add new lines or services which you do not have? Yes _____ No_____. What _____.
How much capital would be needed? _____. How much additional would this bring in? _____

Which phase of your operation do you consider most profitable? _____.

Have you aggressively attempted to push it in anyway? _____ How? _____

_____

Have you held grain for higher prices or bought future contracts throughout the year?

_____

Do you pick up or deliver many commodities which you handle?

Item	% picked up From suppliers	% picked up From farmers	% delivered to buyers	% delivered to farmers	Charge
Feed					
Fertilizer					
Grain					
Petroleum					
Other					

What percent of your feed volume is from your mixing operation? _____

What percent is from merchandised feeds? _____

What percent of your feed volume is for:		Average price for each kind of feed
1. Poultry		
2. Dairy cattle		
3. Beef cattle		
4. Hogs		
5. Other		

What kind of a pricing policy do you have?

	Grain	Feed	Other supplies	Other services mixing, cleaning, trucking, etc.
Take supplies or buyers suggested mark-up				
Try to meet competitors price				
Base mark-up on est. cost irrespective of competitors				
Try to beat competitors				

What community projects does your business sponsor or support? _____

_____

Who has the authority in practice for the following types of problems?

	Owner	Manager	Directors	Others
a. Setting prices				
b. Pricing feed and supplies				
c. Selecting sales outlet				
d. Buying major equipment				
e. Hiring employees				
f. Complaints				
_____				
_____				

How many competitors do you have? _____

Location	Kind of ownership	Estimated total volume of sales	
		Grain	Other

Which of the plants previously mentioned give you the strongest competition? (Name in order)

1. _____
2. _____
3. _____
4. _____
5. _____

What do these businesses do that cause you trouble? _____

_____

_____

How do you meet this competition? _____

_____

_____

How much government grain did you handle last year? _____

_____

_____

Did you suffer any unusual losses on commodities handled last year? _____

_____

_____

_____

Considering now the amount of business available and your competetive situation what maximum volume of business do you think you ought to have in the trade territory you operate in?

	Feed	Grain	Other
About right	____	____	____
Should increase	____	____	____
(How much - in percent)	____	____	____

If you feel you should increase -- what has prevented it? _____

_____

_____

BUILDING AND FIXTURES RECORD

Elevator

Grain storage capacity _____ Bu.

Bag storage capacity _____

Cost value of bldg. _____

Present book value _____

Age of building _____

Mill

Bulk storage capacity _____

Bag storage capacity _____

Cost value _____

Present book value _____

Age of building _____

Office and retail

Size of building _____ x _____ ft.

Cost value _____

Present book value _____

Age of building _____

Warehouse No. 1

Use _____

Capacity _____

Cost value _____

Present book value _____

Age of building _____

Warehouse No. 2

Use _____

Capacity _____

Cost value _____

Present book value _____

Age of building _____

Warehouse No. 3

Use _____

Capacity _____

Cost value _____

Present book value _____

Age of building _____

Other buildings

_____ _____

_____ _____

_____ _____

_____ _____

Other buildings

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

EQUIPMENT RECORDS

Elevator or Grain Handling

Cost value _____

Present book value _____

Average age _____

Daily grain capacity _____

Mill

Cost value _____

Present book value _____

Average age _____

Grinding and mixing capacity _____

Office and retail

Cost value _____

Present book value _____

Average age _____

Warehouse equipment (Include loading-unloading equipment, such as coal loader, petroleum handling equipment, etc.)

Cost value _____

Present book value _____

Average age _____

Make & year	Kind and capacity	Purchase price	Present book value

Other equipment

Use _____

Cost value _____

Present book value _____

Average age _____