Productivity of management in local cooperative elevators

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PRODUCTIVITY OF MANAGEMENT IN
LOCAL COOPERATIVE ELEVATORS

by

Clarence Phillip Baumel

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Dean of Graduate College

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INTRODUCTION

Country elevators perform an increasingly vital function in the agricultural marketing system. The early elevator business consisted largely of grain trading and local flour milling. With the continuous growth of agricultural technology, farmers have looked to the country elevator as one source of supply of a host of products and services necessary for profitable farming operations. Further, country elevators play an important role in the storage and marketing of grain taken over by government price support programs. As a result, country elevator firms have grown in size and complexity. In some firms, annual sales surpass four million dollars; fixed investments range up to one-half million dollars and the number of employees may exceed thirty.

The efficiency of these firms is largely dependent on the productivity of management; yet their rapid growth has intensified the complexity of management. The owners and managers of these firms have shown considerable interest in managerial research as a means of increasing the productivity of management and the returns to the business. The impact of any increase in managerial productivity at this level of marketing should be reflected in increased efficiency of the entire agricultural marketing system.

This study is an attempt to determine the effect of alternative managerial practices and techniques and of personal characteristics of the manager on firm profitability. Measurement of these productivities should be extremely valuable in selecting and training country elevator managers. However, the methods of analysis used in this study are not
Management Delimited

The concept of management has not been precisely defined in economic literature. Some writers have used management and entrepreneurship synonymously (18). Management, when used in this context, generally consists of the risk and uncertainty bearing function and the policy decision making function of the entrepreneur and excludes routine or administrative responsibilities of management.

Heady suggests that management consists of coordination and supervision (12, pp. 165-167). Coordination is the fundamental role of management and is concerned with the formulation of expectations, decision making, developing a production plan and finally, bearing the economic consequences. Supervision involves the actual implementation of the plans. Heady considers the latter role as being of a "lower order", and suggests that management in the true sense is synonymous with coordination.

For this study, the definition of management as entrepreneurship possesses two weaknesses. First, the supervision role of management determines the extent to which the potential profitability of the production plan is achieved; in fact, it may spell the difference between profit and loss. For the purpose at hand the supervisory role will be included in the managerial function. In part, this study will be concerned with measuring the productivity of this aspect of management.

Secondly, for purposes of this study, difficulties arise in combining the risk and uncertainty bearing function with the managerial function. In many country elevators, as well as in most corporate firms, profits or
losses accrue primarily to persons other than those making the managerial decisions. A salaried general manager is responsible for a certain portion of the so-called coordination and is fully responsible for the supervision role in these firms. Thus, the managerial function and the risk and uncertainty bearing function are frequently separated in the real world.

Other writers have defined management to include more than the entrepreneur's specific risk and uncertainty bearing function. Reder defines the managerial activity as being performed by any person whenever he performs any action in which he is free to exercise discretion (23, p. 151). Thus, every person employed would be, to some extent, a manager. Management used in this sense would greatly complicate an already complex research study since a study of management would require a model specifying the decisions of each employee.

Business management texts generally expand the concept of management beyond the policy decision making function of the entrepreneur. Terry defines management as the "activity which plans, organizes and controls the operations of men, materials, machines, methods, money and markets, providing direction and coordination, and giving leadership to human efforts so as to achieve the sought objectives of the enterprise" (26, p. 8).

Phillips has suggested that management consists of decision making under uncertainty, decision making based on known information and certainty, and of implementing these decisions (22, p. 7). Within this framework, management has been separated into two distinct levels. The first level is overall managerial planning. The responsibilities of
overall managerial planning include decision making regarding the nature of the organizational structure, the location and size of the activity, the quality and combination of inputs, the financial structure, the enterprises in which the firm engages, as well as the establishment of basic operational policies and the selection of management responsible for the operation of the business.

The second level of management (operational management) utilizes the planning from overall management in operating the firm from day to day. The operational manager is fully accountable to overall management for operational management. Further, he must operate within the restrictions imposed by the first level of management. In the short run, he must take as given the entire assets of the firm, the type of organization, the financial structure and the labor resources. He must take the competitive situation, the resource and product markets and other environmental factors as given. Within these restrictions, the operational manager is responsible for making the business as profitable as possible.

In the longer run, the operational manager ordinarily must consider some aspects of the input combination as variable. Within the restrictions imposed by overall managerial policies, the operational manager has authority to change the composition of the asset structure through decisions regarding inventory levels and accounts receivable policy; he may affect the financial structure by altering the composition of current liabilities; he may modify the input combination by changing the quality and quantity of labor resources, as well as changing the levels of other variable inputs. These aspects of long run operational management represent more detailed phases of decision making than those included in
The general manager, whether he is salaried or the owner of the business, assumes responsibility for operational management. Because this responsibility generally falls on one individual, he is unable to utilize the managerial specialization commonly found in large firms. In addition to being general manager, he must perform the duties of the personnel manager, the sales manager, the advertising manager, the purchasing manager, the credit manager and the customer relations manager. Each of these duties represents a distinct area of management and the problems involved in each are somewhat different. Phillips has suggested the most important of these areas in country elevator management include (22, pp. 258-271):

1) Employee management
2) Merchandising management (both wholesale and retail merchandising)
3) Inventory management
4) Retail credit management
5) Custom services management
6) Fixed asset management
7) Financial management
8) Customer relations management

The concept of management as outlined by Phillips includes decision making under certainty as well as uncertainty and encompasses the implementation of decisions and the control for assurance that the decisions are carried out properly. Management is divided into the two distinct levels of (1) overall management and (2) operational management. Overall
management is performed by the owners or by the board of directors. Full responsibility for operational management usually rests with a salaried general manager who is directly accountable to the owners or the board of directors.* In the longer run, the general manager may perform some aspects of overall management. This concept of management closely approximates management as it actually exists in cooperative elevators and other agricultural marketing firms; furthermore, it delimits management to a degree that is amenable to statistical and economic analysis.

Following the management concept developed by Phillips, this study will be concerned primarily with operational management. Models will be developed to measure the productivity of the salaried general manager under the assumption that the level of inputs are fixed as well as under the assumption that the operational manager can alter the level of some inputs. However, the risk and uncertainty bearing function will not be considered in these models.

Statement of the Problem

The efficiency of any firm probably depends more on the productivity of management than any other factor. A firm is inefficient if the necessary conditions for profit maximization are not achieved. These conditions require the firm to produce the optimum combination of products and services, to select the least cost combination of inputs and to

*Actually, the general manager assumes full responsibility only in the case of a one man firm. In larger firms, he usually shares some of the responsibility with employees. In fact, the employees may have considerable influence on managerial decisions. It appears plausible to impute the employees' contribution to the general manager since, in the long run, he is responsible for selecting high caliber employees.
produce at the most profitable level of production. A further requirement implied in these conditions is that any combination of inputs be utilized in the most effective manner in producing and distributing any combination of outputs.

The optimum combination of products is achieved when the marginal rate of substitution in production between any two products or groups of products is equal to the ratio of the marginal returns between the two products or groups of products. Mathematically, this product-product condition can be stated as

$$\frac{dB}{dA} = \frac{MR_A}{MR_B}$$

where $\frac{dB}{dA}$ is the marginal rate of substitution in production and $\frac{MR_A}{MR_B}$ is the ratio of the marginal returns for the products A and B.

The least cost combination of inputs is achieved when the marginal rate of substitution in production between any two inputs or groups of inputs is equal to the ratio of the marginal expenditures between the two inputs or groups of inputs. This factor-factor condition can be written as

$$\frac{dY}{dX} = \frac{ME_X}{ME_Y}$$

where $\frac{dY}{dX}$ is the marginal rate of substitution between the two inputs X and Y and $\frac{ME_X}{ME_Y}$ is the ratio of the marginal expenditures of the two inputs.

The firm will be producing the optimum volume of output when the marginal rate of transformation between any input and output or group of inputs and outputs is equal to the ratio of the marginal expenditure for
the input (inputs) and the marginal return for the output (outputs).

Algebraically, this can be stated as

$$\frac{dA}{dX} = \frac{MEX}{MP_A}$$

These conditions must be modified in the case of joint production and integration where market and technical interdependence is likely to exist. Interdependence, in this sense, is defined as competitive or complementary relationships in production or in the market for inputs and outputs. Technical interdependence has been adequately discussed in the literature (12, pp. 201-236). Market interdependence is not usually considered and can be illustrated in the case of complementarity among two outputs A and B. If B is complementary with A, increased sales of A shifts the demand curve for B to the right. Hence, more B can be sold at the same price or the original quantity of B can be sold at a higher price. Ordinarily a higher profit will be the result of this relationship. The firm must consider such complementarity in demand when planning its combination of products and its pricing and promotion programs on individual products. If the two products were competitive, an increase in the sales of A would decrease the sales and/or the price of B and would normally result in lower profits. The firm must consider this possible relationship when developing the production plan. In the event of these interdependencies, marginal return must be expanded from the concept of the return from the sale of the last unit of the product to the notion of the net effect on total return from all products to the firm resulting from the sale of one additional unit of product. Similarly, marginal expenditure must be expanded from the concept of the
additional cost of the last unit of an input purchased to conception of
the net effect of the purchase of one additional unit of the input on the
total cost of all inputs to the firm.

Further modifications are required to account for time. The common
method of considering time consists of discounting future returns and
costs to their present value.*

From a practical viewpoint, the conditions specifying economic effi­
ciency are indeed complex. However, they serve as guides or benchmarks
for managerial decisions. The product-product condition, for example,
provides a basis for product pricing, product volume and the optimum com­
bination of outputs. In a like manner, the factor-factor condition fur­
nishes a basis for selecting the optimum quantity and combination of
inputs as well as the prices to be paid for the inputs. Unfortunately
it is extremely difficult and costly to obtain some of the required data
to meet these conditions. Other data are not available because of uncer­
tainty. Hence, one would expect managers to approximate the efficiency
conditions.

Managers use a variety of managerial methods and techniques to
approximate economic efficiency. Some managers make random decisions in
some areas of management. Inputs may be added with no consideration of
other alternatives. Products and services may be added simply because
a customer asks for them. Outputs may be retained because the business
has always provided them. Other managers utilize methods and techniques
suggested by management texts such as sales planning. Although these

*For a rigorous treatment of these conditions including the suffi­
cient and total conditions see (22, pp. 42-57).
methods logically seem to be associated with efficiency or high managerial productivity, no estimates of the productivities of these methods exist. Thus, it is plausible that managers are not as productive as they might be because they are not aware of the most productive managerial methods.

In a like manner, managers may not utilize the set of inputs in the most effective manner. Activities may be uncoordinated. Employees may be unaware of their responsibilities. These situations may arise because the manager may be unaware of the most effective tools or techniques for implementing the plans and controlling the business.

Firm inefficiency always results in added costs since the same output (revenue) could be produced with fewer inputs or more output could be produced with the same inputs. These added costs often are reflected in the prices the farmer pays for supplies and services and in the prices the farmer receives for his products. Some of the costs of distributive inefficiency are ultimately shifted to society in higher costs of food and fiber. An additional cost of these inefficiencies to society is reflected in slower economic growth since, under these conditions, agricultural industries use extra inputs which could be employed more productively in other industries. Further, the costs of agricultural adjustment can be increased by such marketing inefficiencies, since many of the price support programs involve agricultural marketing industries.

Method of Analysis

Economic theory generally recognizes management as the fourth factor of production. The literature has given extensive treatment to the
effects of management on returns to scale, costs, and growth. In addition, the productivity bias arising with the omission of the managerial input from the production function has been demonstrated (8). Nevertheless, the efforts of applied economists to empirically estimate the contribution of management to the production process have largely been unsuccessful. This failure stems primarily from the difficulty involved in obtaining quantitative measures of the management input. The source of this measurement problem arises from the nature of management. Management of each area of the business can be divided into three distinct functions (22, p. 7). These functions are planning, direction and control.

Planning begins with a goal or end-in-view. It involves consideration of all possible alternatives, collecting and evaluating all relevant information pertaining to each alternative and selecting the most effective policy or course of action to attain the goal; furthermore, it includes decisions with respect to when, where and how the action should be implemented.

Direction provides the internal organization whereby each individual is aware of his responsibilities; it coordinates all activities to achieve the desired objective; it involves employee motivation, standards of performance, training, and day to day instructions.

Control is the activity which furnishes the assurance that the policies and courses of action are carried out according to the prescribed schedules and standards, and provides the necessary action to correct any deviations.

Thus, business management may be regarded as a diverse complex of mental and physical activity which develops plans as well as directs and
controls resources in implementing the plans to produce and market a product at a profit. The measurement of an exact management input is obstructed by our inability to measure human behavior. However, it may be possible to predict the effect of management on output or profit if attributes related to the management input can be measured.

Previous research has attempted to predict the level of the management input on the basis of personal characteristics of the manager. Moreover, firms have traditionally selected and evaluated managers on the basis of personal characteristics alone. An executive of an association of cooperative elevators in Iowa has mentioned the following attributes as the reasons for success of the better managers in the association:

1) A liking for people
2) Aggressiveness
3) Personality
4) An ability to handle people
5) Education

Some reasons given for the lack of success included:

1) Personal financial troubles
2) Inexperience
3) Inability to handle people

The writer would not dispute the contention that some basic personal characteristics are necessary for productive management. Clearly, a manager must be able to make decisions; he must have some formal education and experience, as well as a personality which permits him to carry out successful relations with customers and employees. However, these attributes alone do not guarantee high productivity; rather, they establish the potential performance of the manager.

Logically, the manner in which the various managerial functions are performed determines the actual accomplishments of the manager and should
be closely related to the managerial input. This approach rests on the assumption that given the ability to make rational decisions, productive management largely consists of the application of basic principles of economics, sociology and other behavioral sciences. The complexity of modern management problems precludes the exclusive use of hunches and snap judgment for successful management. Therefore, it seems reasonable that the actual productivity of management is primarily a function of the methods and techniques utilized in making and implementing management decisions. An alternative method of estimating the productivity of the management input, then, is to estimate the productivity of the methods and techniques utilized in making and implementing decisions.

An evaluation of the productivity of operational management must consider the environment in which the firm is operated. The environment may be defined as those factors which are not in the range of alternatives open to the manager; they may be considered as restrictions or exogenous variables. Included in these restrictions are the personal characteristics of the manager, the competitive situation and the quality of the available resources. Two managers utilizing the same methods and techniques may produce entirely different levels of revenue if the restrictions facing each are different. These restrictions do vary from firm to firm. Therefore, an analysis of the productivity of management requires an accounting for the variation in revenue attributable to these environmental factors.

The productivity of management is sometimes subjectively evaluated on the basis of the manager's performance in one area of management. However, such evaluations cannot be supported from a logical point of
view. The problems involved in each area of management are quite different. Thus a study of managerial productivity should involve all areas of management.

A statistical analysis of management methods and techniques requires quantification of each of these factors. Therefore, an attempt in this study has been to work out methods for scaling or assigning numerical values to the various managerial procedures used and to the restrictions encountered in each area of management. On the basis of these measurements, regression models have been developed to estimate managerial productivity.

Objectives

The short run objectives of research on firm efficiency should be directed toward increasing the profits of the firm. Assuming the firm goal of profit maximization, any other objective would not motivate management to utilize the results of the completed research. This objective of increased profits is sound on the assumption that the marketing industries are sufficiently competitive for the increases in efficiency ultimately to be reflected in price advantages to agriculture and to society as a whole. Although the structure of these industries varies with respect to the degree of competition, one can reasonably assume they are sufficiently competitive for the benefits of increased efficiency ultimately to be passed on to society (21).

It is believed that the productivity of individual managers can be increased through formal and informal training. Measurement of the productivity of the analytical methods and tools utilized in each phase of
management would be extremely valuable in planning and executing management training programs. Moreover, knowledge of the effect of personal characteristics of the manager on firm efficiency could greatly aid in the selection of management trainees.

In some cases, restrictions on the manager's range of alternatives can be altered. Estimates of the effect of restrictions on the profitability of the firm may lead the owners or overall management to make the appropriate changes. These modifications should further increase the efficiency of the firm.

With the end-in-view of increased knowledge of the managerial processes so as to reduce inefficiency within the firm, the specific objectives of this study are:

(1) To estimate the productivity of selected operational management methods and techniques in each area of elevator management.

(2) To estimate the effect of specific environment factors on the efficiency of the firm.

In addition to these primary objectives, the study has the auxiliary goal of developing statistical models for the estimations specified by the primary objectives.

It is hoped that the methods used in this study will serve as a basis for more refined studies of management in agricultural industries as well as to stimulate further research into the measurement of managerial productivity in firms generally.
REVIEW OF LITERATURE

Research directed toward the productivity of managers has probably received less attention from research workers than any other area of economics and related sciences. This neglect stems, in part, from the difficulties involved in measuring and quantifying the managerial processes. For example, some managerial research efforts have been directed toward operations research. However, operations research is not concerned with the manager himself but rather with how to combine resources in a given problem. This approach assumes the problem to have been previously formulated and the relevant information available for the solution. The current study is concerned with defining managerial problems, selecting sources of information and defining practical methods of solving the problem.

Agricultural economists have been most concerned with measuring management primarily because of the effect of management on the production function. One of the earliest attempts to measure the management factor was conducted by Reiss (24) who endeavored to predict the level of management on Illinois farms. Descriptive essays of good and poor farmers were obtained from people closely associated with the farmers under study. The basis of these evaluations was primarily personal characteristics. While this approach may be of value from the point of view of vocational guidance, it probably has little application in the field of management training and extension which may be one of the most fruitful methods of reducing firm inefficiency.

A somewhat different problem was attacked by Hardcopf (11). The
objective of this thesis was to determine the relative importance of several areas of management in cooperative elevators. It was suggested that the residuals from an empirically estimated production function largely represent the contribution of management to output. This method assumes that all other inputs are included in the model and that there are no errors in the data. It is the writer's opinion that neither assumption can be justified. A second methodological limitation of the residual approach involves the omission of the management factor itself, which leads to specification bias and in turn, affects the residuals.

One of the most recent attempts to measure management was conducted by Halter and Paris who investigated the possibility of predicting the level of management on the basis of input changes (10). Management was defined as the input which results in changes in the physical input or output combinations. The methodology with respect to input changes consisted of computing a production function from 1952 data for a group of farms. The estimates of the production function parameters were used to derive the least cost combinations for the 1952 and 1956 observed incomes. A managerial function was then specified on the basis of the difference between the expected change in the quantity of each input between 1952 and 1956 and the observed change in each input between 1952 and 1956. Personal characteristics were then related to the management function for the purpose of discovering a basis of predicting the level of management.

In assuming that all firms move along the same production function, the authors make a fundamental assumption that can hardly be justified. This procedure ignores differences in the ability of managers to effectively utilize inputs. A further weakness lies in the comparison of two
years separated by three years. This procedure introduces the possibility of a firm accidentally achieving the least cost combination in both periods. In addition, relating the managerial function to personal characteristics alone has little application in management training.
The role of an economic model in empirical research is to specify the important variables in a specific problem and to describe the structural relationship among these variables. Restrictions which include manageability and limited research funds necessitate the specification of only the important variables; hence, the model abstracts from reality. Quite naturally, controversy has arisen regarding the definition of important variables. One extreme position is that all variables (in the Walrasian sense) are important and the model should approximate a one to one correspondence with reality. This position can easily be attacked. First, mathematics and computing technology have not provided the tools to adequately analyze extremely complicated models. Secondly, it would be very difficult to conceptually establish the structural relationships for the system and to obtain the data for the analysis. Thirdly, research funds are, of course, limited. Assuming away our inability to develop and analyze realistic models, it would be most costly to attempt such projects. The cost of developing realistic models would limit research to very few problems.

Friedman (7) has taken the opposite position that a hypothesis cannot be tested by the realism of the assumptions of the model; rather a hypothesis can only be tested by its ability to predict. Thus, he is not concerned with the realism of the model.

Friedman has been quite justifiably criticized on this position. If the model is totally unrealistic, there may be no logical basis for the hypothesis. In this case, one could have little confidence in the
predictions.

On the other hand, Baumol (3, p. 2) holds that a useful model describes an imaginary world that is sufficiently complex and similar to reality to permit one to make inferences about the data. In addition, it is sufficiently simple to understand and manipulate with available tools. In this sense, the model may be only a half truth; yet it adequately approximates the real world to permit one to have confidence in the predictions.

The models developed in this study follow the Baumol position with respect to realism. The primary basis for their formulation is economic theory, specifically the static theory of the firm. Classical economic theory rests on the profit maximization assumption. It has been suggested that profit maximizing models are unrealistic since other goals (for example, stability of income) are relevant to the decisions of management (3,12,23). Baumol suggests the goal of large oligopolistic firms is the maximization of total revenue subject to a profit restraint (3, pp. 45-53). In developing the revenue maximizing theory, however, Baumol shows that taking the level of expenditure as given, the sales maximizing firm will produce the same quantity of each product as the profit maximizer. In a like manner, given the level of revenue, the sales maximizing firm will use identical inputs in the same quantities and will allocate these resources in the same manner as a profit maximizing firm. In view of the evidence supporting constant returns to scale, the decisions regarding the factor-factor and product-product conditions may be most important. Thus, it would make little difference whether the model for analysis of these large oligopoly firms is based on profit or sales maximization.
On the basis of the Baumol analysis, it is possible that there may be little difference in the conclusions from profit maximizing models and models based on other maximization goals.

With respect to the use of profit maximizing models for this study, it is the writer's opinion that salaried operational managers of country elevators tend to approximate profit maximizing behavior since they frequently measure their managerial success by level of profits of the firm. However, the primary justification of the use of profit maximization, although only an approximation to reality, is that the theory is well developed and some useful inferences can be made on the basis of the model.

A second criticism of the traditional theory of the firm lies in its static nature; that is, it neglects the dynamic aspects of decision making. In general, the decision maker is unable to determine the probabilities of the future outcomes or payoffs of given actions; hence the firm operates in an environment of uncertainty. Uncertainty arises in the market on both the demand and supply side. On the demand side, dynamic planning is required to anticipate changes in tastes, preferences, shifts in the demand curves and reactions of competitors. On the supply side, dynamic planning is necessary because of the uncertainty of the quantity and quality of future supplies.

Unfortunately, a dynamic theory of the firm has not been formulated. There have been some partial contributions to a dynamic theory. Hicks has modified traditional theory by introducing time through the discounting of future revenues and costs to their present value. Other contributions have been made by Lange (20), Tintner (28) et al. Nevertheless, these contributions have made little improvement in the predictive
power of traditional theory. In any case, the static theory of the firm is not totally inappropriate for the present study since many operational decisions are made under certainty as implied in the above meaning of management.

Basically, two sets of models have been developed to represent the assumed behavior of the operational manager under specified situations. Each will be modified for alternative functional forms.

The first set considers the behavior of the operational manager under short run conditions. Following the managerial framework developed by Phillips, the operational manager must, in the short run, take the inputs of the firm as given. Under this assumption, the total expenditure is given and the operational manager can maximize profits by simply maximizing total revenue. Hence, a single equation production function model which relates output to the various inputs is appropriate.

The logic of the production function approach to this problem can be demonstrated in terms of the theory of the firm. Classical theory, in assuming only one production function, presupposes technical efficiency. That is, the theory assumes management will obtain the maximum output attainable given the current level of technology. However, there is little reason to expect this maximum relationship to hold in the real world.
As shown above, classical theory, in relating total output, $Y$, to the input, $X$, assumes the firm to be operating on curve A. Of course, the firm cannot operate on any function above curve A since A presumably is the maximum attainable output. However, the firm may be operating on curve B or C or any other function under A. The classical production function model represented as

$$Y = f(X_1, X_2, \ldots, X_n)$$

states that the physical inputs, $X_i$, are transformed into output, $Y$, in a manner determined only by technological considerations.

Consider a production function in value units; that is, the output and inputs are expressed in dollar values. There are three fundamental reasons why a firm may not be operating on the maximum production function, or why firms within an industry may be operating on different production functions.
First, the manager can affect the total physical output through the efficiency with which he utilizes the given resources. This efficiency is determined by the manner in which he plans, directs and controls the utilization of the given resources. These are the technical aspects of operational management.

Secondly, the manager can affect the level of income attained from the actual physical output by selecting the kinds, qualities and quantities of a predetermined set of major lines of products and services which yield the highest ratio of marginal revenue to marginal cost. Because elevator firms operate in an imperfect market, he can widen this ratio through his pricing policy, advertising program and other aspects of his market offer. Moreover, he can increase the total return from the actual total volume of output by promoting complementary products and services and de-emphasizing one or more items of a group of competitive outputs. These are the economic aspects of operational management.

Thirdly, the level of income obtained from given resources is, in part, a function of the environment in which the firm operates. These restrictions on the manager's choice of alternatives include the factor and product markets, the quality of resources, restrictions imposed by overall management and personal characteristics of the operational manager.

It is plausible that many environmental factors are related to the level of management. Productive managers, for example, may be reluctant to manage firms facing severe restrictions. Further, the severity of these restrictions may over the long run be influenced by the level of management. If this is true, the estimates of the productivity of management in a Cobb-Douglas type function will be biased if these
environmental factors are not included in the model (8).

Making use of these relationships, it is possible to specify an economic model such that total income (TI) is a function of the level of physical inputs (X₁), managerial methods and techniques (zᵢ), and environmental variables (uᵢ). In a general mathematical form, the model for a multiproduct firm facing multiple production processes can then be written as

2.2 \[ F(T₁, T₂, \ldots Tₙ; X₁, X₂, \ldots Xₙ; z₁, z₂, \ldots zᵢ; u₁, u₂, \ldots uᵢ) = 0 \]

The lack of independence in the production processes and in the market as well as the failure of accounting data to separate the sources of income and costs prohibit the estimation of enterprise production functions. However, with respect to management, one can draw valid and possibly more useful inferences from a function aggregated over all products and inputs. This model can be written as

2.3 \[ TI = f(X₁, X₂, \ldots Xₙ; z₁, z₂, \ldots zᵢ; u₁, u₂, \ldots uᵢ) \]

For estimation purposes, the functional form must be specified. Normally, the criteria for selecting the appropriate form is consistency with economic theory, a priori knowledge and conformance with the data. The complete lack of previous estimates reduces the criteria for the present models to consistency with theory. A further problem in determining the specific form of the model is the designation of the manner in which management and environmental factors affect the production function. They can modify the intercept and/or the slope of the function. Many forms of production functions are consistent with economic theory.
Therefore, several alternative forms have been developed for estimation.

The fundamental assumptions of the first set of models are:

1. There are certain fixed factors of production, $X_{fj}$, over which the operational manager has no control.
2. There are certain measurable environmental variables restricting the alternatives of manager $j$ denoted by $u_{qj}$.
3. There are certain measurable management methods and techniques, denoted by $z_{pj}$ which are utilized by operational manager $j$.

The estimation of the functional relationship between income and $z_p$ implies the $z_p$ are not highly correlated. Observing the use of highly productive $z_p$ in one area of management by manager $j$ does not necessarily imply the existence of highly productive $z_p$ within the same area or in other areas of management.

Model I

The first model is developed in linear form. Although one would not expect the total income function to be linear throughout, it is entirely possible that it is linear within the range of data available for this study. The basic hypothesis of the first model is that the input-output coefficient of the $i$th input is a function of the management of the $i$th input and of environmental factors affecting the use of the $i$th input; that is, management and environmental factors affect the slope of the production function.
As shown above, with a given level of inputs, the firm utilizing the most productive management methods, would be operating on curve A. With an input of $X_1$, income would be $Y_2$. The firm utilizing less productive methods would be operating on curve B and would realize only $Y_1$ income with an input of $X_1$. In linear form, Model I can be written as

$$2.4 \quad TI_j = A + \gamma_j X_j + e$$

where

- $TI_j = \text{total income (value added) of the } j^{\text{th}} \text{ firm}$
- $A = \text{intercept}$
- $\gamma_j = \text{input - output coefficient}$
- $X_j = \text{input of the } j^{\text{th}} \text{ firm in dollars}$
- $e = \text{error term}$.

Let $\gamma_j$ be given by
2.5 \[ Y_j = a_0 + a_1 U_j + a_2 Z_j. \]

Let \( U_j \) be an index of environmental factors affecting the productivity of \( X \) such that

2.6 \[ U_j = u_{1j} + B_j u_{2j}. \]

where \( u_q \) is the \( q^{th} \) restriction imposed on the management of \( X \).

Let \( Z_j \) be an index of management such that

2.7 \[ Z_j = z_{1j} + z_{2j}. \]

where \( z_p \) is the \( p^{th} \) management practice or technique affecting \( X \).

Substituting and solving

2.8 \[ T_j = A + [a_0 + a_1 u_{1j} + a_2 B_{2j} + a_2 z_{1j} + a_2 z_{2j}] X_j + e. \]

The method of least squares can be used to estimate 2.8. Under rigid assumptions, this method gives the best linear unbiased estimates of the parameters in the generalized least squares model

2.9 \[ Y = X \beta + \epsilon \]

where \( Y \) is a column vector of values of the dependent variables, \( \beta \) is the column vector of parameters to be estimated, \( X \) is a matrix of values of all independent variables and \( \epsilon \) is the error vector with elements \( e_i \).

If the following assumptions regarding the errors hold, i.e.,

(1) \( e_i \) are random and normally distributed

(2) \( E(e_i) = 0 \)
(3) $E(e_i^2) = \sigma^2 < \infty$

(4) $E(e_i e_j) = 0 \quad i \neq j$

(5) The $e_i$ are fully independent of the $X_i$, the estimates of $\beta$ are unbiased, consistent, efficient and sufficient (30, pp. 9-47). Further, the assumptions of normality and independence permit one to make tests of significance on the various estimates. If the assumption of normality is relaxed, the estimates remain the best linear unbiased estimates. If assumption (5) does not hold, single equation estimates are biased. However, the first set of models assumes the level of inputs to be predetermined; hence, by this assumption the errors are independent of the $X_i$. More will be said of this assumption in the discussion of the second set of models.

Use of the method of least squares will yield the following estimators of the parameters of Model I:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimator</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A$</td>
<td>$b_0$</td>
</tr>
<tr>
<td>$a_0$</td>
<td>$b_1$</td>
</tr>
<tr>
<td>$a_1$</td>
<td>$b_2$</td>
</tr>
<tr>
<td>$B$</td>
<td>$b_3/b_2$</td>
</tr>
<tr>
<td>$a_2$</td>
<td>$b_4$</td>
</tr>
<tr>
<td>$z$</td>
<td>$b_5/b_4$</td>
</tr>
</tbody>
</table>

The $u_q$ and $z_p$ are discontinuous variables. The usual tests of significance can be applied to the net regression of total income on the $u_q$ and $z_p$. The "t" test can be used to test the null hypothesis, $b_i = 0$. Rejection of this hypothesis can be interpreted as meaning a significant change in the total income from the alternative managerial methods or
techniques used in a specific phase of management. The "F" test can be used to test for significance of management areas; that is, to test the null hypothesis, $b_2 = b_3 = 0$.

Model I has been specified as a linear function which will not permit diminishing marginal returns. The Cobb-Douglas function, which is linear in logarithms, does permit decreasing marginal returns (27). Although a function linear in logarithms does not permit decreasing total returns, such phenomena probably do not occur in the relevant range of the size of cooperative elevators. The transformation of Model I into the Cobb-Douglas form can be made as follows

\[ 2.10 \quad T_I = A X \]

Taking the logarithms of 2.10, Model I becomes

\[ 2.11 \quad \log T_I = \log A + \left[ a_1 + a_2 u_1 + a_3 u_2 + a_4 z_1 + a_5 z_2 \right] \log X + \epsilon \]

The usual tests can be applied to the function.

Model II

A second model can be specified to test the hypothesis that the height of the production surface is a function of management and environment.
As shown above in logarithms, the firm utilizing the most productive management methods and techniques would be operating on curve A and would realize a higher income than the firm operating on curve B. This relationship, when specified as a linear additive model with arithmetic values, implies an absolute difference in income from alternative management methods; that is, the increase in income from highly productive management is independent of the level of inputs. This relationship clearly does not hold. For example, if, in the case of wholesale purchasing, the productive manager is able to purchase merchandise at a lower price, the resulting increase in total income is not independent of the size of the firm. Thus, the algebraic form should clearly be multiplicative if the model specifies management as affecting the height of the surface.

Using the Cobb-Douglas form and the same symbols as before, Model II becomes
2.12 \[ TI = A \begin{bmatrix} a_1 & a_2 & a_3 & a_4 \\ u_1 & u_2 & z_1 & z_2 \end{bmatrix} x_1^{a_5} e \]

where the term \( A \begin{bmatrix} a_1 & a_2 & a_3 & a_4 \\ u_1 & u_2 & z_1 & z_2 \end{bmatrix} \) is the intercept. Taking logarithms, 2.12 becomes

\[ 2.13 \quad \log TI = \log A + a_1 \log u_1 + a_2 \log u_2 + a_3 \log z_1 + a_4 \log z_2 + a_5 \log X_1 + e \]

Within the relevant range of country elevator data, it is probable that the marginal returns to the physical inputs are decreasing. This does not preclude the possibility of management and environmental factors being specified in an exponential form. Hence Model II in this form becomes

\[ 2.14 \quad TI = A 10^{a_1 u_1 + a_2 u_2 + a_3 z_1 + a_4 z_2 + a_5} \]

Taking logarithms, 2.14 becomes

\[ 2.15 \quad \log TI = \log A + a_1 u_1 + a_2 u_2 + a_3 z_1 + a_4 z_2 + a_5 \log X_1 + e \]

Again, the usual tests can be applied to the \( u_q \) and \( z_p \).

A third model could be developed by combining the features of Models I and II. For example, the \( z_p \) could be permitted to affect the height and the \( u_q \) could affect the coefficients. Interpretation of such a model would, however, be difficult because of interaction. That is, a firm with a high valued \( z \) affecting the height and a low valued \( u \) affecting the slope would show a relatively large output at low levels of inputs and a relatively small output at large inputs compared to a firm with a low
value of the same \( z \) affecting the height and a high value of the same \( u \) affecting the slope.

Unfortunately, it is difficult to determine which specification is the true function. Tests are not available to determine which function best fits the data. One method of selecting among them is to compare the fit of the functions and select the one with the largest \( R^2 \). A second method is to select the function which yields the most significant variables with signs consistent with logic, principles of management and economic theory.

Model III

A second set of models can be formed by relaxing the assumption of fixed inputs and assigning the responsibility for the level of some inputs to the operational manager. In practice, operational management possesses more authority than postulated by the first set of models; that is, operational management does exercise control over the levels of some inputs and so can maximize profits in the usual sense. The relaxation of the fixed input assumption introduces statistical difficulties into the estimation of production function coefficients. As noted above, the method of classical least squares requires, among others, the assumption of fixed \( X_i \) if the estimates of the parameters are to be unbiased. If the level of variable inputs is determined by maximizing with respect to current output, the production function is, in reality, a member of a system of equations. In this system, the level of variable inputs, the level of output and the level of profits are jointly dependent. In modern terminology, these jointly dependent variables are called endogenous. An
endogenous variable is defined as a variable whose value is assumed to be correlated with the error in the equation in which it occurs. If an equation contains two or more endogenous variables, the least squares assumption of fixed $X_i$ is not fulfilled. It has been shown that the least squares estimates of an equation containing two or more endogenous variables will be statistically biased (9).

Wold has indicated the magnitude of the resulting simultaneous bias in the least squares estimate of an equation in a simultaneous system (32, p. 37). For the one variable case where $y = \beta x + z'$ is the true relationship and $y = bx + z$ is the observed relationship,

$$
\text{plim } b = \frac{E(xy)}{E(x^2)} = \beta + \frac{E(xz')}{E(x)^2} = \beta + r(xz') \frac{\sigma z'}{\sigma x}
$$

where $r(xz')$ is the correlation between $x$ and $z'$. Thus, if $r(xz')$ is small and $\frac{\sigma z'}{\sigma x}$ is small, the bias is small of the second order.

As a means of avoiding the bias in the single equation approach to jointly dependent variables, the simultaneous equation method of estimation has been developed. The following assumptions are made in the simultaneous method:

1. The exogenous or predetermined variables, i.e., those variables not influenced by the system, are independent of the error $e_i$.

2. The $e_i$ are normally distributed

$$
E(e_i^2) = \sigma^2 < \infty
$$

3. $E(e_i e_j) = 0 \quad i \neq j$

4. The $e_i$ are the result of errors in the equation.

A just identified system is one such that the number of exogenous variables
in the system and not in the equation, is one less than the number of endogenous variables in the equation at hand. If the number of excluded variables equals or exceeds the number of endogenous variables in the equation, the equation is overidentified.

The coefficients of the specified structural equations in a just identified system can be estimated in the following manner. By algebraic manipulation, transform the system in a manner such that each endogenous variable is expressed as a function only of the predetermined variables in the system. Estimate each of the transformed equations, the so-called reduced form equations, by least squares. Then transform these coefficients into the coefficients of the structural equations. If the equation is overidentified, the method of limited information can be used to estimate the coefficients.

A simultaneous system to estimate the relationship between profits and managerial methods logically should be based on the theory of the firm. Assuming one endogenous input \( X_v \) and one fixed input \( X_f \), the equation defining the quantity of \( X_v \) to be used in production should, therefore, be a function of the quantity of \( X_f \), the price of the variable input \( P_v \), the price of the output \( P_o \), management methods \( Z_p \), and environmental restrictions \( U_q \). The system would consist of the following three equations:

\[
\begin{align*}
\text{2.16} & \quad \pi = T - P_f X_f - P_v X_v \\
\text{2.17} & \quad T = f(X_f, X_v, Z_p, U_q) \\
\text{2.18} & \quad X_v = g(X_f, Z_p, U_q, P_o, P_v)
\end{align*}
\]

where 2.16 is a profit identity, 2.17 is a production function in value
terms and 2.18 is an equation defining the quantity of \( X_v \) to be used in production. Ignoring the \( z_p \) and \( u_q \), the optimum quantity of \( X_v \) can be specified by taking the partial derivative of 2.17 with respect to \( X_v \). However, if deviations from the optimum quantity of \( X_v \) are assumed to be a function of management, it is difficult to specify 2.18 because both positive or negative deviations from the optimum quantity of \( X_v \) are undesirable. As illustrated below, \( X_v \) then becomes a double valued function of management and the optimum quantity of \( X_v \) can be approached from either direction. Thus, one cannot easily specify \( X_v \) as a single valued function of the \( z_p \) and \( u_q \). If such a function could be conveniently specified, one procedure would be to estimate 2.18 directly and combine 2.17 and 2.18 to get a reduced form equation. On the other hand, it is reasonable to assume profit to be a single valued increasing function of management. Thus, it may be possible to go directly to a profit model which is itself a sort of reduced form equation. This type of
model is derived below.

Let the production function in value terms be

\[ TI = b_1 T - b_2 X_v \]

with the specified restriction of constant returns to scale (i.e.,
\[ b_1 + b_2 = 1 \]). Since \( P_o = P_v = 1 \), the optimum quantity of \( X_v \) is given by

\[ \frac{\partial TI}{\partial X_v} = \frac{b_2 TI}{X_v} - 1 = 0 \]

or

\[ X_v = b_2 TI \]

\[ = \left[ \frac{b_2}{b_1} \right]^{1/b_1} X_f. \]

From 2.16 and 2.21, maximum profit is given by

\[ \max \tau = TI - X_f - b_2 TI \]

\[ = (1-b_2) TI - X_f \]

\[ = (1-b_2) a (b_2 a)^{b_2/b_1} X_f - X_f. \]

Let

\[ K = (1-b_2) a (b_2 a)^{b_2/b_1}. \]

Therefore,

\[ \max \tau = KX_f - X_f \]

Simplifying,

\[ \left[ \max \frac{\tau}{X_f} + 1 \right] = K. \]
Now assume deviations from maximum profits are due to operational management and environment; that is, $K$ can be affected by the choice of $X_y$ as well as by the manner in which the $z_q$ and $u_p$ affect the production function. Further, assume the total effect can be represented by

$$2.26 \left[ \frac{\text{actual } \Pi}{X_f} + 1 \right] = a^i Z_1 b_{1i} b_{2i} \cdots b_{pi} \cdots b_{p+1} u_1 b_{p+2} \cdots b_{p+q} u_q.$$ 

This equation can be transformed into logarithms and estimated by least squares.* The estimates will be free of simultaneous bias, since all regressors are assumed to be exogenous.

Since the operational manager is assumed to determine the level of some inputs with respect to current output, the appropriate model to estimate managerial productivity is 2.26. Nevertheless, the fixed input models can provide some indication of the effect of management on the production function. Therefore, models of each type will be estimated in this study.

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*This model generalizes to $n$ variable inputs by deriving the optimum quantity of all variable inputs in terms of one variable input.
APPLICATION OF THE MODELS

The Data

In actual practice, the general manager may be responsible for both overall and operational management. The amount of assistance given the general manager for overall management depends primarily on the basic economic structure of the firm (22, p. 14). Because of these differences in managerial responsibility in firms of different economic structure, it seemed desirable to select a sample in which the responsibility of the general manager was somewhat comparable. The sample was selected from a population of cooperative elevators audited by the Farmers Grain Dealers Association of Iowa.*

The objective of the sampling methods used in this study was to select a sample of firms operated under varied levels of managerial productivity. Because of the exploratory nature of the study, it was believed that managerial variability was more important than proportionate representativeness of the population. The population of elevators considered was stratified on the basis of two levels of return on investment, two levels of rate of growth and two levels of manager tenure. Six observations were chosen at random from each of the eight cells.

The data for this study came from two principle sources: (a) financial statements from the sample of 148 elevators and (b) a survey of the managers of the elevators in the sample.

*Actually, three corporate type firms were included in the sample. However, in each of these three cases, the responsibilities of the salaried manager were similar to those of cooperative managers.
More observations were required for the estimation of the coefficients in the above models than necessary for the estimation of traditional production functions. To meet this requirement, eight years (1950-57) of financial data were obtained from each of the 48 elevators. The time series data also were obtained for other reasons. These data minimize the possibility of some firms operating at the optimum input and output combinations by accident. Further, these data reduce the effect of any windfall gains reflected in the accounting data in a given year.

Accounting data are not ideal for regression analysis. Such data are normally available only on a fiscal year basis with the fiscal period varying among firms. The balance sheet, the primary source of data for capital inputs, indicates the level of capital inputs at the end of the fiscal period. The levels of some inputs, such as accounts receivables and inventories, fluctuate widely during the year. Under these conditions, the financial data for two firms with different fiscal periods would indicate a wide difference in the quantity of inputs even though the firm might actually be using approximately the same amounts of each input. Use of uncorrected financial data implies errors in the independent variables. In the case of one independent variable, Fox (6, pp. 29-35) has shown the direction and magnitude of the bias in the estimate of the least squares coefficient resulting from errors in the independent variable. Ladd has suggested that the coefficients may not be biased but the standard errors may be larger in the multiple variable case (19). To minimize the implications of errors in the variables, the data were adjusted to a common fiscal period. The adjustment was made on
the basis of monthly statements obtained from firms in the sample.

Further adjustments were required to approximate the actual level of capital inputs. If the end of the period values are used directly from the balance sheet, one would be hypothesizing that conditions at the end of the period influence the behavior of the firm at the beginning of the same period. Accordingly, the mean of the beginning and ending values were used as an approximation to the actual inputs.

Valuation of fixed assets presented another serious accounting problem. These assets are normally entered on the firm's records at cost. If comparable assets are purchased in different time periods, inflation or deflation will result in different costs. Since the models used in this study are in value terms, differences in cost imply different quantities of assets. To circumvent this difficulty, an iterative method was devised to deflate the net yearly additions to fixed assets. Current additions were excluded from fixed assets in the deflation process under the assumption that new additions to fixed assets are largely unemployed during the fiscal year in which the inputs are purchased. To simplify the presentation of the deflation process, assume only two years of data.

Let

\[
\text{fixed assets} = FA \\
\text{depreciation} = D \\
\text{wholesale price index} = PI
\]

The deflation method used was:

\[
3.1 \quad \text{Deflated } FA_{t-1} = \frac{FA_{t-2}}{PI_{t-2}} - \frac{D_{t-1}}{PI_{t-2}}
\]
3.2 Deflated \( FA_t = FA_{t-1} + \frac{FA_{t-1}}{PI_{t-1}} \left( FA_{t-2}(PI_{t-2}) + (\Delta FA_{t-1})(PI_{t-1}) \right) \)

\[
= \frac{FA_{t-2} + \Delta FA_{t-1}}{FA_{t-2} + \Delta FA_{t-1}}
\]

Income and profits were also adjusted to reflect returns arising only from the business itself. Patronage refunds from regional cooperatives and dividends on stock were subtracted from revenue and profits, since these items are exogenous sources of income. Likewise, investments in regional cooperatives were excluded from total assets. Moreover, accelerated depreciation was added to profits so to avoid institutional differences in profitability.

An adjustment was also made on the value of the labor input as reflected by the accounting statements. Normally, total labor expense includes the manager's salary. Some managers do perform labor services. To approximate the total labor input, a scale was used to arrive at the portion of the manager's salary which would constitute a labor input. It was assumed the amount of labor performed by the manager was inversely related to the number of employees. If non-manager labor expense was less than $30,000, seventy-five percent of the managers' salary was assumed to represent labor. For each $10,000 increase in non-manager labor expense, twenty-five percent of the total managers' salary was subtracted from the labor input.

Finally, all data were deflated by the wholesale price index other than farm products and foods (31, p. 24).
Construction of scales

The schedule for the survey consisted of both quantitative and non-quantitative questions.* The quantitative questions were concerned with price levels, some personal characteristics of the manager, and the capacity and location of facilities. The non-quantitative questions were concerned with the analytical methods and tools used in each area of management and with restrictions in each area of management. The answers to the latter questions required quantification for application to the regression models.**

The quantification of the non-numerical answers was accomplished by two methods. First, the answers were scaled on the basis of the regression coefficients of the regression of total income on dummy variables for a given question. The dummy variables, R_i, were given the property that R_i = 1 if the manager responded with a given answer; otherwise R_i = 0. If all dummy variables (all answers) are included in the equation, this method will result in a singular moments matrix and indeterminate estimates of the parameters (25). Imposing the restraint that one of the regression coefficients equal zero will permit determinate estimates. Using this procedure, the estimated regression coefficients were assigned as the numerical values provided the coefficients were consistent with logic and a priori knowledge and possessed at least a 50 percent chance

---

*The schedule was based primarily on a group of hypotheses set forth by Phillips in (22, pp. 253-552).

**It should be pointed out that these answers were not measurements of actual behavior; rather they were opinions or statements by the manager of what managerial methods and techniques were used. It is recognized that some responses may not reflect actual behavior.
of differing from zero. In all cases, the scales were coded into positive numbers. When the "t" test indicated the regression coefficients had less than a 50 percent of differing from zero, the answers were scaled exclusively on the basis of logic and the writer's a priori knowledge of management supplemented by management texts; specifically (22).*

Construction of indices

Available computing equipment (IBM 650) restricts regression models to a maximum of thirty variables. Approximately eighty variables were considered for each of the models to be estimated in this study. Assuming the variables relevant to each model are correlated, estimation of an incomplete model would result in specification bias. This leads to an attempt to construct artificial variables or indices as combinations of the real variables. The method of factor analysis has been developed to deal with similar problems in psychology.

Factor analysis is a mathematical extension of correlation analysis. The purpose of factor analysis is to obtain r factors which account for the correlations of p primary variables such that $r \leq p$. If $r < p$, it appears that factor analysis would be useful in constructing indices of management methods used in each area of management and to develop indices of restrictions which limit the alternatives open to the operational manager. A method of factor analysis developed by Hotelling (17), the so-called principle components, was used to construct indices for this study.

*Scaling as used in this study refers to operationalizing theoretical concepts into empirical measures.
Principle components are normalized linear combinations of the original variables. The first principle component contains more statistical information about the p variables than any other index; in other words, the first principle component has maximum variance. Each succeeding principle component contains more of the residual statistical information than any other index.

The concept of principle components is as follows. Assume a linear combination,
\[ \sum_{i=1}^{p} a_i x_i \]
and the coefficients normalized by \( a_i^2 = 1 \). The variance of 3.3 is given by
\[ \frac{\sum_{i,j} \sigma_{ij} a_i a_j}{\sum (a_i)^2} \]  
(2, pp. 17-20).

The variance is maximized if the coefficients \( a_j \) satisfy
\[ \sum_{j=1}^{p} \sigma_{ij} a_j = \lambda a_i \]
where \( \lambda \) is the largest root of the determinantal equation
\[ (K - \lambda I) = 0, \]
and where \( K \) is the covariance matrix of the \( x_i \). It has been shown that the coefficients, \( a_j \), maximizing 3.4 are the elements in the characteristic vector of \( K \) corresponding to the largest characteristic root (1, pp. 272-279).

The linear combination
\[ U_1 = \sum_{i=1}^{p} a_i (1) x_i \]
is called the first principle component of \((X_1, X_2, \ldots, X_p)\) and its variance is \( \lambda_1 \). The second principle component is orthogonal to the first and
accounts for the maximum variance after the first principle component. Successive principle components are orthogonal and each accounts for the maximum residual variance.

There are p principle components of the observed variables \( (X_1, X_2--X_p) \). Frequently, most of the statistical information of these variables rests in the first few principle components. In this event, the components with relatively small \( \lambda \) can be ignored and the objective of constructing \( r \) artificial variables from \( p \) real variables were \( r < p \) is fulfilled.

The variables \( (X_1--X_p) \) are frequently measured in different units. Principle component analysis is most satisfactory when the \( X_i \) are measured in the same units (1, p. 279). A method of specifying a standard unit is to define each variable in terms of its standard deviation. Thus, \( K \) is replaced by \( R \), the correlation matrix.

For ease of calculation, the characteristic vectors were not normalized; that is, the elements in the characteristic vectors were not divided by the square root of their sums of squares. This factor is a constant for each principle component. In effect, the elimination of this step modifies the absolute values of the weights.

Since many of the elements in the characteristic vectors were negative, the linear combination \( \sum a_i x_i \) frequently was negative. The logarithm of a negative number is undefined. To satisfy the requirements of a Cobb-Douglas model, a constant was added to make the indices positive. The addition of this constant amounts to shifting the origin of the surface.

From a statistical point of view, principle components contain more
information than any other index and further are uncorrelated and ordered according to their variance. However, it was believed that one subjective index based on a priori knowledge of management could be formed to represent the management of a given area and would replace two or more principle components representing the same area of management. Models composed of each type of index were estimated. The usefulness of principle components as a method of constructing indices for this study was tested by comparing the estimates of these models. The type of index resulting in the best fit and the most significant variables was judged as better.

Statistical Tests

As indicated above, the "t" and "F" tests of significance are to be applied to the statistical estimates obtained from the models. However, time series data and possible errors in scaling the non-numerical data violate, to some extent, the assumptions required of the error term to make the tests precise. Furthermore, the interpretations of the tests must be tempered when several regressions are computed from a given set of data. However, these tests do provide an indication of the reliability of the estimates and will be applied to the estimates in this study. The term "significant" will be applied to estimates which reject the null hypothesis at the 5 percent level.

Description of Questionnaire and Scales

The purpose of this section is to describe the schedule questions and answers, to present the numerical scales where scaling was required, and to discuss the logic of the questions and numerical scales. Since one objective of this study was to estimate the productivity of management
in each area of operational management, indices were constructed from management variables or environmental variables within a given area of management. Accordingly, this section will be discussed in terms of management areas. The specific areas of operational management considered in this study were: (1) employee management (2) customer relations management (3) merchandising management which includes retail merchandising and wholesale trading management, (4) inventory management, and (5) retail credit management. On the assumption that this sample of managers has partial responsibility for overall management, an attempt was made to measure the productivity of the salaried manager at this level of management.

To facilitate description of the variables and indices, let $z_{pj}$ be management variables where $j$ is the $j$th variable in the $p$th management area. Let $z^k_p$ be the $k$th principle component in the $p$th management area. Let $u_{qj}$ be the $j$th variable in the $q$th environmental factor. Let $v^k_q$ be the $k$th principle component of the $q$th environmental factor. Let $Z_p$ be the subjective index of the $p$th management area and $V_q$ be the subjective index of the $q$th environmental factor.

**Restrictions on retail merchandising management**

**Plant and equipment** A major environmental factor restricting the productivity of the manager in the general area of merchandising is the quality of the available plant and equipment. Clearly, the capacity and dependability of these facilities restrict the maximum physical volume of business. Moreover, the operating efficiency of the equipment affects the cost per unit of output and the profitability of the firm.
Given the same quantity of plant and equipment, differences in capacity may arise from quality differences which include plant layout and design, and obsolete (or worn out) units which create restrictions on the efficiency of other equipment. Data available from financial statements do not reflect quality or capacity of the plant and equipment. To approximate a quality variable, the schedule was designed to obtain data on the capacities of plant and equipment per unit of time. It was believed that differences in capacity of the plant and equipment of these firms exist primarily in grain and feed handling facilities and in warehousing facilities. Therefore, the managers were asked to estimate the following:

- \( u_1 \) = grain receiving capacity per 10 hour day
- \( u_2 \) = grain grinding capacity per 10 hour day
- \( u_3 \) = grain and feed mixing capacity per 10 hour day
- \( u_4 \) = grain drying capacity per hour
- \( u_5 \) = number of head house bins
- \( u_6 \) = average capacity of head house bins
- \( u_7 \) = number of bins in the mill
- \( u_8 \) = average size of bins in the mill
- \( u_9 \) = tons of bulk feed that can be moved out of the warehouse per 10 hour day
- \( u_{10} \) = tons of bagged feed that can be moved out of the warehouse per 10 hour day
- \( u_{11} \) = tons of bulk fertilizer that can be moved out of the warehouse per 10 hour day
- \( u_{12} \) = time required to unload a 40 ton car of bulk feed
The questions required numerical answers and no scaling problem was involved. Three indices of these data were constructed by principle components and one by subjective evaluation.* The $\lambda$ for the three principle components were 4.20, 2.37, and 1.82, respectively. The total variance of these variables equals sixteen; it follows that the first principle component accounted for twenty-six percent of the total variance; the second principle component accounted for fifteen percent and the third principle component accounted for eleven percent. Thus, the three principle components accounted for over one half of the total variance of the sixteen variables. From Table 1, it can be seen that the first principle component was primarily a function of grinding and mixing capacity, number of bins in the mill, and bulk feed handling facilities. The second principle component was largely a function of grain receiving facilities whereas the third component was largely a function of warehousing facilities. The subjective index was primarily a function of the grain receiving, grain drying, and grinding and mixing capacities.

**Competitive situation** The adequacy of plant and equipment can affect the productivity of the manager in retail merchandising, wholesale merchandising and inventory management. Another environmental factor which is closely related to retail merchandising management is the

*See Table 1 for the weights of these indices.*
competitive environment in which the firm operates.

The total demand facing the firm is restricted by the size of the market areas serviced by the firm. Moreover, the individual firms share of this total market further depends on the number, location, and aggressiveness of the competitors operating in this market. Based on these variables, an attempt was made to approximate the competitive situation facing the firms in the sample. The managers were queried on the following:

\[ u_2 1 = \text{total number of competitors} \]
\[ u_2 2 = \text{number of competitors in the same town} \]
\[ u_2 3 = \text{number of competitors in the trade area but not in the same town} \]
\[ u_2 4 = \text{number of competitors outside the trade area} \]
\[ u_2 5 = \text{economic structure of the most aggressive competitor} \]
\[ u_2 6 = \text{reciprocal of the size of the trade area in square miles} \]
\[ u_2 7 = \text{location of the most aggressive competitor} \]

All questions required numerical answers except \( u_2 5 \) and \( u_2 7 \). The answers to \( u_2 5 \) were classified as (a) cooperative, (b) independent, and (c) line company. The scales assigned to these three answers were 3.0, 2.0, and 1.0, respectively. The high value assigned cooperatives was based on the competitive advantage given these firms by member loyalty and potential patronage refunds. Further, it was assumed that the probability of the independent owner being a member of the community would result in a competitive advantage over the line firm. Some respondents were unable to decide between two very aggressive competitors. In this case, a value of 4.0 was assigned since two very aggressive competitors
would probably result in further restrictions on the demand facing a
given firm.

The answers to ug 7 were classified as (a) outside the trade area
(b) inside trade area but not in the same town and (c) in the same town.
It seemed reasonable to place answers a and c at opposite ends of the
scale. The values assigned to the three answers were 1.0, 2.0, and 3.0,
respectively.

Two indices of these variables were constructed by principle com­
ponents and one by subjective evaluation.* The \( \lambda \) for the two principle
components were 2.39 and 2.08, respectively. The first principle com­
ponent removed thirty-four percent of the total variance and was primarily
a function of the number of competitors in the same town, the location
of the most aggressive competitor and the size of the trade area. The
second principle component was primarily a function of the total number
of competitors, the number of competitors outside the trade area and the
economic structure of the most aggressive competitor. It accounted for
thirty percent of the total variance. The subjective index was primarily
a function of the total number of competitors and the size of the trade
area.

**Level of margins** Taking the level of demand as given, a retailing
firm can alter the quantity sold by changing the markup or per unit mar­
gin. The effect on these changes on total income will depend on the elas­
ticity of demand where elasticity of demand is defined as

\[
\frac{\text{relative change in quantity}}{\text{relative change in markup}}
\]

If the absolute value of this ratio is
greater than one, the demand is said to be elastic. In this event, a

*See Table 2 for weights of these indices.*
reduction in margins will increase total income since the quantity sold will increase relatively more than the reduction in margins. If the absolute value of this ratio is less than one, the demand is said to be inelastic. If this case exists, an increase in margins will increase total income since the quantity sold will decrease relatively less than the increase in margins.

The effect of margin changes on profits can be determined by defining unit costs to include the net change in the wholesale costs associated with changes in volume. If the change in margins results in larger increases or smaller decreases in total income than in total costs, profits will increase.

However, the above holds exactly only if rival firms are not significantly affected by the change in margins and do not react to the change. Managers of country elevators have discovered, however, that they must consider the reactions of their competitors. Although there are over one thousand country elevators in Iowa alone, only a very small number of firms compete for the business in a given area. In fact, the respondents in this study indicated the number of competitors in the given market areas ranged from only two to thirteen. These mutually interdependent firms operate in an oligopoly setting characterized by highly stable margins. A theoretical explanation of this behavior is the existence of a kinked demand curve.

The fundamental assumption of the kinked demand curve is that competitors will, in reaction to a decreased price, lower their own prices to maintain their share of the market. However, if one firm increases its price, competitors are assumed to maintain the current price, thereby
increasing their share of the market. In a sense, the firm faces two demand curves; one curve represents the demand facing the firm assuming no reaction (DD); the other (D'D') represents the demand facing the firm assuming reaction on the part of the competitors (13, p. 186).

The effective demand curve, DD', contains a kink which results in a discontinuous section of the marginal revenue curve. Assuming the marginal cost curve MC, the profit maximizing price and output are Po and Qo, respectively. Shifts of the firm's marginal cost curve within the range of the vertical section of the marginal revenue curve will not affect the profit maximizing price and the price level remains stable.

Although the kinked demand curve explains price rigidity in some circumstances, it does not explain the location of the kink. Clearly,
the position of the kink affects the level of revenue and profits of the firm. The level of margins, although relatively stable within the trading area of country elevators, vary widely among trading areas. To account for differences in potential profitability arising from different price levels among trading areas, an index of margins was included in the model. The managers were asked what margins they take on the following:

\[ u_3^1 = \text{corn} \]
\[ u_3^2 = \text{soybeans} \]
\[ u_3^3 = \text{feed} \]
\[ u_3^4 = \text{fertilizer} \]
\[ u_3^5 = \text{petroleum products} \]
\[ u_3^6 = \text{seed} \]
\[ u_3^7 = \text{lumber} \]
\[ u_3^8 = \text{chemicals} \]
\[ u_3^9 = \text{grinding and mixing} \]
\[ u_3^{10} = \text{corn storage} \]

To approximate the level of margins within trading areas, the various commodity margins taken by firms located in the same general market area were averaged. This average value was applied to all firms within the trading area. Two indices of these average margins were computed by principle components and one by subjective evaluation.* The \( \lambda \) for the two principle components were 2.88 and 2.32, respectively. The first principle component was primarily a function of feed, fertilizer, lumber and chemical margins and corn storage charges. It accounted for twenty-nine percent of the variance. The second principle component was

*See Table 3 for the weights of these indices.
primarily a function of grain margins and removed approximately twenty-three percent of the total variance.

The subjective index was based on the assumption that the commodity weight should be proportional to the part of the total income derived from each commodity or service. These weights, therefore, were computed by dividing the total income derived from each source by the total income of all firms. The subjective index was mainly a function of grain and feed margins.

Retail merchandising management

The kink in the demand curve is sharpest for homogenous products. Conversely, buyers tend to be less responsive to price changes of differentiated products. As a result, competing firms do not react as strongly to price changes and the kink in the demand curve becomes less sharp or may even disappear. Therefore, the manager cannot assume the current price always maximizes profits. Rather he must attempt to establish margins which equate marginal revenue and marginal costs.

Elevator managers use a variety of methods in setting retail margins. To ascertain whether the level of revenue or profit is affected by these methods, the managers were asked how they determine their pricing policy. The replies were classified as: (a) use wholesalers suggested price, (b) custom, (c) competition, (d) cost plus, and (e) planned pricing. These answers were scaled as 1.0, 1.0, 1.0, 2.0, and 3.0, respectively. Logically, a pricing policy based on planning to approximate demand and cost conditions should be the best procedure. Therefore, (e) was assigned the largest value. It has been suggested that under certain conditions,
pricing on a cost plus basis may approximate profit maximization (5, pp. 273-274). Therefore, the cost plus method was assigned a value of two.* No attempt was made to differentiate among the first three answers and each was assigned a value of one. A regression of total income on cost-plus as one dummy variable and the grouped answers as a second dummy verified the direction of these scales.

Determining a discount policy is closely related to the problem of determining the level of margins. A properly planned discount program can be an effective pricing strategy in country elevators because competitors do not tend to react strongly to this type of pricing. The question "How do you determine your discount policy" was included in the schedule. Some managers had no definite discount policy. A value of .1 was assigned to this answer. Other managers had discounting systems based on wholesaler recommendations or custom or competition. These systems may be better than no system but there is no guarantee that they will result in the optimum policy. Another group of discount policies were based on costs only; specifically handling costs or accounts receivable costs.

In assigning values, no attempt was made to distinguish between the policies based on competition, custom and wholesale recommendations and those based on costs. A value of .2 was assigned to each. A third group of policies was based on some degree of planning which considered the change in income and costs. Logically, a system of discounts should be based on the expected change in total income relative to the expected

*Some managers in this group indicated they added a percentage of purchase price to arrive at the retail price. It was assumed that this percentage yielded a margin approximately equal to the cost of handling that commodity plus a profit margin.
change in total costs. Therefore a value of 1.1 was assigned to these answers.

A third phase of retail merchandising management is advertising. The basic purpose of advertising is to shift the demand curve to the right; thereby making it less elastic at a given price. In planning an advertising program, the manager must make decisions about the type and amount of advertising. Clearly, any approximation of the optimum type and amount of advertising should be made on the basis of expected changes in total income and total costs resulting from additional units of advertising. However, many managers have no advertising program or devise programs by methods other than the marginal income-marginal cost approach. The managers were asked how they plan their advertising program. The answers were categorized into (a) no advertising program (b) follow the wholesalers program, (c) use seasonal advertising only, (d) planned budget for seasonal advertising, and (e) a planned budget which integrates the entire advertising program. The values assigned to these answers were .1, .3, .6, 1.1, and 1.3, respectively.

A fourth phase of retail merchandising management considered in this study is the planning of farm service programs. The role of a farm service program is to provide the customer with sufficient information to enable him to properly utilize the purchased product. The results of a recent study of the effectiveness of farm services offered by fertilizer dealers indicated educational services seem to be associated with relatively high sales, markup and gross profits (h). This would suggest that these services can shift the demand curve to the right. A question was included in the schedule to determine how the manager planned his farm
service program. The answers were categorized as (a) no service program, (b) use the wholesalers service program, (c) follow competition, (d) use the service program to supplement sales of specific commodities, and (e) plan a service program to include all major commodities. Values of .1, .3, .5, and 1.0 were assigned to these respective answers.

The final phase of retail merchandising included in this study was concerned with the selection of the kinds and qualities of merchandise to handle. Although overall management has the responsibility for decisions regarding the major product lines, operational management is usually responsible for the specific combination of the predetermined major lines. As indicated earlier, the product-product condition should be the guiding principle in making these decisions. However, managers frequently base these decisions on other criteria. When asked how they determine what lines, types and qualities of merchandise to handle, some managers indicated they handle the same products the organization has sold over the years; this frequently meant that the manager relied on previous decisions. In a like manner, other managers permitted the wholesaler to make the decision. A value of .1 was assigned to these answers. A second basis for this decision was customer requests. Although customer demands may be a better basis than no decision, it may not be profitable to handle all the kinds and quantities of products desired by the customers. Therefore, a value of 1.0 was assigned to this answer. A third group of managers indicated some degree of planning to approximate the efficiency condition by considering the potential sales or profits from alternative choices. A value of 1.5 was assigned to this answer.
One index of retail merchandising management was constructed by principle components and one by subjective evaluation.* The variables in these indices were:

- \( z_{11} \) = method of determining the advertising program
- \( z_{12} \) = method of determining the pricing policy
- \( z_{13} \) = method of determining the discount policy
- \( z_{14} \) = method of determining the lines, types and qualities of merchandise to handle
- \( z_{15} \) = method of establishing a farm service program.

The principle component, which accounted for approximately forty percent of the total variance, was primarily a function of establishing a farm service program, and determining the pricing and advertising programs. The subjective index was mainly a function of determining the pricing and discounting policies and determining the lines, types and quantities of merchandise to handle.

Table 4b presents the correlation matrix from which this principle component was computed. The largest \( r \) is .45. This suggests that individual managers do not consistently use high or low valued management decision making procedures in all phases of retail merchandising management; that is, the fact that a manager performs well in one phase of retail merchandising management does not mean he performs well in other phases of the same area of management.

Wholesale trading management

According to the static theory of the firm, any managerial action

*See Table 4a for the weights of these indices.
which shifts the supply curve to the right will increase profits. Therefore, by defining marginal costs to include the net change in wholesale costs associated with changes in volume, method of delivery, etc., it is clear that the manager can increase profits by improving the terms, and the timing of each wholesale purchase and sale, and by obtaining better services such as lower cost delivery and more timely shipments.

It is plausible that the selection of the wholesale firms from which to buy or sell will result in changes in the wholesale cost. Managers use various criteria in selecting these firms. To ascertain the differences in total income or profitability associated with the criteria for this choice, the managers were asked the basis on which they select their wholesale sources and outlets. The answers were categorized as (a) customary sources, (b) reliability of the wholesaler, (c) buy from cooperatives, (d) price, and (e) service. In assigning scales, it was assumed that merely accepting a previous decision is probably the least rational basis; therefore, custom was assigned the lowest value. The remaining answers were scaled on the basis of the coefficients of total income on each answer. The values assigned to the five answers were .05, .10, .18, .20, and .52, respectively. The answers to this question were not mutually exclusive; that is, some managers used two or more criterion. To obtain a manager's score for this question, the scales were aggregated in a linear fashion.

A second phase of wholesale trading is keeping posted on wholesale prices and market trends. The manager must maintain current price information to evaluate alternative sources of supply and outlets and to
provide a basis for timing purchases. There are many potential sources of this information. Naturally, a manager is not limited to one source. It is hypothesized that some sources provide more useful data than others. Further, it is hypothesized that the greater the number of sources used, the more productive the management of wholesale trading. To test this hypothesis, managers were queried on their sources of wholesale market price and outlook information. The answers to this question were (a) radio, (b) salesman, (c) commercial reports, (d) newspapers, and (e) trade papers.* Finally, some managers gathered outlook information primarily from general observations and from farmers.

The markup system of pricing requires the manager to follow daily prices. Since the radio gives the most current information which can be used for pricing and to determine price trends, this source was scaled the heaviest. The lowest scale was assigned to general observations and farmers since these are probably somewhat unreliable sources. The other scales were assigned on the basis of regression coefficients of total revenue on each answer. The specific scales were .56, .38, .27, .15, .15, and .10, respectively. Again, the answers were not mutually exclusive and the managers score was obtained by linear aggregation.

A third important managerial consideration in wholesale trading is the terms of the purchase of sale. In addition to price and quantity, each purchase or sale normally includes specifications with respect to delivery, payment, guarantees, etc. Each of these considerations can affect wholesale cost. The managers were asked the question "When

*Wholesalers price quotations were an additional source of information. However, all managers indicated they used this source, and it was omitted from the analysis.
purchasing supplies for resale, what terms do you consider other than price and quantity." The replies were (a) discounts, (b) guarantee of quality, (c) time of payment, (d) freight cost, (e) time of shipment, (f) method of shipment, and (g) none. These answers were scaled as 1.8, 1.5, 1.3, 1.3, 1.2, 1.1, and .1, respectively. Some managers considered more than one specification of the sale other than price and quantity. The score for these managers was obtained by linear aggregation.

Frequently, the manager has alternative methods of wholesale buying and selling. One alternative is to make advance contracts. These contracts can be effective over various periods of time. The managers were questioned on the type of contracts they use and the reasons for entering into the contracts. The types of contracts used were separated into two groups on the basis of the time covered by the agreement. The first group of contracts considered were those covering relatively short periods of time (for example, one season). If the manager made no short run contracts, a value of .1 was assigned to this variable. A value of 1.0 was assigned if the manager normally made short run contracts for one product; a value of 2.0 was assigned if he contracted for more than one commodity.

The second group of contracts were longer run agreements; primarily franchise dealerships. The number of firms entering these agreements was so small that no attempt was made to differentiate between types of contracts. A value of .1 was assigned if the firm did not enter into these contracts and 1.0 was assigned if the firm made such an agreement.

The terms of these contracts vary widely. The managers were asked why they enter into these contracts. The responses were (a) no contracts, (b) quantity insurance, (c) price insurance, (d) quantity discounts (e)
seasonal price, and (f) to save capital. The scales applied to these answers were 0.1, 0.5, 1.0, 1.1, 1.5, and 1.5.

Two indices of wholesale trading management were constructed by principle components and one by subjective evaluation from the following variables:*

\[ z_{21} = \text{basis for the selection of wholesale sources and outlets} \]
\[ z_{22} = \text{sources of market price and outlook information} \]
\[ z_{23} = \text{terms considered in each purchase or sale} \]
\[ z_{24} = \text{terms considered in entering into contracts} \]
\[ z_{25} = \text{use made of short run contracts} \]
\[ z_{26} = \text{use made of longer run contracts} \]

The first principle component explained twenty-seven percent of the variance and was primarily a function of the terms considered in entering into contracts and the use made of short run contracts. The second principle component explained twenty-four percent of the total variance and was primarily a function of the sources of price and outlook information and the terms considered in each purchase or sale.

The subjective index was primarily a function of the basis for the selection of wholesale sources and outlets, and the terms considered in each purchase or sale.

Table 5b presents the correlation matrix from which the principle components were computed. The small r's suggest that individual managers do not consistently use high or low valued procedures and techniques in managing wholesale trading.

*See Table 5a for these indices.
Restrictions on wholesale trading management

The productivity of management in the area of wholesale trading is probably affected by the environment in which the manager operates. The warehouse facilities, for example, affect the quantities and forms in which products can be handled and stored; furthermore they influence methods of transportation and times of delivery. These factors were approximated by the index of plant and equipment. Another environmental factor which must be considered is the distance from wholesale sources and outlets. This factor affects the delivered cost price, the method of transportation, frequency of purchase and ease of communication between buyer and seller. The managers were asked the location of their sources of supply of the following commodities:

- \( u^1 \) = feed concentrates
- \( u^2 \) = soybean oil meal
- \( u^3 \) = mealscraps and tankage
- \( u^4 \) = fertilizer
- \( u^5 \) = petroleum products
- \( u^6 \) = lumber
- \( u^7 \) = seeds
- \( u^8 \) = chemicals

These estimates were converted into indices by principle components.*

The first principle component removed twenty-five percent of the variance and was largely a function of the distance from lumber, seed, and chemical sources. The second principle component accounted for twenty percent of

*See Table 6 for these weights.
the variance and was primarily a function of the distance from petroleum, fertilizer, and feed sources.

Inventory management

The area of inventory management involves a determination of the optimum inventory level for each product; moreover, management must achieve the lowest possible cost of maintaining this level of inventory.

Changing market prices have important implications on the optimum level of inventories and on the cost of maintaining a given level of inventory. There are several alternative courses of action in meeting expected price changes. The managers in this sample were asked how they protect themselves against market price changes on supplies and on grain in inventory. With respect to supplies, some managers did not consider price changes in establishing inventory levels. In a relatively short run it is possible that this policy would result in substantial windfall gains or losses. However, the period under study was generally characterized by declining prices of farm products and supplies and it is probable that this policy resulted in losses during this period. Therefore, this answer was given a value of 1.0; the lowest scale. Other managers indicated they made some attempt to adjust inventories to expected market price changes by buying when prices are expected to rise and by lowering the inventory level prior to expected price declines. This policy amounts to speculation and could result in losses; however, given a reasonable amount of study of market trends in formulating expectations, this policy could result in some gains. Therefore, a value 1.5 was assigned to this answer. A third alternative given by these managers was
purchasing on consignment whereby the wholesaler assumes the price risk. This method gives maximum price protection and a value of 2.0 was assigned.

Similar methods were used as protection against changes in grain prices. The specific methods were (a) none, (b) buying on the low market, (c) hedging, and (d) forward sales (i.e., buying and selling the same day). The values assigned to these answers were 1.0, 1.2, 1.8, and 2.0, respectively.

An important consideration in reducing the cost of maintaining a given level of inventory is minimizing losses from old inventories. If old merchandise is not sold immediately, its market value could fall to zero and the firm would sustain a total loss on the item. One method of avoiding this possibility is to reduce the price of the item to a level which will "make it move" quickly. However, many managers have an aversion to reducing prices below wholesale costs. The managers were asked the purposes for which they use special prices. The answers were (a) none, (b) loss leaders, and (c) disposing of old inventories. Because most items handled by country elevators are relatively expensive, loss leaders are not likely to be very profitable. On this basis, the values of 1.0, 1.5, and 2.0 were assigned to the respective answers.

Indices of inventory management were constructed by principle components and subjective evaluations for the following variables:

\[ u_{3.1} = \text{purposes for which special prices were used} \]
\[ u_{3.2} = \text{method of protecting supply inventories from market price changes} \]

*See Table 7a for these weights.
The first principle component was rejected because of unreasonable weights. The second principle component removed thirty-four percent of the variance and was largely a function of methods of protecting grain inventories against price changes. The subjective index was primarily a function method of protecting both supply and grain inventories against price changes. Table 7b presents the correlation matrix between the $z_{3j}$. The small correlation coefficient suggest the managers do not consistently use high or low valued managerial methods in inventory management.

**Retail credit management**

The role of credit is similar to that of advertising; that is, to shift the demand curve upward and to the right. For each price or volume of output, there is an optimum level of credit. Taking the price or volume of output as given, the optimum level of credit is the amount at which the addition in total income from the last unit of credit equals the addition in total cost from the same unit of credit. It is, however, extremely difficult to determine the optimum level of credit. Customers of country elevators differ widely in their responsiveness to credit; moreover, the cost of extending credit varies considerably among individuals. As a result, managers normally must determine the most profitable level of credit for individual customers to approximate the optimum total level of credit.

Some customers are very poor credit risks. The most profitable level of credit for these individuals may be no credit. Therefore, the first
step in establishing individual credit levels is to determine which customers will be granted credit. One would expect the most rational decision to be based on past ratings and ability to pay. The managers were asked how they determine the credit rating of each customer. Some managers actually made no determination of the credit rating. Others indicated the rating was based on personal knowledge of the individual, a credit bureau rating, or a combination of a credit bureau rating supplemented by personal knowledge of the individual. Values of .1, 1.0, 1.5, and 2.5 were assigned to the respective answers.

Given the decision to grant credit to the customer, the manager must determine the amount of credit to grant to each customer. It seems reasonable that this decision should be based on the customers' potential ability to pay. The manager should have access to information contained in a balance sheet and a budgeted profit and loss statement to adequately ascertain the customers' potential ability to pay (22, p. 533). The managers were asked how they determine the amount of credit to be granted to each customer. The responses were (a) no limit, (b) uniform limit for everyone, (c) past experience, (d) managers judgment, (e) credit union rating, (f) personal interview, and (g) financial statements. Scales of 1.0, 1.5, 2.1, 2.5, 2.6, 2.6, 3.0 respectively were assigned to these responses.

In addition to determining the amount of credit for each customer, the manager must decide on a repayment plan. The length of time for which the credit is needed also varies among customers. The managers in this sample either had a uniform time limit for all customers or established individual time limits. These policies were assigned values of 1.0 and
Ideally, the limits on the amount and time should be communicated to the customer prior to the opening of the account. It is hypothesized that the manner in which the customer is informed of these limits determines, in part, the effectiveness of these limits, the response of the customers to credit and the cost of extending credit. To test this hypothesis, the managers were asked how the established limits were communicated to the customer. The answers were categorized as (a) verbally at the time the account is opened, (b) by mail at the time the account is opened, (c) sign in the office, (d) verbally at the time the limit is reached, and (e) by mail at the time the limit is reached. These answers were scaled as 2.0, 1.5, 1.3, 1.1, and 1.0, respectively.

Having granted the credit, the manager must collect the account receivable to make the credit profitable. The first step in the generally accepted method of collecting accounts receivable is to mail to the customer an itemized statement of his account. Some manager in this sample, however, did not send statements. Others mailed statements only when the account reached the limit on amount or time. A third group mailed regular statements to all unpaid accounts. These answers were coded 1.0, 1.5, and 2.0, respectively.

If the account remains unpaid, it is hypothesized that the most productive collection procedure consists of a reminder notice followed by personal letters and finally personal visits in an attempt to collect the account. The procedures used by managers were obtained and categorized as incomplete, fairly complete and complete on the basis of these criteria. Scales of 1.0, 2.0, and 3.0 were assigned to the respective
categories.

If the collection procedure fails, the manager has the alternative of taking no further action, turning the account over to a collection agency or taking court action through an attorney. It is hypothesized that the latter action is the most effective in terms of collecting the greatest amount at the least cost. Therefore, scales of .1, .5, and .9 were assigned to the respective alternatives.

The manager may decide that the most profitable level of credit may exceed the firms resources. There are two basic methods of obtaining short term capital to finance additional credit. First, the manager may borrow capital to finance open accounts. However, some managers may be reluctant to borrow for this purpose. A second method of financing credit is to supplement the firm's own capital by inducing the customer to sign a note with a bank or wholesale supplier. It is hypothesized that productive management will utilize each of these methods to increase the returns from credit. To test this hypothesis, managers were first asked if they would borrow capital to finance open accounts. The replies were, (a) would not borrow, (b) have never needed to borrow, and (c) do borrow from banks. These answers were scaled as .1, 1.0, and 2.0. Next, the managers were asked what methods they use to finance notes and contracts. The replies were categorized as (a) do not use notes or contracts, (b) finance with own capital, (c) finance through banks and wholesalers, and (d) finance notes and contracts with own capital as well as through banks and wholesalers. These answers were coded as 1.0, 1.5, 2.0, and 2.5, respectively.

Three indices of retail credit management were constructed by
principle components and one by subjective evaluation from the following variables:*  

\[ z_{11} \] = method of establishing the customers credit rating  
\[ z_{12} \] = method of determining individual limits on the amount of credit  
\[ z_{13} \] = method of determining individual limits on the repayment plan  
\[ z_{14} \] = method of communicating the limits to the customer  
\[ z_{15} \] = method of informing the customer of his account status  
\[ z_{16} \] = completeness of the collection procedure  
\[ z_{17} \] = last step in collecting the account  
\[ z_{18} \] = methods of financing open accounts  
\[ z_{19} \] = methods of financing notes and contracts.

The first principle component which removed twenty-three percent of the variance was primarily a function of \[ z_{13} \], \[ z_{15} \], and \[ z_{16} \]. The second principle component accounted for seventeen percent of the variance and was mainly a function of \[ z_{12} \], \[ z_{17} \], and \[ z_{19} \]. The third principle component removed fourteen percent of the variance and was largely a function of \[ z_{11} \] and \[ z_{18} \]. The subjective index was mainly a function of \[ z_{12} \], \[ z_{13} \], and \[ z_{14} \].

Table 8b presents the correlation matrix of the \( z_j \). The low correlation coefficients suggest there is little correlation between the managerial methods used by individual managers in retail credit management.

*See Table 8a for these weights.
Restrictions on retail credit management

The affect of credit on the position of the demand curve as well as the costs of extending credit may be influenced by the environment in which the firm operates. For example, customers possessing adequate working capital may look upon credit as a convenience rather than as an important economic service (22). In this case, credit may not be an effective demand shifter. A second variable influencing customer response to credit is the willingness of local credit agencies to extend credit for working capital at reasonable rates. If farmers can obtain the needed capital from these agencies at a reasonable cost, credit may offer little inducement to buy from a particular firm.

Another important variable influencing customer response to credit is the competitive situation. If competing firms feel they are mutually interdependent with respect to this type of sales promotion, each firm will attempt to duplicate or exceed the amount of credit offered by competitors. Competitors, therefore, tend to follow when one firm offers more credit but do not follow a reduction in credit extension. As a result customer response will be lower and costs may be higher for each additional unit of credit offered.

To avoid specification bias, an attempt was made to measure and incorporate these environmental variables into the models. To approximate differences in response due to varied levels of need for credit, the managers were asked to estimate what percent of their credit business is a matter of convenience rather than a real necessity. These answers were numerical and did not require scaling.
To account for differences in credit response due to credit agency policies, the managers were asked if local banks, production credit associations and other lending institutions were willing to extend credit to farmers to purchase the elevator supplies. The answers were categorized into (a) quite willing, (b) fairly willing, and (c) willing only to a limited extent and were scaled as 1.0, 1.5, and 2.0, respectively.

To approximate the effect of competition on credit response, the managers were asked to estimate the percent their total annual sales would decrease if they permitted no credit accounts to run over 30 days. These answers did not require scaling.

To estimate the affect of competition on costs of extending credit, the managers were asked what effect the credit policies of their competitors had on average monthly accounts receivables. The answers were as follows: (a) no effect, (b) forced the firm to extend more credit to customers who were able to pay promptly, (c) forced the firm to extend more credit to all customers, and (d) forced the firm to extend more credit to those requiring more time to pay. These answers were scaled as 1.0, 2.0, 2.5, and 3.0, respectively.

Two indices of environmental factors affecting retail credit management were constructed by principle components and one by subjective evaluation from the following variable:

\[ u_5^1 = \text{affect of competition on average accounts receivables} \]
\[ u_5^2 = \text{percent sales would decline if no credit accounts were extended beyond 30 days} \]

*See Table 9 for these weights.*
\[ u_5^3 = \text{reciprocal of percent of credit business which is a matter of convenience rather than necessity} \]

\[ u_5^4 = \text{willingness of credit institutions to extend credit to farmers to buy farm supplies.} \]

The first principle component, which removed thirty-four percent of the variance, was primarily a function of \( u_5^1 \) and \( u_5^2 \). The second principle component explained thirty percent of the variance and was largely a function of \( u_5^4 \). The subjective index was largely a function of \( u_5^1 \), \( u_5^2 \), and \( u_5^3 \).

**Employee management**

One of the most important areas of operational management responsibility is employee management. Achievement of economic efficiency requires the selection of the optimum quantity of labor in relation to other inputs. Moreover, the success of plans and policies in other areas of management depend, in part, on the productivity of management since these plans generally must be implemented through employees.

Phillips has suggested that employee management consists of determining the optimum number and qualifications of employees, selecting and training these employees, establishing wage, salary and bonus plans and finally motivating the employee group (22, pp. 273-275).

Taking the level of output and the physical plant as given, the determination of the optimum number of employees requires a work organization whereby specific responsibilities and jobs are assigned to given positions. In effect, a work organization amounts to the development of job descriptions. In addition to serving as a basis for specification of
the optimum number of employees, job descriptions insures that all activities of the operation are interrelated and further serve as a basis for employee understanding of his specific responsibilities. It is hypothesized that development of job descriptions will increase the total income and profits of the firm. To test this hypothesis, the managers were asked if they have written job descriptions for each position. The answers to this question were categorized as (a) do not write job descriptions, (b) have verbal job descriptions for all employees, (c) have written job descriptions for supervisory employees only, and (d) have written job descriptions for all employees. Ideally, job descriptions should be in writing to facilitate completeness and understanding. Therefore, scales of 1.0, 1.5, 2.8, and 3.0 were assigned to the respective answers.

Prior to the selection of the employees to fill the positions outlined by the job descriptions, the manager must establish the qualifications needed for each position. The managers were asked how they determine the qualifications needed in new employees. The replies to this question were (a) no determination, (b) based on personal characteristics such as honesty, appearance, attitude and family life, (c) type of job, and (d) job description. Clearly, any rational selection of employees requires a prior specification of needed qualifications. Therefore, no determination was assigned the lowest scale. The second response indicated only a partial consideration of the required qualifications. The third answer, although suggesting a more complete recognition of the required qualifications, did not indicate any formal basis for determining the qualifications. Logically, the written job description would provide the most complete basis for this problem since all responsibilities and
duties presumably have been clearly defined. Therefore, scales of 1.0, 1.5, 2.0, and 3.0 were assigned to these respective answers.

Given a set of qualifications needed for each position, applicants can then be properly evaluated to determine which individual is best fitted for the position. However, the manager must first gather the relevant information about the individuals to make the decision. There are at least four sources of this information (22, p. 291). These are application forms, references, tests and interviews. It is particularly important that complete information be obtained on applicants for supervisory positions. Therefore, the managers were asked if applicants for key positions were required to fill out application forms. The answers were yes or no. Scales of 2.0 and 1.0 were assigned to these respective answers. Next, the managers were asked if they check with the people given as references by the applicants. The answers were (a) no, (b) check with out of town people, and (c) check with all listed references. Scales of 1.0, 1.8, and 2.0 were assigned to these answers. Finally, the managers were asked if the applicants were given tests and interviewed. None of the respondents indicated the applicants were tested. With respect to interviews, the answers were (a) no interviews, (b) interviewed by the board of directors, (c) interviewed by both the manager and the board, and (d) interviewed by the manager. Ideally, the interview should be conducted in a relaxed atmosphere by the person making the selection decision. Therefore, the last answer was assigned the highest scale. Since the manager would supervise the employee, it was assumed that an interview conducted by the board alone would yield less information than when the manager was present. Therefore, scales of 1.0, 1.5, 2.0, and
2.5 were assigned to the respective answers.

It is indeed unusual that a manager can hire individuals meeting all the required qualifications. Frequently, the manager can improve the productivity of the selected employees through training programs. Moreover, present employees must be developed to insure a source of personnel to fill vacancies of higher responsibilities. Thus, employee training should be an important phase of employee management. To test the effect of training programs on profitability of the firm, the managers were asked what methods they use to train and develop employees. The answers were (a) have no training programs, (b) use on the job training, employee meetings, short courses, or service schools. No attempt was made to determine the relative value of each type of training. Rather it was assumed that employee productivity was in part a function of the number of training methods. Therefore, a value of 1.0 was assigned to no employee training, 2.0 to the use of one training method, 2.5 to two training methods and 3.0 to three training methods.

Establishing salary and wage levels is another phase of employee management. Logically these levels should be based in part on the amount of responsibility and should be in line with comparable jobs in other firms. However, there seems to be two schools of thought with respect to the role of incentive plans in wage and salary determination. By using incentive plans, managers imply that promotion of individual effort will improve net employee productivity. Sociologists, on the other hand, have suggested that efforts to minimize individual effort will actually increase net output (16).

Basically there are two types of incentive programs. One consists of
individual incentives; the other, group incentives. Individual incentive programs can be awarded in the form of a commission on individual sales or in the form of merit promotions and salary increases. Sociologists object to the commission type of payment on the basis that it creates an attitude of self interest rather than group interest. Other than petroleum tank truck drivers, there is little opportunity for commission type incentives in country elevators. Rather, most individual incentive programs take the form of salary increases and merit promotions based on the employees contribution to net output. It is hypothesized that this form of incentive program will increase employee productivity. To test this hypothesis managers were asked if they utilize merit promotions. If the answer was no, 1.0 was assigned. A value of 1.5 was assigned to yes answers.

Group incentive programs are usually paid in the form of a bonus (usually a percent of net earnings). However, profits depend on a large number of variables beyond the control of most employees. Most employees probably would not wish to have their wages depend in part on the level of profits. Therefore, it was hypothesized that bonus plans do not have a positive effect on employee productivity. To test this hypothesis, the managers were asked if they have a bonus plan for all employees. The answers were yes or no. Scales of 1.0 and 2.0 were assigned to the respective answers.

An additional responsibility of employee management is to develop goals within the employee group which are consistent with the goals of the firm. To fulfill this responsibility, the manager must be aware of individual feelings and emotions. Most country elevators are sufficiently
large that the manager directly supervises department heads only. It is believed that one method by which the manager can win the complete cooperation of key employees is to permit and encourage their participation in major managerial decisions. This technique insures that key employees are aware of the prescribed goals and the methods of attainment. Furthermore, it gives them a feeling of belonging and encourages them to support the joint decisions. Managers were asked to describe how key employees are consulted in making major decisions. The procedures used categorized as excellent, good, fair, poor, and none. Scales of 4.0, 2.8, 2.0, 1.5, and 1.0 were assigned to the respective answers.

Another method of gaining the cooperation of the key employees is to provide them with information. This can be accomplished by providing the employees with well understood operating policies. This technique should increase employee productivity by insuring that each individual understands all policies and decisions which affect him and his role in the firm. The managers were asked what type of operating policies he has for key employees. Again these answers were categorized into excellent, good, fair, poor, and none and scales of 2.0, 1.6, 1.3, 1.1, and 1.0 were assigned respectively.

Three indices of employee management were constructed by principle components and one by subjective evaluation from the following variables:

\[ z_1 = \text{type of job descriptions prepared for each position} \]
\[ z_2 = \text{type of operating policies provided for key employees} \]
\[ z_3 = \text{method of determining the qualifications needed in} \]

*See Table 10a for these weights.*
new employees

$z_5^4$ = are applicants required to fill out application forms

$z_5^5$ = does manager check references given by job applicants

$z_5^6$ = is the applicant interviewed

$z_5^7$ = number of methods used in training employees

$z_5^8$ = degree in which key employees are consulted on major managerial decisions

$z_5^9$ = use of merit promotions

$z_5^{10}$ = use of employee bonus plans.

The first principle component removed twenty-seven percent of the variance and was primarily a function of $z_5^1$, $z_5^2$, $z_5^3$, $z_5^7$, and $z_5^8$. The second principle component accounted for fourteen percent of the variance and was primarily a function of $z_5^4$, $z_5^5$, and $z_5^6$. The third principle component removed thirteen percent of the variance and was mainly a function of $z_5^9$ and $z_5^{10}$. The subjective index was mainly a function of $z_5^1$ and $z_5^2$.

Table 10b presents the correlation matrix of the $z_5^j$. Again the evidence suggests there is little relationship between the methods used by individual managers within each phase of operational management.

Restrictions on employee management

As in other areas of management, environment probably affects the productivity of employee management. The ability of the employees is probably the primary variable limiting the productivity of employee management. Several questions were asked to approximate differences in employee ability. First the managers were asked to rate their key
employees with those in the typical country elevator. These ratings were average, above average, and superior. Values of 2.0, 1.5, and 1.0 were assigned to the respective answers. Secondly, the managers were asked to estimate the percent of their employees not striving for advancement. Thirdly, it was assumed some firms will occasionally experience an employee who is a "troublemaker." Although, it is the managers responsibility to see that these people are brought in line or discharged, it may take some time to carry out this process. In the meantime, employee productivity may decline. To account for this possibility, the managers were asked if they have had any such employee relation problems. The answers were no trouble, very little, occasionally and some trouble. Scales of 1.0, 1.2, 1.4, and 1.6 were assigned to these answers.

The availability of well trained key employees also affects employee management. If the manager is able to hire well trained people, employee productivity should be consistently higher than if the manager must completely train each new individual. The managers were asked how much difficulty they have had in obtaining well trained key employees. The answers were (a) were available or have hired none, (b) available but needed some additional training, and (c) could not locate key employees to hire. Scales of 1.0, 1.5, and 2.5 were assigned to these answers.

Other variables influencing employee management are restrictions placed on the manager's choice of employees by the board of directors. It is hypothesized that the greater the managerial freedom in selecting the employees, the higher the level of employee productivity. To test this hypothesis, inquiry was made into the role of the board in hiring
and discharging employees. The answers were (a) no interference, (b) manager must keep the board informed, (c) manager can either hire or discharge with board approval but not both, and (d) manager must receive board approval to do either. These answers were scaled as 1.0, 2.0, 3.0, 4.0, and 5.0, respectively.

One index of environmental variables affecting employee management was constructed by principle components and one by subjective evaluation from the following variables:

\[ u_1 = \text{role of the board of directors in selecting employees} \]
\[ u_2 = \text{availability of well trained key employees} \]
\[ u_3 = \text{amount of employee relation problems} \]
\[ u_4 = \text{manager rating of key employees} \]
\[ u_5 = \text{percent of employees not striving for advancement} \]

The first principle component removed thirty-five percent of the total variance and was mainly a function of availability of well trained key employees and employee relation problems. The subjective index was primarily a function of availability of well trained employees.

**Customer relations management**

The purpose of advertising is to increase the sales of a product or group of products. The purpose of customer relations is to improve the attitude of the customer toward the business (22, pp. 328-330).** If

*See Table 11 for these weights.*

*Since all but three of the businesses in the sample were farmer cooperatives, perhaps the term "member relations" would be more appropriate than "customer relations." However, because of its more general meaning, it was decided to retain the latter meaning.*
successful, each activity will shift the demand curve upward and to the right. However, a successful customer relation program should result in a more permanent shift in the demand curve. This is not to say that advertising should be neglected in favor of customer relations; rather advertising is useful in inducing customers to buy specific products from the firm whereas a successful customer relation program should result in continued patronage of these customers.

There are many methods of improving customer relations. Participation in community affairs is one method frequently used by managers. Although participation in any community activity should have some customer relation value, one would expect farmer customers to be more impressed by firm participation in agricultural activities. To estimate the effect of the type of participation in community affairs on total income and profits, the managers were asked how their business participates in community events. The answers were (a) donations only, (b) sponsor contests, (c) engage in civic activities, (d) engage in youth activities (primarily FFA and 4-H), and (e) engage in adult activities (such as night schools for farmers, church projects and Farm Bureau activities). It was assumed that donations would make the least contribution to good customer relations. Furthermore, it was assumed that farmers would be most impressed by youth and adult activities. Therefore, a scale of .10 was assigned to donations, .20 to contests and civic activities, and 1.0 to youth and adult activities. Many firms participated in more than one type of activity and the manager's total score was obtained by linear aggregation.

The amount of activity as well as the type of activity should have some affect on customer relations. The roughness of the data precluded
any attempt to incorporate interaction between the amount and type of activity. It did seem feasible, however, to classify the managers into approximate frequency groups with respect to frequency of participation. The frequency groups were classified as inactive, relatively inactive, fairly active, active, and very active. Scales of .1, .5, 1.0, 2.0, and 3.0 were assigned to the respective answers. The manager was classified as inactive if there was no participation or donations only. The other classifications were based on an evaluation of the answers to the question on how the business participates in community affairs.

The annual meeting presents another opportunity to improve customer relations. One would expect the annual meeting to be useful in improving customer relations if customers actively participate in the meeting. In preparing for the meeting, this can be accomplished by taking vigorous action to insure a large attendance and by involving the members in the preparations and plans.

The type of program should also influence the customers attitude toward the business. Iowa law requires cooperatives to hold an annual business meeting. The business meeting itself probably has little influence on customer relations. However, the program can be developed to improve customer relations by including specific educational and entertainment activities. Educational activities useful in improving customer relations include panel discussions, question and answer periods, and special speakers. Possible entertainment activities include amateur acts, dinner, prizes and passing out patronage refunds.

Data on these aspects of customer relations management were obtained by asking the managers how they prepare for the annual meeting and how
the meeting is used to improve customer relations. On the basis of the above criteria, answers to each question were classified as excellent, good, fair and poor. Scales of 2.0, 1.0, .5, and .1 were assigned to these answers, respectively.

Employees can also create a favorable customer attitude toward the business. If they are courteous, efficient and competent, customers will be more anxious to patronize the firm. The impression given the customer by the employees is largely under the manager's control. The managers were asked what procedures they use to insure that employees create a favorable customer attitude—toward the company. The replies were (a) no procedures, (b) verbal policies such as "don't argue with customers," (c) supervision, (d) training meetings, and (e) employee selection. Employee selection should be the most efficient means of insuring that employees create a favorable impression. Hiring people with the needed qualifications will insure that employees are competent to do the job. However, it is possible that training and supervision also are necessary to create and maintain a courteous attitude among employees. Verbal policies should be helpful but it is probable that they would need to be repeated frequently to be effective. On this basis, the above answers were scaled as .1, .5, 1.0, 1.5, and 2.0. If the manager utilized more than one procedure, the total score was obtained by linear aggregation.

Two indices of customer relations management were obtained by principle components and one by subjective evaluation from the following variables:

*See Table 12a for these weights.
\( z_6 1 = \) the type of community activities in which the firm participates

\( z_6 2 = \) the frequency of participation in community activities

\( z_6 3 = \) the amount of preparation for the annual meeting

\( z_6 4 = \) the type of annual meeting program

\( z_6 5 = \) procedures used in insuring that employees create a favorable customer attitude toward the firm.

The first principle component removed forty-five percent of the total variance and was primarily a function of \( z_6 1, z_6 3, \) and \( z_6 4 \). The second component explained twenty-four percent of the variance and was largely a function of \( z_6 2 \) and \( z_6 4 \).

Table 12b presents the correlation matrix between the \( z_6 j \). Again there seems to be little correlation between the managerial methods used within each phase of operational management.

**Restrictions on customer relations management**

Strong differences of opinion among the members arising from sources such as religion or politics can affect customer relations management. Regardless of their source, it is possible that these differences can be manifested in ill feelings toward the organization, thereby making customer relations management more difficult. The managers were asked to what extent their member relations were affected by such member differences. The answers were categorized as (a) none, (b) very little, (c) some, and (d) substantially. Scales of 2.0, 1.0, .5, and .1 were assigned to these answers.

The manner in which cooperative type organizations are accepted in
the community could also affect a given company's customer relations. With respect to the present sample, it could be argued that the greater the acceptance of cooperatives, the greater the productivity of a given customer relations program since the program would not be required to overcome an anti-cooperative attitude. Farmers in a cooperative-minded community will probably belong to more than one cooperative and the manager with a successful program could draw the customers to his organization. Therefore, the managers were asked the number of cooperatives to which their customers belonged on the average. These answers required no coding.

The tenure status of the farming community may also make customer relations management more difficult. It seems logical that tenant farmers might be more concerned with short run economies. The possibility that patronage refunds may be used for financing the elevator rather than allocated to the customer may make current price the prime consideration for these individuals and therefore make them less inclined to have a favorable attitude toward cooperatives. Therefore, the managers were asked what percent of their active members were owner operators. Again no coding was required.

A fourth variable which may make customer relations more difficult is frequent manager changes. In this event, customers may be discouraged with the organization if they feel that each time they get to know the manager, a new one takes over. Furthermore, if the old manager was unsuccessful, customers may not be willing to accept the new manager. This possibility was incorporated in the schedule by asking if frequent manager changes affected their member relations. The answers were
(a) none, (b) some, and (c) substantially. These answers were coded as 2.0, 1.0, and .1, respectively.

One index of environmental restrictions on member relations was constructed by principle components and one by subjective evaluation from the following variables:* 

\[ u_7 = \text{affect of strong differences of opinions among members on customer relations} \]

\[ u_7_2 = \text{number of other cooperatives to which the members belong} \]

\[ u_7_3 = \text{percent of active members which are owner-operators} \]

\[ u_7_4 = \text{effect of numerous manager changes on member relations} \]

The first component explained thirty-nine percent of the variance and was primarily a function of \( u_7_1 \), \( u_7_3 \), and \( u_7_4 \). The subjective index was largely a function of \( u_7_1 \) and \( u_7_3 \).

**Overall management**

As implied by Model III, the salaried manager may also be responsible for some aspects of overall management. In fact, it may be argued that even if the manager does not make any overall managerial decisions, his familiarity with the total business operation should enable him to suggest action for board approval and thereby increase the potential profitability of the firm as well as the degree to which the potential profitability is achieved. To test the effect of this aspect of management on profits, the managers were asked if they initiate recommendations regarding problems requiring board decision. Some managers indicated

*See Table 13 for these weights.*
they recommended all action requiring board decision and the board automatically approved these recommendations. A second group of managers indicated they made many recommendations to the board but the board normally discussed the recommendations prior to approval or disapproval. The third group disclosed that their recommendations were concerned primarily with operational decisions and they relied on the board to the extent of asking approval on most of these decisions. Within the management framework established above, this latter group was not fulfilling its responsibility to the board and this answer was assigned the lowest scale. The first group, in effect, was running the board and was given the highest scale. The actual values assigned were 3.0, 2.0, and 1.0, respectively.

One would expect the manager to be most productive in his overall management role if his decisions or recommendations are made on the basis of a projection of potential profits for each alternative. The managers were asked if they project figures from their records and work out paper profits for each alternative when making major decisions or recommendations to the board. The answers were: (a) usually work out paper profits, (b) work out paper profits for some decisions and recommendations, (c) rarely use records for working out profits, (d) work out potential volume or expenses but not both, and (e) rely solely on judgment. These answers were coded 4.0, 3.0, 2.5, 1.5, and 1.0, respectively.

If each overall managerial decision is made on a short run basis without consideration of the potential effect on future operations, it is probable that the total operation will not be as efficient as possible. Buildings may not be located at the most convenient spots; equipment
installed today may not have sufficient capacity or may not integrate well with future operations. One method of reducing this type of inefficiency is to develop long range plans for future expansion. Logically, the manager should be responsible for developing these plans. A question was included in the schedule to determine if long range planning was performed by the manager. The answers were (a) no long range planning, (b) plans for the next year only, (c) hazy long run plans, and (d) definite long run plans. These answers were scaled 1.0, 2.0, 3.0, and 4.0, respectively.

The degree of managerial success in fulfilling his responsibilities in both overall management and operational management should depend on how well he uses accounting records in making recommendations and decisions. Most accounting systems used in country elevators leave much to be desired. Nevertheless, they do provide a basis for evaluating current operations and can serve as a historical base for approximating future costs, sales and elasticities of demand. It is contended that the thoroughness with which managers utilize these records would serve as a rough quality variable for managerial actions such as projecting paper profits and developing long range plans. The managers were asked how they use monthly financial statements to help them perform their managerial tasks. The answers were categorized as: (a) don't use records at all, (b) make only the minimum use of the records such as checking margins and expenses, (c) utilize the records fairly well by checking expenses, margins and some asset balances, (d) make good use of the financial statements by making month to month comparisons on margins, income, expenses and all asset balances. Values of 1.0, 2.0, 2.5, and 3.0 were assigned, respectively.
One index of overall management was constructed by principle components and one by subjective evaluation from the following variables:

\[ Z_1 = \text{degree of use of financial statements} \]
\[ Z_2 = \text{are decisions and recommendations based on paper profits} \]
\[ Z_3 = \text{does manager initiate recommendations to the board} \]
\[ Z_4 = \text{have long range plans been formulated.} \]

The \( \lambda \) for the first component was 2.10; hence, it removed approximately fifty-three percent of the total variance. The weights for all variables in both the principle component index and the subjective index approached unity. Therefore, inferences with respect to these indices must consider all variables.

**Board of directors**

In a cooperative organization, the ultimate responsibility for overall management rests with the members. However, this responsibility is largely delegated to an elected board of directors. The duties delegated to this body normally include the establishment of operating policies, selection and supervision of operational management, and decision making with respect to expansion. Clearly, the manner in which these responsibilities are carried out can affect the productivity of operational management and should be included in the models.

Overall management is no less complex than operational management. As suggested above, the efficiency criteria are appropriate for evaluating each level of management. To approach these conditions, both levels must perform the planning, directing, and controlling functions.

*See Table 14 for these weights.*
of management. The success attained in these functions depends to a great extent on how well the managers are informed. An essential source of information for performing these functions is the monthly financial statements. However, not all boards of directors utilize these records. Thus, to partially account for differences in profitability due to the board of directors, the managers were asked if their board required a monthly operating statement and a balance sheet. A value of 1.0 was assigned to the no answers and 2.0 was assigned to yes replies.

In addition to the financial statements, board members can gain first hand information about the business by becoming active customers of the firm. Moreover, the attitude of the entire membership toward the business could be affected by the degree in which each board member patronizes the business. Information was obtained on this aspect of overall management by asking the managers what percent of the board members were among the best ten percent of their customers. The answers were numerical and required no coding.

In addition to having information about the business, successful overall management must be willing to make the necessary changes to attain economic efficiency. Constantly changing technology, demand, and prices introduce new product line opportunities, lower cost input combination possibilities and opportunities for expansion of current outputs. Unless the board of directors is willing to make the changes consistent with the efficiency criteria, the productivity of the operational manager will be limited. An attempt was made to approximate the willingness of the board to take advantage of profit opportunities by asking the manager "What is the attitude of your board toward management innovations?" The answers
were: (a) eager for innovations, (b) receptive to change, (c) neutral, (d) the change must have been proven elsewhere, and (e) resist innovations. Scales of 5.0, 4.0, 3.0, 2.0, and 1.0 were assigned to the respective answers.

The policies of the board of directors with respect to management salaries can also influence the productivity of operational management. Normally the board plays a role in establishing maximum salary levels for key employees and, of course, sets the salary level for the general manager. Unless the board is willing to pay salaries commensurate with value productivity and competition, the manager may have difficulty motivating the management team or may be unable to secure and retain productive key employees. To account for this possibility, the managers were asked how difficult it was to get the board to increase the salaries of the general manager and key employees to the levels of alternative opportunities. The answers were (a) impossible to get salaries up to a competitive level, (b) requires constant effort to obtain salary increases, (c) some lag in getting adjustments, and (d) salaries are kept in line with other opportunities. Scales of 1.0, 3.0, 4.0, and 5.0 were assigned to the respective answers.

Since the general manager exerts considerable influence on the level of profits of the firm, Phillips has suggested that a bonus plan for the manager may be effective in increasing his productivity (22, pp. 307-310). The board of directors must make the decision with respect to the use of bonus plans at this level. Therefore, the managers were asked if they are on a bonus or other incentive system. The answers were (a) no,
(b) receive a bonus at the discretion of the board, and (c) receive a fixed percent of net profits. It was assumed that a bonus at the option of the board would not provide as much incentive as a fixed percentage of net profit. Therefore, scales of 1.0, 2.0, and 4.0 were assigned to these answers.

Another variable which can influence the productivity of the operational manager is the job security given him by the board. If he feels each decision can jeopardize his job, the manager may be reluctant to make decisions which afford opportunity for large gain but, because of uncertainty, may also result in some loss. One technique the board can use to increase the manager's job security is to provide the manager with a contract. Each manager was asked if his board provided him with a contract. A yes answer was coded 2.0 and 1.0 was assigned to the no answers.

One final attempt was made to approximate the contribution to the business by the board of directors. The manager was asked to give an overall appraisal of how the net earnings of the business would change if the manager had no board of directors. The replies were categorized into much higher, slightly higher, no change, slightly lower, and much lower. Scales of 1.0, 2.0, 3.0, 4.0, and 5.0 were assigned to these answers.

Indices of the effect of the board of directors on the profits of the firm were constructed by principle components and subjective evaluation from the following variables:

*See Table 15 for these weights.
\[ u_8^1 = \text{does the board require financial statements} \]
\[ u_8^2 = \text{is the manager given a tenure contract} \]
\[ u_8^3 = \text{percent of the board members which are among the best ten percent of the firms customers} \]
\[ u_8^4 = \text{attitude of the board toward management innovations} \]
\[ u_8^5 = \text{difficulty in achieving competitive salaries for the general manager and key employees} \]
\[ u_8^6 = \text{type of bonus given the manager} \]
\[ u_8^7 = \text{affect of the board on net earnings}. \]

The \( \lambda \) for the first two principle components were 1.82 and 1.42, respectively. Thus, the two components removed forty-six percent of the total variance. The first component was largely a function of \( u_8^4 \) while the second component was largely a function of \( u_8^7 \) and \( u_8^3 \). The subjective index was dominated by \( u_8^1, u_8^4, u_8^5, \) and \( u_8^7 \).

**Personal characteristics of the general manager**

In the short run, the personal characteristics of the manager can impose further restrictions on alternatives open to management. If his training and experience are inadequate, he may be unable to foresee all alternatives. Moreover, he may be unable to effectively evaluate the known alternatives. Closely related to experience and training is age which may also impose difficulties. If the manager is too young, the membership may be hesitant to accept him as the manager. Length of tenure may also affect the manager's performance. It could be argued that if the same individual has been manager of the organization for a large number of years, he will begin to feel that the organization has progressed in
the past and there is no reason to make any change. To obtain information on each of these variables, the managers were asked their age, length of tenure, highest grade attended in school and previous experience. These answers were numerical and required no coding.

The managers attitude toward the goals of the firm may also affect his productivity. The above models assume a profit maximization goal. If the managers attitudes are consistent with this goal, there should be no conflict between the assumed goals and the manager's attitude. However, if the manager's behavior is inconsistent with this goal, profit probably will not be maximized. To incorporate this possibility into the models, the managers were asked the things they like most and least about their present position. The responses to these questions were taken as measures of the manager's attitude. These expressed attitudes were categorized using a rational-traditional criterion or the degree to which the expressed satisfaction or dissatisfaction relates to the goal of profit maximization.

Rational and traditional behavior represent polar types of human behavior (15, pp. 15-34). This analysis implies a continuum of behavior between these poles. For the purpose at hand, rational behavior was defined in terms of the optimum allocation of resources to attain the profit maximization goal. Traditional behavior typically includes an orientation toward means as goals in themselves. This represents conformity to established means without evaluation of their effect on the profit maximization goal.

The answers to the questions concerning what the manager liked most were categorized into seven groups. These were: (a) likes people, (b)
likes the cooperative way, (c) likes the satisfaction from salary or community prestige, (d) likes the merchandising part of the business, (e) likes an orderly system, (f) likes responsibility or non routine, and (g) likes the potential growth and development of the business. Values were assigned to these groups on the basis of the judged relevance of each to the profit maximization goal.

Clearly, the first two answers (likes people and the coop way) could be grouped together at the traditional end of the continuum. Answer (c) is largely traditional but requires some degree of rationality to attain these objectives. Merchandising and orderly system also imply some degree of rationality. Responsibility and non routine probably fall closer to the rational end of the continuum. Those who liked the potential growth and development were assumed to represent the rational pole. Therefore, (a) and (b) were scaled 1.0, (c) was scaled 1.1, (d) and (e) were scaled 1.2, (f) was scaled 1.5, and a value of 1.6 was assigned to the last answer.

An attempt was also made to categorize the manager's dissatisfactions with the job in terms of the rational-traditional criterion. The expressed dissatisfactions were categorized as (a) those implying some factors effecting the individual only, (b) those indicating no dissatisfaction, and (c) those who were dissatisfied with restrictions on the ability to maximize profits. Although it was difficult to assign values to those who indicated no dissatisfaction with their job, it was assumed that this implied a lack of awareness of those restrictions and a ritualistic approach to management. For this reason, this answer was assumed to indicate a traditional attitude and was assigned a value of 1.0. A second
group of answers consisted of irregular hours, small town, low salary. These answers imply more concern about the manager himself and were assumed to be largely unrelated to profit maximization of the firm and each was assigned a value of 1.1. Other managers indicated they dislike routine tasks associated with their positions. This answer implies concern about the manager himself. It was considered as approaching the rational pole and a scale value of 1.4 was assigned. The last group of managers indicated they dislike the restrictions imposed on them by members and the board of directors. These restrictions included lack of facilities, failure to invest more money into the business, customer demands for excessive services and credit. These answers are related to profit maximization and a value of 1.5 was assigned to each.

The managers' ability to react quickly to a given situation may affect his productivity. Under ideal conditions, the managerial functions of planning, directing, and controlling would be performed over a time period sufficiently long to permit the manager to thoroughly analyze each alternative and reach a sound conclusion. In practice, however, many decisions must be made in a matter of seconds. Unless he is able to complete the decision making process rapidly, the manager may miss profit making opportunities or may arrive at less than optimum decisions. To approximate the manager's ability to react quickly to a given situation, the interviewer subjectively rated the managers according to their ability to comprehend the questions in the schedule and how rapidly they answered the questions. Those who responded quickly to the questions were assigned a value of 3.0; a value of 2.0 was assigned if some probing was required, and 1.0 was assigned if it was difficult to obtain an answer.
Finally, an attempt was made to obtain an evaluation of the work habits of the manager as reflected by the general appearance of the office, mill, and employees. In making the evaluation, the interviewer looked for cleanliness and the general appearance of the employees and facilities. If a very clean and orderly atmosphere prevailed, the manager was rated with a 3.0. If the employees and facilities were reasonably clean, a value of 2.0 was assigned. A value of 1.0 was assigned if the interviewer observed a disorderly atmosphere.

Two indices of personal characteristics of the manager were derived by principle components and one by subjective evaluation from the following variables:

\[ u_{9 \, 1} = \text{what the manager liked most about his position} \]
\[ u_{9 \, 2} = \text{what the manager liked least about his position} \]
\[ u_{9 \, 3} = \text{age of the manager} \]
\[ u_{9 \, 4} = \text{last grade of school attended} \]
\[ u_{9 \, 5} = \text{length of tenure} \]
\[ u_{9 \, 6} = \text{previous experience} \]
\[ u_{9 \, 7} = \text{cleanliness and orderliness of the business} \]
\[ u_{9 \, 8} = \text{responsiveness of the manager} . \]

The \( \lambda \) for the first and second principle components were 2.48 and 1.44, respectively. Thus, these components removed forty-nine percent of the total variance. The first component was dominated by \( u_{9 \, 3}, u_{9 \, 4}, \) and \( u_{9 \, 5} \) whereas the second component was largely a function of \( u_{9 \, 6} \) and \( u_{9 \, 7} \) and \( u_{9 \, 8} \). The subjective index was primarily a function of \( u_{9 \, 1}, u_{9 \, 2}, u_{9 \, 4}, \) and \( u_{9 \, 8} \).

*See Table 16 for these weights.*
EMPIRICAL RESULTS

Model I assumes management and environment affect the slope of the production surface. If the objective is to estimate the productivity of the operational manager in each area of management, application of Model I is extremely difficult. First, estimation of this model requires specification of the inputs used in each area of management. Accounting data, however, are not adequate to group the inputs in this fashion. Secondly, the areas of operational management suggested by Phillips as being important, are grouped by type of input and by type of function. Thus, estimation of the productivity of management for each of these areas of management would require an equation in which each input is considered as a separate variable and a second equation with the inputs aggregated by managerial functions. This procedure would frustrate attempts to avoid specification bias. Therefore, estimates of the effect of management and environmental factors on the production function will be restricted to Model II.

Model II

Until now, Model II has been discussed only in the general form. The specific output and input variables included in the alternative forms of Model II are as follows:

\[ T = \text{deflated (gross commodity margins plus income from services)} \]
\[ X_1 = \text{deflated (adjusted salaries and wages plus other payroll costs)} \]
\[ X_2 = \text{deflated ("old" fixed assets)} \]
\[ X_3 = \text{deflated (other assets) plus (total expenses minus expenses)} \]
associated with $X_1$, $X_2$, and other assets).*

The principle component indices included in the model were:

- $z^k_1 = \text{retail merchandising management}$, \( k = 1 \)
- $z^k_2 = \text{wholesale trading management}$, \( k = 1, 2 \)
- $z^k_3 = \text{inventory management}$, \( k = 2 \)
- $z^k_4 = \text{retail credit management}$, \( k = 1, 2, 3 \)
- $z^k_5 = \text{employee management}$, \( k = 1, 2, 3 \)
- $z^k_6 = \text{customer relations management}$, \( k = 1, 2 \)
- $z^k_7 = \text{overall management}$, \( k = 1 \)
- $u^k_1 = \text{capacity of plant and equipment}$, \( k = 1, 2, 3 \)
- $u^k_2 = \text{competitive situation}$, \( k = 1, 2 \)
- $u^k_3 = \text{level of margins}$, \( k = 1, 2 \)
- $u^k_4 = \text{distance from source of supply}$, \( k = 1, 2 \)
- $u^k_5 = \text{restrictions on retail credit management}$, \( k = 1, 2 \)
- $u^k_6 = \text{restrictions on employee management}$, \( k = 1 \)
- $u^k_7 = \text{restrictions on member relations management}$, \( k = 1 \)
- $u^k_8 = \text{board of directors}$, \( k = 1 \)
- $u^k_9 = \text{personal characteristics of the manager}$, \( k = 1, 2 \)

In addition, the corresponding $Z_p$ and $U_q$ were included in some forms of Model II.

Logic and preliminary analysis suggested the physical inputs and outputs should enter the equations in logarithmic form.** However, the

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*Inventories and accounts receivables were specified as separate variables in equations estimated for preliminary analysis. However, the coefficients for these variables were non-significant. These variables were then aggregated with "other assets and expenses" to save degrees of freedom.

**Since the inputs were specified in logarithmic form, $X_3$ was aggregated geometrically.
the question of the form in which management and environmental indices should enter the equation remained to be answered. To shed some light on this question, the principle component indices were entered in equation 1 in an exponential fashion and in equation 2 in a logarithmic fashion. In general form, these equations can be written as:

\[ TI = f(x_1, x_2, x_3, z_1, z_2, z_3, z_4, z_5, z_6, z_7, u_1, u_2, u_3, u_4, u_5, u_6, u_7, \text{time}) \]

These two regressions were based on 1956 and 1957 data. Because of possible autocorrelation, time series data could violate one of the assumptions required to make tests of significance on least squares estimates. An approximate test for autocorrelation was obtained by computing the correlation coefficient between successive residuals from equation 2. Since the correlation coefficient was non-significant, the data failed to reject the hypothesis that the errors are independent.

Equation 2 yielded the best results in the sense that it contained twelve significant indices whereas equation 1 contained only one significant index. The \( R^2 \)'s were .9170 and .8898, respectively. An analysis of variance was computed for equation 1 and equation 2 to test the null hypothesis that the coefficients for all management and environmental indices equal zero. The null hypothesis was accepted for equation 1 and rejected for equation 2.** Thus, the management and environment indices in logarithmic form made a significant contribution to the regression whereas the same variables in exponential form did not make a significant

*See Table 17 for the corresponding regression coefficients and standard errors.

**See Tables 18 and 19 for these tests.
contribution to the explanation of total income. This evidence suggests that the indices should enter the production function in a logarithmic form. However, one cannot conclude from these results that there are diminishing marginal returns to management since many variables included in the indices were quantified with arbitrary scales.

Equation 3 was obtained by regressing total income on the subjective indices corresponding to the indices included in equation 1 and 2. In general form this equation can be written as:

\[ TI = f(X_1, X_2, X_3, Z_1, Z_2, Z_3, Z_4, Z_5, Z_6, Z_7, U_1, U_2, U_3, U_4, U_5, U_6, U_7, \text{time}). \]

From the results of equation 1 and 2, it seemed reasonable to enter these indices in a logarithmic fashion. The \( R^2 \) of this equation was .8904. However, only two indices were significant. An analysis of variance indicated the indices in this equation did not make a significant contribution to the regression. This evidence suggests that inferences regarding the affect of management and environment on the production function should be based on equation 2.

Management indices

Among the significant management indices in equation 2 was the second principle component of wholesale trading.** The regression coefficient for this index was over four times as large as its standard error. The

*See Table 20 for the estimates of this equation.

**See Table 17 for these estimates.
dominant variables in this index were (a) the terms considered in each
purchase or sale, (b) the sources of market price and outlook information,
and (c) the basis for the selection of wholesale sources and outlets.
The regression coefficient and the weights for each of these variables
were positive. Thus, the hypothesis was accepted that total income
increases as the manager (a) considers the type of services offered as
well as the prices offered when making the choice of the wholesale source
from which to buy or sell, (b) uses many sources of price and market trend
information (especially radio, salesmen and commercial reports), and (c)
considers other terms of each sale in addition to price and quantity.

The remaining three variables in this index were concerned with short
and long run contracts. The weights for these variables were relatively
small. Of these three variables, only the use of long run contracts had
a positive index weight. As indicated above, only a small number of firms
entered into long run contracts. This suggests that the small variability
of this variable could account for the small weight.

The weights for the use of short run contracts and the terms con-
sidered in entering into contracts were negative. However, one would not
expect total income to decrease with their use. Since these weights were
not constructed on an economic basis, it appears that more reasonable
weights for these two variables might be zero.

The second significant index in equation 2 was inventory management.
The regression coefficient for the index was over three times as large
as its standard error. The dominant variable in this index was the method
used to protect grain inventories against price changes. The regression
coefficient and the index weight for this variable were both positive.
Thus, the hypothesis was accepted that the policy of buying and selling on the same market results in higher gross income than if the manager takes no action to protect grain inventories against price changes or alternatively speculates on the grain market. This is not to say that speculation is never profitable. These results, however, suggest that, ceteris paribus, the managers in this sample who bought and sold on the same market were more successful over a two year period than those who speculated or took no action to protect inventories against price changes.

The remaining two variables in this index were (a) methods of protecting supply inventories against price changes and (b) the purposes for which special prices are used. The index weights for these variables were also positive but relatively small. One could infer from these weights that increased price protection for supply inventories and lowering the price of old merchandise to "make it move" would increase total income but less than price protection on grain inventories. However, a more reasonable explanation for the small weights is that these variables possessed relatively small variability in this sample.

The third significant index in equation 2 was the third principle component of retail credit management. The regression coefficient for this index was negative and over twice as large as its standard error. However, the $\lambda$ for this component was relatively small; i.e., it accounted for only fourteen percent of the total variance of retail credit management. The second principle component, while not significant at the 5 percent level, did have a "t" value of 1.53.* Moreover, it

*This "t" value is significant at approximately the 15 percent level.
accounted for seventeen percent of the total variance, and possessed more reasonable index weights than the second component. Therefore, it is the author's opinion that inferences regarding retail credit management should be based on both the second and third principle components.

The dominant variables in the second component were (a) method of determining individual limits on the amount of credit, (b) last step in collecting the account, and (c) methods of financing notes and contracts. However, this index also had relatively large weights for the method of establishing the customer's credit rating, the method of determining individual limits on the repayment plan, the method of informing the customer of his account status and the completeness of the collection procedure. The dominant variables in the third principle component were (a) method of establishing a customer's credit rating, and (b) method of financing open accounts.

To determine the net change in total income associated with an increase in the value of each variable, the average of the two regression coefficients was computed. Since both regression coefficients were negative, this evaluation indicated total income decreased as the level of retail credit management (as measured in this study) increased for each variable. Therefore, the hypothesis that total income increases with an increased level of retail credit management was rejected.

The retail credit variables which resulted in relatively large decreases in total income were (a) method of establishing the customers credit rating, (b) method of determining individual limits on the amount of credit, and (c) method of determining the repayment plan. These results are not surprising in view of the accounting methods used in
country elevators. When a product is sold on credit, the sale is credited to the income account. Thus, even if the receivable is never collected, total income increases during the current period. A high level of management for each of the above variables would probably result in a reduction in the amount of credit extended to customers with a low credit rating or with a low ability to pay. Since these customers probably have the greatest response to increased credit extension, a high level of management for these variables would decrease sales and presumably decrease total income. Thus, while the management of retail credit ultimately affects the production function, it appears that total income is not the appropriate criteria to evaluate the productivity of this area of management.

The fourth significant management index in equation 2 was the first principle component of employee management. The regression coefficient was almost twice as large as its standard error.* The dominant variables in this index were (a) type of operating policies provided for key employees, (b) degree to which key employees are consulted on major managerial decisions, (c) number of methods used to train key employees, (d) type of job description prepared for each position, and (e) the methods used to determine the qualifications needed in new employees. The index weight for each of these variables was positive. The regression coefficient was also positive. Therefore, the hypothesis was accepted that, other things being equal, total income is increased by (a) providing better operating policies for key employees, (b) consulting key

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*The regression coefficient actually was significant at the 7 percent level. Nevertheless, it was accepted as being significant for this study.
employees on major managerial decisions, (c) using more methods to train employees, (d) providing written job descriptions for all employees, and (e) using the job description to determine qualifications needed in new employees.

The index weights for the remaining five variables were relatively small. It appears that the small weights for $z_{54}$, $z_{56}$, and $z_{59}$ can be attributed to a lack of variability. In fact, only five managers required prospective employees to fill out application forms; only seven indicated the candidates were not interviewed or were interviewed by the board alone; and only ten managers indicated they used merit promotions.

It is possible that the small index weight of $z_{55}$ means that checking the references given by prospective employees does not affect the productivity of employee management. It could be argued that references are hesitant to reveal any undesirable information about the candidate. On the other hand, the managers may fail to ask for specific information about the candidate. As a result, the evaluation may be meaningless. In any case, the low weight could not be attributed to lack of variability since approximately fifty percent of the managers checked with references.

The index weight for $z_{510}$ was also small but negative. The scales assigned to this variable were 2.0 if the manager did not use a group incentive bonus and 1.0 if the managers used a group incentive bonus.

It is possible that the negative scale could mean this type of incentive program does increase employee productivity. Perhaps if more precise information on incentive programs had been obtained on the schedule so that this variable could have been quantified more precisely, this type of analysis might provide more significant answers to the value of group
The fifth significant management index was the first principle component of customer relations management.* The regression coefficient for this index was over four times as large as its standard error. The dominant variables in this index were (a) the amount of preparation for the annual meeting, (b) the type of annual meeting program, and (c) the type of community activities in which the firm participates. The remaining variables, (i.e., the frequency of participation in community activities and procedures used in insuring that employees create a favorable customer attitude toward the firm) had somewhat smaller index weights. The index weights for all five variables were positive. However, the regression coefficient was negative. This suggests that increased emphasis on customer relations decreases total income. At first, one would consider this to be an unreasonable coefficient. By introspection, one would probably conclude that emphasis on these activities should have a favorable influence on the customers attitude toward the business. However, it is possible that these variables do not result in an immediate sales response and have only a long run effect. This is clearly plausible in the case of the first four variables and especially for the annual meeting variables since these events occur only once each year. Therefore, the area of customer relations management will not be considered as an unproductive activity on the basis of equation 2.

The last significant management index in equation 2 was the first principle component of overall planning. The regression coefficient for

*See Table 17 for these estimates.
this index was positive and over three times as large as its standard error. All the weights in this index were positive and relatively large. Therefore, the hypothesis was accepted that total income increases as the operational manager takes an active role in overall management by (a) initiating recommendations on matters requiring board approval, (b) by developing long range plans for expansion, and (c) basing these recommendations and plans on projected profits. Moreover, total income increases as financial records are used as the foundation for projecting the above paper profits.

The only non-significant management area in equation 2 was retail merchandising management. The regression coefficient for this index was slightly smaller than its standard error. The dominant variables in this index were (a) the method of determining the advertising program, (b) the method of determining the pricing policy, and (c) the method of establishing a farm service program.

There are several possible reasons for the non-significance of this index. First, there may be interaction between the variables in the index; that is, the effect of one variable could depend on the level of other variables in the index. For example, it is plausible that the effectiveness of the farm service program or the advertising program depends on the lines, types and qualities of merchandise handled. The indices used in this study were linear combinations of the variables. If interaction exists, it destroys the additivity of the index and interaction terms should be included.

A second possible reason for the non-significance is the lack of quality variables in the index (such as the quality of the farm service
A third possible reason could be the failure of the managers to revise retail merchandising policies and programs to meet changing demand conditions. If this case exists, there would be little variability in the management of retail merchandising, since in effect, each variable would be determined by custom or competition. There was some evidence to support this hypothesis. While obtaining data for the index of the level of margins, inquiry was made to determine if the margins had changed over time. In most cases, the managers indicated no change had taken place.

While the statistical methods failed to verify the hypotheses with respect to retail merchandising management, one cannot logically reject them on the basis of these data. It is possible that the criteria used for this index do not delineate the management of retail merchandising, or there may be insufficient variability in these variables in this sample.

**Environmental indices**

Among the significant environmental indices in equation 2 were the first and second principle components of plant and equipment capacity. The regression coefficient for the first component was positive and almost four times as large as its standard error. The dominant variables in this component were (a) grain grinding and feed mixing capacity, (b) the number of bins in the mill, (c) tons of feed that can be moved out of the warehouse in a ten hour day, and (d) time required to unload a 15 ton semi-trailer of bulk feed. The index weights for a, b, and c were positive.
while d was negative.

The regression coefficient for the second principle component of plant and equipment capacity was also positive and over twice as large as its standard error. The dominant variables in this index were (a) grain receiving capacity and (b) the number and average capacity of head house bins. The weights for each of these variables were positive. Thus, the hypothesis was accepted that, ceteris paribus, total income increases with (a) increased grain receiving and handling capacity, (b) with increased mill capacity, and (c) with increased bulk feed capacity in the warehouse.

Another significant environmental index in equation 2 was the first principle component of the competitive situation. The regression coefficient for this index was almost three times as large as its standard error. The dominant variables in this index were (a) reciprocal of the size of the trade area, (b) location of the most aggressive competitor, and (c) number of competitors in the same town. Variables (b) and (c) were highly correlated. The competitor located in the same town, in almost every case, was designated as the most aggressive competitor. Therefore, the significance of this index can be interpreted in terms of (a) and (b).

The signs of the regression coefficient and the weight of the location of the most aggressive competitor were positive whereas the weight for the reciprocal of the size of the trade area was negative. With respect to the latter weight, the hypothesis was accepted that, ceteris paribus, total income decreases as the size of the market area decreases.

With respect to the location of the most aggressive competitor,
these results suggest that total income increases as the most aggressive competitor is located closer to the firm at hand. These results are plausible if being located close to the most aggressive competitor provides more information about the competitors operating techniques and thereby enables the firm at hand to respond more effectively.

Another significant environmental index in equation 2 was the first principle component of the average level of margins received by elevators within the trade area.* The regression coefficient for this index was negative and almost three times as large as its standard error. The dominant variables in the index were feed, fertilizer, lumber, and chemical margins, and corn storage charges. In view of the assumption of relatively stable margins within trading areas, one would expect identical signs for the regression coefficient and the weights of the dominant variables in this index. The only negative weights were for feed and fertilizer margins. Thus, the hypothesis was accepted that total income increases as average feed and fertilizer margins increase within the area. However, the positive weights for the remaining dominant variables indicate that total income increases as the average margins for lumber and chemical margins and corn storage charges decrease. The margins taken on lumber and chemicals are high relative to the margins taken on feed and fertilizer. In addition, it has been previously suggested that country elevator storage charges are also relatively high (29). Thus, it is possible the margins taken on lumber and chemicals and the charges for corn storage are above the optimum price. This may induce customers

*See Table 17 for these estimates.
to seek alternative sources of lumber and chemicals and to build on-farm grain storage facilities. This analysis implies an elastic market demand for these items. If the demand for lumber, chemicals and corn storage is elastic, lower margins would indeed increase total income.

The remaining significant environmental indices in equation 2 were the first and second principle components of the distance from wholesale sources. The regression coefficient for the first principle component was positive and over twice as large as its standard error. The dominant variables in this index were the distances from the wholesale sources of (a) lumber, (b) seed, (c) chemicals, and (d) feed concentrates.

The regression coefficient for the second principle component was also positive and over twice as large as its standard error. The dominant variables in this index were the distances from the wholesale sources of petroleum, fertilizer, feeds, and chemicals.

Interpretation of the individual indices was difficult because of conflicting signs between the indices. Therefore, the average regression coefficient was computed to determine the change in income associated with an increase in distance from each source of supply. The evaluation indicated a relatively large decrease in total income as the distance increased from the source of supply of feeds and fertilizer and a relatively large increase in total income as the distance increased from the source of supply of petroleum. The results with respect to feeds and fertilizer appear reasonable if the increase in distance is beyond managerial control. However, one would not expect total income to increase as the distance from the source of petroleum supplies increases for these firms because most of the firms in this sample purchased petroleum from
the same wholesaler. Therefore, it appears a more reasonable weight for petroleum products might be zero.

The non-significant environmental indices in equation 2 were restrictions on customer relations management, retail credit management, and employee management. Possible explanations of this non-significance are:

(1) The productivity of operational management is not affected by the variables in these indices.

(2) The variables used to construct the indices do not adequately measure the true restrictions.

(3) There was insufficient variability within each of the variables included in the indices.

It was suggested earlier that managers are frequently evaluated on the basis of their performance in one area of management. Implied in this procedure is the hypothesis that high managerial productivity in one area of management is correlated with high productivity in other areas. However, as measured in this study, the level of management in one area does not appear to be related to the level of management in other areas. In fact, the highest simple correlation coefficient among management indices in equation two was .56. In most cases, $r \leq .30$. Therefore, the hypothesis that the level of management in one area is related to the level in other areas was rejected.

The capacity of the IBM 650 was not sufficient to include all principle component indices in equation 2. Three indices omitted from this equation were the first and second principle components of personal

*See Table 21 for this matrix.
characteristics of the manager and the first principle component of the board of directors. These three indices were included in a fourth equation to determine their effect on the production function. To avoid specification bias, selected variables from equation 2 were also included in this equation.

The only significant index among these three indices was the second principle component of personal characteristics of the manager. The regression coefficient was negative and over twice as large as its standard error. The dominant variables in this index were (a) amount of previous experience, (b) cleanliness and orderliness of the business, and (c) the responsiveness of the manager. The weights for (a) and (b) were positive whereas (c) had a negative weight. In view of the negative regression coefficient, the hypothesis was accepted that the ability to think and respond quickly to specific situations is associated with increased total income. However, the positive weights for previous experience, and orderliness and cleanliness suggest that high values of these variables, as measured in this study, are associated with lower total income. With respect to orderliness and cleanliness, these results could mean that the manager spends most of his time keeping the business clean and orderly rather than performing his managerial functions. On the other hand, it could mean that there were few customers patronizing the business and there was little opportunity for the business to become disorderly. Because of the unclear meaning of these results, the null hypothesis with respect to this variable was not rejected. With respect to previous experience, these results suggest that previous experience actually decreases total income. This may be possible if several years
experience is associated with older "old school" managers who manage by the "seat of their pants." However, since the level of management has been partially held constant in the regression equation, it appears that a more reasonable weight for previous experience might be zero.

Although the regression coefficient for the index of restrictions imposed by the board of directors was statistically insignificant, one could not logically conclude that this level of management has no effect on the production function. The board should clearly influence the production function through the operational policies established to guide operational management. Therefore, it appears reasonable that the criteria used to construct this index do not reflect the contribution made by the board of directors.

Under the assumptions that the managers use the same method over time and no autocorrelation in the data, a fifth equation based on eight years was computed to obtain more information about the effect of retail credit management and customer relations management on total income. In general form, this equation can be written as

\[ T_1 = f(X_1, X_2, X_3, Z_1, Z_2, Z_3, Z_4, Z_5, Z_6, Z_7, Z_8, Z_9, Z_{10}, Z_{11}, Z_{12}, Z_{13}, Z_{14}, Z_{15}, Z_{16}, Z_{17}, Z_{18}, \text{time}) \]

The results of equation 5 were consistent with those in equation 2 with the following exceptions:

(1) The regression coefficients of both principle components of customer relations management were significant in equation 5. As in equation 2, the sign of the coefficient of the first principle component was negative. However, the sign of the coefficient for the second component

*See Table 22 for the corresponding regression coefficients and standard errors.*
principle component was positive. To determine the net change in total income associated with a change in the level of each customer relations variable, the average of the two regression coefficients was computed. This evaluation indicated total income decreased as the level of management increased for all variables except $z_6^2$ (i.e., the frequency of participation in community activities). However, the evaluation indicated only a small increase in income was associated with this latter variable. Moreover, the roughness of the data for this variable precludes any firm statements about its productivity. Therefore, the hypothesis was rejected that customer relations management (as measured in this study) has a long run positive effect on total income. One possible reason for the failure to verify this hypothesis is differences in the ability of managers to use a given method of customer relations management.

(2) The regression coefficient for the second principle component of retail credit management was non-significant. Nevertheless, the sign of the coefficient was consistent with equation 2.

(3) The regression coefficient for retail merchandising management was significant. However, the sign of the coefficient was negative. Clearly, one would not expect total income to decrease as the level of retail merchandising management increases. Notwithstanding its statistical significance, one cannot reject the original hypotheses with respect to retail merchandising management on the basis of this coefficient.

Model III

In Model III, it was assumed the operational manager is responsible for determining the levels of all inputs other than fixed assets. Thus,
X_f, as used in 2.26, refers to X_2 in Model II.

The question of the form in which the indices should enter Model III remained to be answered. In Model II, the assumption that management affects the intercept and the need for a convenient estimating procedure precluded the indices from entering the production function in any form other than multiplicative. The multiplicative form assumes the level of management in one area substitutes for the level of management in other areas at a diminishing rate; that is, output would be greater with an average level of management in each area than with a high level of management in one area and a low level of management in another area. However, the specification of Model III permits the indices to enter in an linear form as well as a multiplicative form. The linear form assumes the level of management in one area substitutes for the level of management in another area at a constant rate; that is, other things being equal, a given output can be obtained with a high level of management in one area and a low level of management in another area or with an average level of management in each area. To gain some insight into the substitutability of management between areas of operational responsibility, the indices were permitted to enter Model III in each form.

The variables entered equation 6 in a logarithmic fashion and in equation 7 in an additive linear fashion. In general form, the equations are

\[
4.4 \frac{[\Pi X_2 + 1]}{X_2} = f(z_{11}, z_{12}, z_{22}, z_{32}, z_{42}, z_{43}, z_{52}, z_{53}, z_{54}, z_{62}, z_{71}, u_{11}, u_{12}, u_{13}, u_{14}, u_{22}, u_{23}, u_{24}, u_{32}, u_{33}, u_{34}, u_{35}, u_{42}, u_{43}, u_{44}, u_{52}, u_{53}, u_{54}, u_{55}, u_{62}, u_{63}, u_{64}, u_{65}, u_{72}, u_{73}, u_{74}, u_{75}, u_{82}, u_{83}, u_{84}, u_{85}, u_{92}, u_{93}, u_{94}, u_{95}, u_2, tenure, (tenure)^2).^*
\]

*See Table 23 for the corresponding regression coefficients and standard errors.
The linear equation yielded the best results in the sense that it contained nine significant indices whereas the logarithmic form contained only two significant indices. Furthermore, the $R^2$'s were .433 and .333, respectively. The $F$ test was used to test the null hypothesis that the $R^2$'s equal zero. The null hypothesis was accepted for the logarithmic form, but was rejected for the linear form. Thus, it is probable that net return on fixed investment is a linear function of management and environment (as measured in this study). It follows that a high level of management in one area of management probably substitutes at a constant rate for a low level of management in another area of managerial responsibility; that is, a manager who is relatively weak in one area of management can compensate for this weakness with a superior performance in another area of management.

The significance of the linear relationship suggests that inferences regarding the affect of management and environment on net return on fixed investment should be based on equation 7.

Management indices

Among the significant management indices in equation 7 was the second principle component of wholesale trading. The regression coefficient was positive and almost three times as large as its standard error. Based on the dominant variables in this index, the hypothesis was accepted that net return on fixed investment increases as the manager (a) considers the type of service offered as well as the prices offered when making the selection of the wholesale source from which to buy or sell, (b) uses many sources of wholesale price and market trend information
(especially radio, salesman, and commercial reports), and (c) considers other specifications of each sale in addition to price and quantity.

The second significant index in equation 7 was the first principle component of customer relations management. The regression coefficient for this index was negative and almost three times as large as its standard error. These results were consistent with those obtained in Model II. Therefore, the hypothesis was rejected that profits increase with increased emphasis on customer relations (as measured in this study).

The third significant management index in equation 7 was the second principle component of retail credit management. The regression coefficient for this index was negative and over twice as large as its standard error. The only dominant variable with a negative weight in this index was the methods of financing notes and contracts. All other dominant variables had positive weights. Thus, on the basis of the negative coefficient, the hypothesis was rejected that return on fixed investment increases as the manager becomes more selective in extending credit and utilizes a more complete billing and collection procedure. However, the hypothesis was accepted that return on fixed investment increases as the manager induces the customer to sign a note with a bank or wholesaler or even with the elevator itself to finance the purchase of supplies. The latter conclusion is reasonable since the customer pays interest on the note if financed by the elevator. Moreover, if the customer signs a note with a bank or wholesaler, the elevator still receives income from the sale but does not have capital tied up in open accounts and has no billing or collecting expense.

The results with respect to the former hypothesis can be attributed
largely to the nature of the accounting methods used in country elevators. In the accounting procedure, credit sales are credited to the revenue account during the period in which the sale is made. A small percent of each credit sale is debited to current expense as a bad debt expense and then credited to current assets as a bad debt reserve. The actual quantity of bad debts is never reflected in the income or profit accounts and the profit model indicates a high level of retail credit management results in decreased profits. However, on the basis of logic, one would not reject the hypothesis that the true return on fixed investment increases with an increased level of retail credit management.

All other management indices in this regression were non-significant. These non-significant indices included inventory management, employee management and overall management. These three areas of management are concerned not only with efficient utilization of given inputs but also with determining the optimum level of inputs. Evidently, the measures of management used in this study do not adequately reflect the phases of management concerned with selecting the levels of physical inputs.

Environmental indices

Among the significant environmental indices in this equation was the first principle component of plant and equipment capacity. The regression coefficient for this index was negative and approximately twice as large as its standard error. The dominant variables were grinding, mixing, and mill capacities and bulk feed handling facilities. All index weights for these variables were positive except those concerned with unloading bulk feed from trucks into the warehouse. Thus,
the hypothesis was rejected that the return on fixed investment increases as feed processing capacity increases. Evidently, modernization and expansion programs resulted in excess capacity. However, it appears that firms with bulk feed facilities did not adequately allow for unloading bulk feed from trucks and consequently may have created a bottleneck in the entire operation.

A second environmental index in equation 7 was the second principle component of restrictions on retail credit management. The regression coefficient was positive and over twice as large as its standard error. The dominant variable in this index was the willingness of credit institutions to extend credit to farmers to buy farm supplies. Since a low value was assigned to this variable if farmers could easily obtain capital from these institutions to buy farm supplies, the hypothesis was accepted that the return on fixed investment increases as farmers are unable to obtain capital from credit institutions to buy farm supplies. Evidently, retail credit is an effective demand shifter.

The third significant environment index was the second principle component of the competitive situation.* The regression coefficient was positive and over twice as large as its standard error. The dominant variables in this index were (a) total number of competitors, (b) number of competitors outside the trade area, and (c) economic structure of the most aggressive competitor. The index weights for these variables were positive; thereby, suggesting that, ceteris paribus, return on fixed investment increases with the increased competition. These results are consistent with those obtained in equation 2. Therefore, the hypothesis

*See Table 23 for these estimates.
was accepted that profits tend to increase as the level of competition increases. This is plausible if increased competition provides more information about productive management techniques and enables and induces management to react more effectively.

The fourth significant environmental index was the second principle component of the board of directors. The regression coefficient was positive and over twice as large as its standard error. The dominant variables in this index were (a) percent of the board members which are among the best ten percent of the firms customers and (b) affect of the board on net earnings. The index weights for these variables were positive. Therefore, the hypothesis was accepted that the board of directors has a significant affect on the rate of return on fixed investment.

The fifth significant environmental index was the first principle component of personal characteristics of the manager. The regression coefficient was negative and over twice as large as its standard error. The dominant variables in this index were age, education and tenure. The index weights for age and tenure were positive whereas the weight for education was negative. With respect to age and education, the hypothesis was accepted that net return on investment increases as the education level of the manager increases; moreover, it decreases as the age of the manager increases (within the range of the data). This suggests that the young educated manager is more productive than the old experienced manager.

With respect to tenure, it was hypothesized that profit at first increases as tenure increases; then as the length of tenure continue to
increase, profits level off and finally decline. To test this hypothesis, a quadratic expression for tenure was also included in the regression equation. The squared term for tenure had a significant but positive regression coefficient. Evaluation of the principle component expression and the squared term suggests that profit increases at an increasing rate with longer tenure. Since age and tenure are positively correlated, these results are inconsistent with the results with respect to age.* Notwithstanding the statistical significance of the squared term, the null hypothesis with respect to tenure was accepted.

The non-significant indices in equation 7 were restrictions on member relations management, employee management, retail merchandising management and wholesale merchandising management. Possible explanations for this non-significance are:

1. net return on fixed investment is not affected by the variables included in these indices,
2. the variables included in the indices do not adequately measure the restrictions,
3. there was insufficient variability within each of the variables included in the indices.

Comparison of the Results from Models II and III

The $R^2$ for Model II (as represented by equation 2) was .917 whereas the $R^2$ for Model III (as represented by equation 7) was only .433. Moreover, a total of thirteen indices were significant in Model II equations.

*The $r$ between age and tenure was .77.
At the same time, only nine indices were significant in equation 7. However, these differences are reasonable. While the number of variables were equal in both models, a large portion of the variability of total income was explained by the physical inputs. These inputs were not specified as independent variables in Model III.

Management indices which were significant in both models were wholesale merchandising management, retail credit management and customer relations management. In addition, these indices possessed identical signs in both models. Based on these results, the hypothesis was accepted that total income and return on fixed investment increase with an increased level of wholesale merchandising. Furthermore, the hypothesis was accepted that total income and return on fixed investment (as reflected by the accounting statements) decrease with an increased level of retail credit management. However, these latter results were attributed to the accounting procedures used in country elevators. Evidently, some changes in accounting methods are in order so as to enable individual managers to properly evaluate their retail credit management. Finally the hypothesis was accepted that both total income and return on investment decrease as the level of customer relations management increases. Failure to verify the original hypothesis that income and profit increase with an increased level of customer relations management may be attributed to the lack of quality variables in this area of management.

Management indices which were significant in Model II but non-significant in Model III were inventory management, employee management and overall planning. These three areas of management are concerned not only with efficient utilization of resources but also with determining
the optimum levels of inputs. The fact that Model II assumes fixed inputs whereas Model III assumes variable inputs suggests that the measures of management used in this study do not adequately reflect those aspects of management concerned with selecting the levels of physical inputs.

Environmental indices which were significant in both models were the competitive situation, personal characteristics of the manager and plant and equipment. With respect to the competitive situation, the hypothesis was accepted that total income and return on investment increase with increased competition. This result is probably due to the added incentive given managers by more competition as well as to knowledge of better managerial techniques obtained from aggressive competitors. With respect to personal characteristics of the manager, the hypothesis was accepted that total income and return on investment are higher if the company is managed by a young educated manager as opposed to an older experienced manager and are higher if the manager is able to respond quickly to a given situation. Finally, with respect to plant and equipment, the hypothesis was accepted that total income increases with increased grain and feed handling capacities. However, the hypothesis was accepted that return on investment decreases as these capacities increase.

Environmental indices which were significant in Model II but non-significant in Model III were the level of margins and distances from sources of supply. However, this latter index was almost significant in Model III. The "t" value for the second principle component of distance from sources of supply was 1.75 in equation 7. The only environmental index which was significant in Model III but non-significant in Model II was the index of the board of directors.
In this study, management was divided into the two distinct levels of (1) overall management and (2) operational management. Overall management is performed by the owners or by the board of directors and is concerned with basic managerial decisions such as the location, size and type of business. Operational management utilizes the planning from overall management in operating the firm from day to day.

The primary objective in this study was to isolate the characteristics of operational management and environment which have an effect on the profitability of a sample of country elevators. Management was conceived as consisting of the application of principles of economics and sociology. The actual productivity of management was assumed to be a function of the managerial methods and techniques utilized in making and implementing managerial decisions and of the environment in which the firm operates. The environment was defined as restrictions on the range of alternatives open to the manager. These restrictions include the quality of available resources, the competitive situation and personal characteristics of the manager.

In the short run, the operational manager must take the level of inputs as given. In the longer run, he must ordinarily consider some inputs as variable. Accordingly, models were developed to estimate the productivity of management under each condition.

Under the assumption of fixed inputs, production function models were developed to estimate the productivity of alternative managerial methods and techniques and of the environment. In this case, production
functions are appropriate, since by the assumption of fixed inputs the regression residuals are assumed to be independent of the physical inputs. Model I assumes that management and environment affect the slope of the production surface. However, since one of the objectives of this study was to estimate the productivity of the operational manager in each area of managerial responsibility, Model I was not estimated. Estimation of this model would have been extremely difficult because financial data are not adequate to group inputs by management functions.

In Model II, management and environment were assumed to affect the height of the production surface. With all variables in logarithms, this model can be written as

$$ T_i = a + \sum_{i=1}^{p} b_i Z_{ij} + \sum_{i=p+1}^{q} b_i U_{ij} + \sum_{i=q+1}^{q+3} b_i X_{ij} + e \quad j=1,2,\ldots,n $$

where

- $T_i$ = total income in dollars
- $Z_{ij}$ = managerial methods
- $U_{ij}$ = environmental restrictions
- $X_{ij}$ = physical inputs in dollars.

If the operational manager is responsible for determining the level of some inputs with respect to current output, the production function becomes a member of a system of equations. Thus, these inputs are actually endogenous variables. If an equation contains two or more endogenous variables, the least squares estimates of the equation will be biased. One method of avoiding this bias is to define the system of equations, then transform the equations so that each endogenous variable is a function of exogenous variables. The transformed equations, the so-called reduced form equations, can be estimated by least squares. However,
this transformation was not convenient for this study because the optimum quantity of variable inputs is a double-valued function of management. As a means of avoiding this difficulty, it was assumed that profits are a single-valued increasing function of management. Under the restriction of constant returns to scale, a profit model was derived such that return on fixed investment plus one was a function of operational management and environment. With all variables expressed in logarithms, Model III can be written as

\[ \frac{P_q}{X_{fj}} = a + \sum_{i=1}^{p} b_i Z_{ij} + \sum_{i=p+1}^{q} b_i' U_{ij} + e \quad j = 1, 2, \ldots, n \]

where

- \( P_j \) = net profit
- \( X_{fj} \) = fixed investment (plant and equipment).

The data for this study were obtained from two sources: (a) financial statements from the sample of firms in the study and (b) a survey of the managers of the elevators in the sample.

Financial data are not ideal for regression analysis. The following adjustments were made on the financial data to make the data more comparable:

1. The data were adjusted to a common fiscal period on the basis of monthly financial statements obtained from the firms included in the sample.
2. Beginning and ending values of variable capital inputs (inventories and accounts receivable) were averaged to approximate the actual level of inputs.
3. Net yearly additions to fixed assets were deflated to avoid...
differences in costs due to inflation. Current additions were excluded from fixed assets in the deflation process under the assumption that new additions to fixed assets are largely unemployed in the fiscal year in which they are purchased.

(4) Income and profits were adjusted to reflect returns arising only from the business itself. In addition, investments in regional cooperatives were excluded from total assets.

(5) The manager's contribution to the actual labor input was estimated on the basis of the total non-managerial labor input. It was assumed that the amount of labor performed by the manager is inversely related to the number of employees.

(6) Finally, all data were deflated by a wholesale price index. Most of the data obtained from the schedule were non-numerical. These data were quantified on the basis of regression coefficients of total income on dummy variables of a given question subject to the restriction that the regression coefficients possessed at least a 50 percent chance of differing from zero and that the weights were consistent with logic and a priori knowledge. In the event the coefficients were non-significant, values were assigned to these data exclusively on the basis of logic and a priori knowledge supplemented by management texts.

The large number of variables considered in this study led to an attempt to construct indices of management and environmental variables. Two methods were used to derive the weights for these indices. These were: (a) the method of principle components and (b) subjective evaluation. Models based on indices derived from each method were estimated to determine which was better.
In general, principal component indices of management and environment had a significant effect on the production function when entered in the estimating equations in a logarithmic fashion. On the basis of the results of the production function estimates, the following hypotheses were accepted:

(1) Management of wholesale trading -- other things being equal, total income increases as the manager (a) considers the type of services offered as well as the prices offered when making the choice of the wholesale source from which to buy or sell, (b) uses many sources of wholesale price and outlook information, and (c) bases each wholesale purchase or sale on the terms of the sale (such as discounts, guarantee of quality, time of payment, freight costs and time and method of delivery) as well as on price and quantity.

(2) Inventory management -- other things being equal, total income increases as the manager protects grain inventories against price changes by buying and selling on the same market.

(3) Retail credit management -- other things being equal, total income decreases with an increased level of retail credit management. This result was attributed to the accounting procedures used in country elevators. It appears that total income, as reflected by the accounting statements, is not the appropriate criteria to evaluate retail credit management.

(4) Employee management -- ceteris paribus, total income increases as the manager (a) provides well understood operating policies for key employees, (b) consults key employees on major managerial decisions, (c) uses more methods of training employees, (d) provides written job
descriptions for all employees, and (e) uses the job descriptions to determine the qualifications needed in new employees.

(5) Customer relations -- *ceteris paribus*, total income decreases as the level of customer relations management (as measured in this study) increases.

(6) Overall management performed by the operational manager -- other things being equal, total income increases as the manager takes an active role in overall management by (a) initiating recommendations on matters requiring board approval, (b) developing long range plans for expansion, and (c) bases these recommendations and plans on projected profits which, in turn, are based on financial records.

(7) Plant and equipment capacity -- other things being equal, total income increases with (a) increased grain receiving and handling capacity, (b) increased mill capacity, and (c) increased bulk feed handling capacity.

(8) Competitive situation -- other things being equal, total income increases as the size of the trade area increases and as aggressive competition motivates the manager to respond more effectively.

(9) Level of margins -- other things being equal, total income increases as the average level of feed and fertilizer margins increase within a given trade area and decreases as lumber and chemical margins and corn storage charges increase. The market demand for these latter items may be relatively more elastic or the results obtained may simply reflect the relative position on the demand curves of the prevailing margins taken on the two categories of commodities.

(10) Distance from sources of supply -- other things being equal, total income decreases as the distance between the firm and the location
of the sources of supply increases.

(11) Personal characteristics of the manager -- other things being equal, total income increases if the manager is able to respond quickly to specific situations.

In general, principle component indices had a significant effect on net return on fixed investment when entered in a linear fashion. On the basis of the estimates of Model III, the following hypotheses were accepted:

(1) Management of wholesale trading -- other things being equal, return on fixed investment increases as the manager (a) considers the type of services offered as well as prices when making the choice of the wholesale source from which to buy or sell, (b) uses many sources of wholesale price and market trend information (especially radio, salesmen, and commercial reports), and (c) considers other specifications of each sale in addition to price and quantity.

(2) Customer relations management -- other things being equal, net return on fixed investment decreases as the level of customer relations management increases.

(3) Retail credit management -- other things being equal, net return on fixed investment (as reflected by the accounting statements) increases as the manager induces customers to sign a note with the bank, wholesaler or the elevator itself to finance credit purchases. However, net return on fixed investment (as reflected by the accounting records) decreases as the manager becomes more selective in extending credit and utilizes a complete billing and collection procedure. On the basis of logic, the hypothesis that the true return on fixed investment increases with an
increased level of retail credit management was not rejected.

(4) Restrictions on retail credit management -- other things being equal, return on fixed investment increases as customers are unable to obtain capital from credit institutions to buy farm supplies.

(5) Competitive situation -- other things being equal, return on fixed investment increased as the firm faces increased competition.

(6) Board of directors -- other things being equal, the board of directors has a significant influence on the return on fixed investment.

(7) Personal characteristics of the manager -- other things being equal, net return on fixed investment increases as the educational level of the manager increases and decreases as the age of the manager increases.

Management indices which were significant in both models were wholesale merchandising management, retail credit management, and customer relations management. Management indices which were significant in Model II but non-significant in Model III were inventory management, employee management and overall management. These areas are concerned with determining the optimum level of inputs in addition to utilizing these inputs effectively. Because Model III assumed some inputs were variable, it appears that the measures of management used in this study do not adequately reflect those phases of management concerned with selecting the optimum level of inputs.

Neither model verified the hypotheses with respect to retail merchandising management. A priori, it was expected that these hypotheses would have a significant effect on total income and return on fixed investment. The failure to verify these hypotheses was attributed to either (a) insufficient variability in the variables included in these
indices or to (b) the variables did not adequately represent the management of retail merchandising.

Environmental indices which were significant in both models were the competitive situation, personal characteristics of the operational manager. While the index on the board of directors was not significant in Model II, it was significant in Model III. Since the measures employed to represent the board of directors was very crude, it appears that fruitful results might be obtained from a study of the effect of the board of directors on the profits of the business.

In computing the correlation matrices for the principal components, it was found that there was little correlation between the level of managerial performance within a given area of management. Furthermore, in computing the regression equations, it was found that there is little correlation between the level of managerial performance in different areas of management. Therefore, one can not assume high managerial productivity in one area of management is correlated with high managerial productivity in other areas of management.

Finally, Model III was estimated in both linear and logarithmic form. The $R^2$ from the linear form was significant at the 5 percent level while the $R^2$ from the logarithmic form was not significant at the 5 percent level. The significance of the linear form suggests that the level of management in one area (as measured in this study) substitutes at a constant rate for the level of management in other areas.
SUGGESTIONS FOR FURTHER STUDY

The results of this preliminary study indicate that the measurement of managerial methods and techniques is a feasible approach to explaining the effect of management on the production function and on the net return to fixed investments. This approach to management is more basic than operations research in that operations research assumes the problem to have been previously formulated and the relevant information available for the solution. On the other hand, this study was concerned with defining managerial problems, with selecting the optimum sources of information and with defining practical methods of solving the problems. In view of our inability to objectively quantify the managerial input, it is the writer's opinion that this approach will provide valuable insights into the effect of management on firm efficiency. However, to make this approach more effective, four basic refinements are suggested.

First, the greatest need for refinement is in existing data. In this study, the quality concept was largely ignored; that is, little effort was directed toward determining how well the given managerial methods and techniques were used. This aspect of management should have an effect on firm efficiency. One possible method of incorporating quality into the questionnaire would be to establish norms or models in each phase of management. The manager's performance could then be evaluated on the basis of this norm. For example, in the area of employee management, a model job description could be formulated. Then job descriptions written by managers could be evaluated on the basis of this model.
In addition, it is possible that some managers were aware of the best answer to a given question and responded with this answer regardless of how he actually performed in the given phase of management. This possibility suggests that fruitful results could be obtained from joint efforts between psychologists and economists in drafting a questionnaire for this type of study.

Finally, with respect to improved data, some effort should be made to determine the level of true profits by approximating that part of total income which is uncollectible. This approximation might consider the amount of time spent in trying to collect "uncollectible amounts" and the historical pattern of bad debt write-offs.

Second only to the requirement for better data is the need for defining new measures which are related to the management input. This refinement is most critical in the phases of management concerned with selecting the levels of physical inputs. With respect to the levels of physical inputs, one possibility is to attempt to determine how managers select the level of these variable inputs.

Thirdly, as suggested in the text, if numerous real variables are converted to artificial variables by linear indices, these indices should be constructed to include possible interaction. Two areas of management in which interaction appears most likely are retail merchandising management and employee management.

A fourth refinement, while not as critical as the above, consists of improvements in the models. All models developed in this study assumed imperfect competition in the product markets. However, the factor markets were assumed to be perfectly competitive. This latter assumption is
probably unrealistic. Since labor represents the largest single input in country elevators, inquiry should be made to determine the type of labor market faced by these firms. The models should then be generalized to include these imperfectly competitive labor markets.

Given the results of this study, the next logical step should be to determine which of the productive managerial methods and techniques can be learned through training and which are innate. While the present study will provide a starting point for such a study, it should not be restricted to the significant results of this study. Incorporation of the suggested refinements in the methods used in this study should provide a better basis for the next step.


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Table 1. Characteristic vectors for three principle components and weights for a subjective index of sixteen plant and equipment capacity variables

<table>
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<th>Variable</th>
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<td>1.000</td>
<td>-.052</td>
<td>1.00</td>
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<tr>
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<td>1.000</td>
<td>.011</td>
<td>.256</td>
<td>.50</td>
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<td>-.117</td>
<td>.191</td>
<td>.50</td>
</tr>
<tr>
<td>$u_4$</td>
<td>.405</td>
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<td>.25</td>
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<td>-.590</td>
<td>.613</td>
<td>.25</td>
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<td>.943</td>
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<td>.364</td>
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<td>-.086</td>
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<td>.20</td>
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<td>$u_{11}$</td>
<td>.426</td>
<td>.394</td>
<td>-.162</td>
<td>.10</td>
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<td>-.373</td>
<td>.10</td>
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<td>$u_{13}$</td>
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<td>.930</td>
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<td>-.109</td>
<td>1.000</td>
<td>.10</td>
</tr>
<tr>
<td>$u_{15}$</td>
<td>-.333</td>
<td>.280</td>
<td>.012</td>
<td>.10</td>
</tr>
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<td>$u_{16}$</td>
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<td>.451</td>
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Table 2. Characteristic vectors for two principle components and weights for a subjective index of seven variables approximating the competitive situation

<table>
<thead>
<tr>
<th>Variable</th>
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</thead>
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<tr>
<td>$u_2 1$</td>
<td>.600</td>
<td>1.000</td>
<td>1.00</td>
</tr>
<tr>
<td>$u_2 2$</td>
<td>1.000</td>
<td>-.116</td>
<td>.90</td>
</tr>
<tr>
<td>$u_2 3$</td>
<td>.732</td>
<td>.398</td>
<td>.80</td>
</tr>
<tr>
<td>$u_2 4$</td>
<td>-.038</td>
<td>.910</td>
<td>.50</td>
</tr>
<tr>
<td>$u_2 5$</td>
<td>-.612</td>
<td>.800</td>
<td>.10</td>
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<td>$u_2 6$</td>
<td>-.845</td>
<td>-.108</td>
<td>1.00</td>
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<td>$u_2 7$</td>
<td>.992</td>
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<td>.40</td>
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</table>

Table 3. Characteristic vectors for two principle components and weights for a subjective index of the level of margins within trading areas

<table>
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<tr>
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<th>$U_3$</th>
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</thead>
<tbody>
<tr>
<td>$u_3 1$</td>
<td>.414</td>
<td>.870</td>
<td>.350</td>
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<tr>
<td>$u_3 2$</td>
<td>.360</td>
<td>1.000</td>
<td>.110</td>
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<td>.270</td>
<td>.303</td>
</tr>
<tr>
<td>$u_3 4$</td>
<td>-.871</td>
<td>-.255</td>
<td>.035</td>
</tr>
<tr>
<td>$u_3 5$</td>
<td>.395</td>
<td>-.297</td>
<td>.027</td>
</tr>
<tr>
<td>$u_3 6$</td>
<td>-.602</td>
<td>.399</td>
<td>.030</td>
</tr>
<tr>
<td>$u_3 7$</td>
<td>1.000</td>
<td>-.391</td>
<td>.050</td>
</tr>
<tr>
<td>$u_3 8$</td>
<td>.947</td>
<td>.004</td>
<td>.015</td>
</tr>
<tr>
<td>$u_3 9$</td>
<td>.558</td>
<td>.636</td>
<td>.060</td>
</tr>
<tr>
<td>$u_3 10$</td>
<td>1.000</td>
<td>-.286</td>
<td>.020</td>
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</table>
Table 4a. Characteristic vectors for the first principle component and weights for a subjective index of the management or retail merchandising

<table>
<thead>
<tr>
<th>Variable</th>
<th>$z_1^1$</th>
<th>$z_1^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$z_1$ 1</td>
<td>0.882</td>
<td>0.50</td>
</tr>
<tr>
<td>$z_1$ 2</td>
<td>0.875</td>
<td>1.00</td>
</tr>
<tr>
<td>$z_1$ 3</td>
<td>0.635</td>
<td>0.90</td>
</tr>
<tr>
<td>$z_1$ 4</td>
<td>0.252</td>
<td>0.90</td>
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<tr>
<td>$z_1$ 5</td>
<td>1.000</td>
<td>0.75</td>
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</tbody>
</table>

Table 4b. Simple correlation coefficients for variables included in the indices of the management of retail merchandising

<table>
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<tr>
<th>Variable</th>
<th>$z_1$ 1</th>
<th>$z_1$ 2</th>
<th>$z_1$ 3</th>
<th>$z_1$ 4</th>
<th>$z_1$ 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>$z_1$ 1</td>
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<td>0.31</td>
<td>0.22</td>
<td>-0.01</td>
<td>0.44</td>
</tr>
<tr>
<td>$z_1$ 2</td>
<td>1.00</td>
<td>0.14</td>
<td>0.10</td>
<td>0.45</td>
<td></td>
</tr>
<tr>
<td>$z_1$ 3</td>
<td>1.00</td>
<td>0.15</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$z_1$ 4</td>
<td>1.00</td>
<td>0.07</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$z_1$ 5</td>
<td>1.00</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Table 5a. Characteristic vectors for two principle components and weights for a subjective index of the management of wholesale trading

<table>
<thead>
<tr>
<th>Variable</th>
<th>$z_2^1$</th>
<th>$z_2^2$</th>
<th>$z_2^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$z_2 1$</td>
<td>-.289</td>
<td>.638</td>
<td>1.00</td>
</tr>
<tr>
<td>$z_2 2$</td>
<td>.523</td>
<td>.754</td>
<td>.60</td>
</tr>
<tr>
<td>$z_2 3$</td>
<td>.472</td>
<td>1.000</td>
<td>.75</td>
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<tr>
<td>$z_2 4$</td>
<td>.977</td>
<td>-.562</td>
<td>.50</td>
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<tr>
<td>$z_2 5$</td>
<td>1.000</td>
<td>-.397</td>
<td>.25</td>
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<tr>
<td>$z_2 6$</td>
<td>.508</td>
<td>.520</td>
<td>.25</td>
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</table>

Table 5b. Simple correlation coefficients for variables included in indices of the management of wholesale trading

<table>
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<tr>
<th>Variable</th>
<th>$z_2 1$</th>
<th>$z_2 2$</th>
<th>$z_2 3$</th>
<th>$z_2 4$</th>
<th>$z_2 5$</th>
<th>$z_2 6$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$z_2 1$</td>
<td>1.00</td>
<td>.04</td>
<td>.12</td>
<td>-.17</td>
<td>-.08</td>
<td>-.01</td>
</tr>
<tr>
<td>$z_2 2$</td>
<td>1.00</td>
<td>.32</td>
<td>.05</td>
<td>.09</td>
<td>.09</td>
<td></td>
</tr>
<tr>
<td>$z_2 3$</td>
<td>1.00</td>
<td>-.01</td>
<td>.05</td>
<td>.23</td>
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</tr>
<tr>
<td>$z_2 4$</td>
<td>1.00</td>
<td>.49</td>
<td>.08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$z_2 5$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
</tr>
<tr>
<td>$z_2 6$</td>
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</table>
Table 6. Characteristic vectors for two principle components of distances from the source of supply

<table>
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<tr>
<th>Variable</th>
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</thead>
<tbody>
<tr>
<td>$u_4$ 1</td>
<td>-.689</td>
<td>-.649</td>
</tr>
<tr>
<td>$u_4$ 2</td>
<td>-.280</td>
<td>-.748</td>
</tr>
<tr>
<td>$u_4$ 3</td>
<td>-.413</td>
<td>-.519</td>
</tr>
<tr>
<td>$u_4$ 4</td>
<td>.600</td>
<td>-.905</td>
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<tr>
<td>$u_4$ 5</td>
<td>.245</td>
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<tr>
<td>$u_4$ 6</td>
<td>.878</td>
<td>.191</td>
</tr>
<tr>
<td>$u_4$ 7</td>
<td>1.000</td>
<td>-.254</td>
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<td>$u_4$ 8</td>
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<td>-.620</td>
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</table>

Table 7a. Characteristic vectors for one principle component and weights for a subjective index of inventory management

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<tbody>
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<td>$z_3$ 1</td>
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<tr>
<td>$z_3$ 2</td>
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</tr>
<tr>
<td>$z_3$ 3</td>
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<td>1.00</td>
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</tbody>
</table>
Table 7b. Simple correlation coefficients for variables included in the indices of inventory management

<table>
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<tr>
<th>Variable</th>
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<th>Z3 2</th>
<th>Z3 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z3 1</td>
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<td>-.10</td>
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<tr>
<td>Z3 2</td>
<td>1.00</td>
<td>.07</td>
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<tr>
<td>Z3 3</td>
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<td>1.00</td>
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</tbody>
</table>

Table 8a. Characteristic vectors for three principal components and weights for a subjective index of the management of retail credit

<table>
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<tr>
<th>Variable</th>
<th>Z4 1</th>
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<th>Z4 3</th>
<th>Z4 4</th>
<th>Z4 5</th>
<th>Z4 6</th>
<th>Z4 7</th>
<th>Z4 8</th>
<th>Z4 9</th>
</tr>
</thead>
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<tr>
<td>Z4 1</td>
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<td>.831</td>
<td>.75</td>
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<tr>
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<td>.654</td>
<td>.496</td>
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</tr>
<tr>
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<td>.75</td>
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<tr>
<td>Z4 6</td>
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<td>-.095</td>
<td>.75</td>
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<td>Z4 8</td>
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<td>.25</td>
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Table 8b. Simple correlation coefficients for variables included in the indices of the management of retail credit

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<th>$z_4 1$</th>
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<th>$z_4 3$</th>
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<th>$z_4 5$</th>
<th>$z_4 6$</th>
<th>$z_4 7$</th>
<th>$z_4 8$</th>
<th>$z_4 9$</th>
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<tbody>
<tr>
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<td>0.00</td>
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<td>0.08</td>
<td>0.25</td>
<td>0.03</td>
</tr>
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<td>0.17</td>
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<td>-0.04</td>
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<tr>
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<td>0.08</td>
<td>0.07</td>
<td>0.05</td>
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<td></td>
<td></td>
</tr>
<tr>
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<td>-0.14</td>
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</tr>
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<tr>
<td>$z_4 9$</td>
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</table>

Table 9. Characteristic vectors for two principle components and weights for a subjective index of restrictions on retail credit management

<table>
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<th>$u_5^2$</th>
<th>$u_5^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$u_5 1$</td>
<td>1.000</td>
<td>-.322</td>
<td>1.00</td>
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<tr>
<td>$u_5 2$</td>
<td>.940</td>
<td>.471</td>
<td>1.00</td>
</tr>
<tr>
<td>$u_5 3$</td>
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<td>$u_5 4$</td>
<td>.047</td>
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</table>
Table 10a. Characteristic vectors for three principle components and weights for a subjective index of employee management

<table>
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<tr>
<th>Variable</th>
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<th>$z_3$</th>
<th>$z_5$</th>
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</thead>
<tbody>
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<td>-.229</td>
<td>1.00</td>
</tr>
<tr>
<td>$z_5\ 2$</td>
<td>1.000</td>
<td>.067</td>
<td>.085</td>
<td>.80</td>
</tr>
<tr>
<td>$z_5\ 3$</td>
<td>.790</td>
<td>.069</td>
<td>-.146</td>
<td>.50</td>
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<td>.273</td>
<td>.961</td>
<td>.044</td>
<td>.25</td>
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<td>$z_5\ 5$</td>
<td>.088</td>
<td>1.000</td>
<td>-.588</td>
<td>.25</td>
</tr>
<tr>
<td>$z_5\ 6$</td>
<td>.014</td>
<td>-.755</td>
<td>-.062</td>
<td>.50</td>
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<tr>
<td>$z_5\ 7$</td>
<td>.889</td>
<td>.092</td>
<td>.088</td>
<td>.60</td>
</tr>
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</tr>
<tr>
<td>$z_5\ 9$</td>
<td>.099</td>
<td>-.040</td>
<td>1.000</td>
<td>.50</td>
</tr>
<tr>
<td>$z_5\ 10$</td>
<td>-.178</td>
<td>.578</td>
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<td>.10</td>
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</table>
Table 10b. Simple correlation coefficients for variables included in the indices of employee management

<table>
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<tr>
<th>Variable</th>
<th>Z5 1</th>
<th>Z5 2</th>
<th>Z5 3</th>
<th>Z5 4</th>
<th>Z5 5</th>
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<th>Z5 7</th>
<th>Z5 8</th>
<th>Z5 9</th>
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</thead>
<tbody>
<tr>
<td>Z5 1</td>
<td>1.00</td>
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<td>.09</td>
<td>-.08</td>
<td>.10</td>
<td>.31</td>
<td>.28</td>
<td>-.01</td>
<td>-.22</td>
</tr>
<tr>
<td>Z5 2</td>
<td>1.00</td>
<td>.31</td>
<td>.14</td>
<td>.06</td>
<td>-.11</td>
<td>.50</td>
<td>.58</td>
<td>.08</td>
<td>-.08</td>
<td></td>
</tr>
<tr>
<td>Z5 3</td>
<td>1.00</td>
<td>.18</td>
<td>.02</td>
<td>-.01</td>
<td>.32</td>
<td>.31</td>
<td>.05</td>
<td>.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z5 4</td>
<td>1.00</td>
<td>.31</td>
<td>-.06</td>
<td>.11</td>
<td>-.02</td>
<td>.14</td>
<td>.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z5 5</td>
<td>1.00</td>
<td>-.13</td>
<td>.14</td>
<td>-.05</td>
<td>-.19</td>
<td>-.06</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z5 6</td>
<td>1.00</td>
<td>.10</td>
<td>-.05</td>
<td>.09</td>
<td>.19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z5 7</td>
<td>1.00</td>
<td>.52</td>
<td>.05</td>
<td>.00</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Z5 8</td>
<td>1.00</td>
<td>.12</td>
<td>.06</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z5 9</td>
<td>1.00</td>
<td>.20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z5 10</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 11. Characteristic vectors for two principle components and weights for a subjective index of restrictions on employee management

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\mathbf{u}_6^1$</th>
<th>$\mathbf{u}_6^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$u_6\ 1$</td>
<td>-.223</td>
<td>.50</td>
</tr>
<tr>
<td>$u_6\ 2$</td>
<td>1.000</td>
<td>1.00</td>
</tr>
<tr>
<td>$u_6\ 3$</td>
<td>.976</td>
<td>.50</td>
</tr>
<tr>
<td>$u_6\ 4$</td>
<td>.539</td>
<td>.25</td>
</tr>
<tr>
<td>$u_6\ 5$</td>
<td>.595</td>
<td>.75</td>
</tr>
</tbody>
</table>

Table 12a. Characteristic vectors for two principle components and weights for a subjective index of customer relations management

<table>
<thead>
<tr>
<th>Variable</th>
<th>$z_6^1$</th>
<th>$z_6^2$</th>
<th>$z_6^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$z_6\ 1$</td>
<td>.892</td>
<td>.417</td>
<td>.90</td>
</tr>
<tr>
<td>$z_6\ 2$</td>
<td>.683</td>
<td>1.000</td>
<td>.90</td>
</tr>
<tr>
<td>$z_6\ 3$</td>
<td>1.000</td>
<td>-.689</td>
<td>.80</td>
</tr>
<tr>
<td>$z_6\ 4$</td>
<td>.965</td>
<td>-.714</td>
<td>.65</td>
</tr>
<tr>
<td>$z_6\ 5$</td>
<td>.672</td>
<td>.487</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Table 12b. Simple correlation coefficients for variables included in the indices of customer relations management

<table>
<thead>
<tr>
<th>Variable</th>
<th>z6 1</th>
<th>z6 2</th>
<th>z6 3</th>
<th>z6 4</th>
<th>z6 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>z6 1</td>
<td>1.00</td>
<td>.48</td>
<td>.39</td>
<td>.28</td>
<td>.21</td>
</tr>
<tr>
<td>z6 2</td>
<td>1.00</td>
<td>1.00</td>
<td>.14</td>
<td>.08</td>
<td>.37</td>
</tr>
<tr>
<td>z6 3</td>
<td>1.00</td>
<td>1.00</td>
<td>.73</td>
<td>.17</td>
<td></td>
</tr>
<tr>
<td>z6 4</td>
<td></td>
<td></td>
<td>1.00</td>
<td>.27</td>
<td></td>
</tr>
<tr>
<td>z6 5</td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

Table 13. Characteristic vectors for two principle components and weights for a subjective index of restrictions on customer relations management

<table>
<thead>
<tr>
<th>Variable</th>
<th>u7^1</th>
<th>u7^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>u7 1</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>u7 2</td>
<td>-.819</td>
<td>.50</td>
</tr>
<tr>
<td>u7 3</td>
<td>-.505</td>
<td>.75</td>
</tr>
<tr>
<td>u7 4</td>
<td>.917</td>
<td>.25</td>
</tr>
</tbody>
</table>
Table 14. Characteristic vectors for one principle component and weights for a subjective index of overall management performed by the salaried manager

<table>
<thead>
<tr>
<th>Variable</th>
<th>$z_7^1$</th>
<th>$z_7^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>z7 1</td>
<td>.813</td>
<td>.75</td>
</tr>
<tr>
<td>z7 2</td>
<td>.972</td>
<td>1.00</td>
</tr>
<tr>
<td>z7 3</td>
<td>.908</td>
<td>.90</td>
</tr>
<tr>
<td>z7 4</td>
<td>1.000</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Table 15. Characteristic vectors for two principle components and weights for a subjective index of restrictions imposed by the board of directors

<table>
<thead>
<tr>
<th>Variable</th>
<th>$u_8^1$</th>
<th>$u_8^2$</th>
<th>$u_8^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>u8 1</td>
<td>.568</td>
<td>-.492</td>
<td>.90</td>
</tr>
<tr>
<td>u8 2</td>
<td>.558</td>
<td>.095</td>
<td>.40</td>
</tr>
<tr>
<td>u8 3</td>
<td>.597</td>
<td>.738</td>
<td>.50</td>
</tr>
<tr>
<td>u8 4</td>
<td>1.000</td>
<td>.122</td>
<td>1.00</td>
</tr>
<tr>
<td>u8 5</td>
<td>.624</td>
<td>-.410</td>
<td>.90</td>
</tr>
<tr>
<td>u8 6</td>
<td>.635</td>
<td>-.436</td>
<td>.50</td>
</tr>
<tr>
<td>u8 7</td>
<td>.195</td>
<td>1.000</td>
<td>.75</td>
</tr>
</tbody>
</table>
Table 16. Characteristic vectors for two principle components of personal characteristics of the operational manager

<table>
<thead>
<tr>
<th>Variable</th>
<th>$u_9^1$</th>
<th>$u_9^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$u_9 1$</td>
<td>-.077</td>
<td>-.229</td>
</tr>
<tr>
<td>$u_9 2$</td>
<td>-.136</td>
<td>-.651</td>
</tr>
<tr>
<td>$u_9 3$</td>
<td>.990</td>
<td>.047</td>
</tr>
<tr>
<td>$u_9 4$</td>
<td>-.874</td>
<td>.171</td>
</tr>
<tr>
<td>$u_9 5$</td>
<td>1.000</td>
<td>-.344</td>
</tr>
<tr>
<td>$u_9 6$</td>
<td>.130</td>
<td>.981</td>
</tr>
<tr>
<td>$u_9 7$</td>
<td>-.274</td>
<td>1.000</td>
</tr>
<tr>
<td>$u_9 8$</td>
<td>-.621</td>
<td>-.785</td>
</tr>
</tbody>
</table>
Table 17. Selected statistics from regression estimates of equation 1 and equation 2

<table>
<thead>
<tr>
<th>Variable</th>
<th>Equation 1</th>
<th></th>
<th></th>
<th>Equation 2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regression coefficient</td>
<td>Standard error</td>
<td>Regression coefficient</td>
<td>Standard error</td>
<td>Regression coefficient</td>
<td>Standard error</td>
</tr>
<tr>
<td>X&lt;sub&gt;1&lt;/sub&gt;</td>
<td>.485</td>
<td>.109</td>
<td></td>
<td>.368</td>
<td>.094</td>
<td></td>
</tr>
<tr>
<td>X&lt;sub&gt;2&lt;/sub&gt;</td>
<td>.250</td>
<td>.100</td>
<td></td>
<td>.187</td>
<td>.076</td>
<td></td>
</tr>
<tr>
<td>X&lt;sub&gt;3&lt;/sub&gt;</td>
<td>.256</td>
<td>.092</td>
<td></td>
<td>.307</td>
<td>.074</td>
<td></td>
</tr>
<tr>
<td>Z&lt;sub&gt;1&lt;/sub&gt;</td>
<td>.002</td>
<td>.008</td>
<td></td>
<td>-.093</td>
<td>.097</td>
<td></td>
</tr>
<tr>
<td>Z&lt;sub&gt;2&lt;/sub&gt;</td>
<td>.089</td>
<td>.115</td>
<td></td>
<td>-.058</td>
<td>.046</td>
<td></td>
</tr>
<tr>
<td>Z&lt;sub&gt;3&lt;/sub&gt;</td>
<td>.101</td>
<td>.090</td>
<td></td>
<td>.192</td>
<td>.084</td>
<td></td>
</tr>
<tr>
<td>Z&lt;sub&gt;4&lt;/sub&gt;</td>
<td>.276</td>
<td>.126</td>
<td></td>
<td>.661</td>
<td>.196</td>
<td></td>
</tr>
<tr>
<td>Z&lt;sub&gt;5&lt;/sub&gt;</td>
<td>-.089</td>
<td>.055</td>
<td></td>
<td>-.078</td>
<td>.114</td>
<td></td>
</tr>
<tr>
<td>Z&lt;sub&gt;6&lt;/sub&gt;</td>
<td>-.007</td>
<td>.084</td>
<td></td>
<td>-.214</td>
<td>.159</td>
<td></td>
</tr>
<tr>
<td>Z&lt;sub&gt;7&lt;/sub&gt;</td>
<td>-.078</td>
<td>.084</td>
<td></td>
<td>-.399</td>
<td>.152</td>
<td></td>
</tr>
<tr>
<td>Z&lt;sub&gt;8&lt;/sub&gt;</td>
<td>-.021</td>
<td>.066</td>
<td></td>
<td>.318</td>
<td>.179</td>
<td></td>
</tr>
<tr>
<td>Z&lt;sub&gt;9&lt;/sub&gt;</td>
<td>-.077</td>
<td>.102</td>
<td></td>
<td>.013</td>
<td>.067</td>
<td></td>
</tr>
<tr>
<td>Z&lt;sub&gt;10&lt;/sub&gt;</td>
<td>-.052</td>
<td>.107</td>
<td></td>
<td>.080</td>
<td>.124</td>
<td></td>
</tr>
<tr>
<td>Z&lt;sub&gt;11&lt;/sub&gt;</td>
<td>-.091</td>
<td>.097</td>
<td></td>
<td>-.505</td>
<td>.122</td>
<td></td>
</tr>
<tr>
<td>Z&lt;sub&gt;12&lt;/sub&gt;</td>
<td>.011</td>
<td>.114</td>
<td></td>
<td>-.013</td>
<td>.050</td>
<td></td>
</tr>
<tr>
<td>Z&lt;sub&gt;13&lt;/sub&gt;</td>
<td>.108</td>
<td>.088</td>
<td></td>
<td>.554</td>
<td>.165</td>
<td></td>
</tr>
<tr>
<td>U&lt;sub&gt;1&lt;/sub&gt;</td>
<td>.003</td>
<td>.006</td>
<td></td>
<td>.272</td>
<td>.069</td>
<td></td>
</tr>
<tr>
<td>U&lt;sub&gt;2&lt;/sub&gt;</td>
<td>.005</td>
<td>.008</td>
<td></td>
<td>.130</td>
<td>.062</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>See p. 102 for the meaning of these variables.
Table 17. (Continued)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Equation 1</th>
<th>Equation 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regression coefficient</td>
<td>Standard error</td>
</tr>
<tr>
<td>$u_3^1$</td>
<td>-.006</td>
<td>.006</td>
</tr>
<tr>
<td>$u_2^1$</td>
<td>.036</td>
<td>.062</td>
</tr>
<tr>
<td>$u_2^2$</td>
<td>-.004</td>
<td>.009</td>
</tr>
<tr>
<td>$u_3^3$</td>
<td>-.044</td>
<td>.051</td>
</tr>
<tr>
<td>$u_3^2$</td>
<td>-.002</td>
<td>.007</td>
</tr>
<tr>
<td>$u_4^1$</td>
<td>.008</td>
<td>.006</td>
</tr>
<tr>
<td>$u_4^2$</td>
<td>.001</td>
<td>.011</td>
</tr>
<tr>
<td>$u_5^1$</td>
<td>-.017</td>
<td>.111</td>
</tr>
<tr>
<td>$u_5^2$</td>
<td>.013</td>
<td>.076</td>
</tr>
<tr>
<td>$u_6^1$</td>
<td>-.049</td>
<td>.079</td>
</tr>
<tr>
<td>time</td>
<td>-.023</td>
<td>.023</td>
</tr>
</tbody>
</table>
### Table 18. Analysis of variance of equation 1

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Degrees of freedom</th>
<th>Mean square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction due to physical inputs</td>
<td>3</td>
<td>1.8164*</td>
</tr>
<tr>
<td>Added reduction by last 26 variates</td>
<td>26</td>
<td>.0092</td>
</tr>
<tr>
<td>Error</td>
<td>63</td>
<td>.0112</td>
</tr>
<tr>
<td>Calculated $F = 0.82$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tabular $F_{0.05 (26,63)} = 1.69$

### Table 19. Analysis of variance of equation 2

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Degrees of freedom</th>
<th>Mean square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction due to physical inputs</td>
<td>3</td>
<td>1.8164*</td>
</tr>
<tr>
<td>Added reduction by last 26 variates</td>
<td>26</td>
<td>.0159</td>
</tr>
<tr>
<td>Error</td>
<td>63</td>
<td>.0084</td>
</tr>
<tr>
<td>Calculated $F = 1.69$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tabular $F_{0.05 (26,63)} = 1.69$
Table 20. Selected statistics from regression estimates of equation 3

<table>
<thead>
<tr>
<th>Variable</th>
<th>Regression coefficient</th>
<th>Standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x_1$</td>
<td>.535</td>
<td>.095</td>
</tr>
<tr>
<td>$x_2$</td>
<td>.266</td>
<td>.071</td>
</tr>
<tr>
<td>$x_3$</td>
<td>.217</td>
<td>.071</td>
</tr>
<tr>
<td>$z_1$</td>
<td>.104</td>
<td>.085</td>
</tr>
<tr>
<td>$z_2$</td>
<td>-.052</td>
<td>.096</td>
</tr>
<tr>
<td>$z_3$</td>
<td>.394</td>
<td>.187</td>
</tr>
<tr>
<td>$z_4$</td>
<td>.116</td>
<td>.272</td>
</tr>
<tr>
<td>$z_5$</td>
<td>.051</td>
<td>.270</td>
</tr>
<tr>
<td>$z_6$</td>
<td>.013</td>
<td>.077</td>
</tr>
<tr>
<td>$z_7$</td>
<td>-.001</td>
<td>.123</td>
</tr>
<tr>
<td>$v_1$</td>
<td>.036</td>
<td>.097</td>
</tr>
<tr>
<td>$v_2$</td>
<td>-.151</td>
<td>.092</td>
</tr>
<tr>
<td>$v_3$</td>
<td>-.274</td>
<td>.341</td>
</tr>
<tr>
<td>$v_4$</td>
<td>.068</td>
<td>.052</td>
</tr>
<tr>
<td>$v_5$</td>
<td>-.016</td>
<td>.058</td>
</tr>
<tr>
<td>$v_6$</td>
<td>.015</td>
<td>.095</td>
</tr>
<tr>
<td>$v_7$</td>
<td>.168</td>
<td>.178</td>
</tr>
<tr>
<td>time</td>
<td>-.076</td>
<td>.119</td>
</tr>
</tbody>
</table>

aSee p. 102 for the meaning of these variables.
Table 21. Correlation coefficients for selected indices from the correlation matrix of equation 2a

<table>
<thead>
<tr>
<th></th>
<th>$z_3^2$</th>
<th>$z_2^2$</th>
<th>$z_5^1$</th>
<th>$z_6^1$</th>
<th>$z_7^1$</th>
<th>$z_4^1$</th>
<th>$z_4^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$z_3^2$</td>
<td>1.00</td>
<td>.03</td>
<td>.03</td>
<td>.24</td>
<td>.08</td>
<td>.05</td>
<td>.11</td>
</tr>
<tr>
<td>$z_2^2$</td>
<td>1.00</td>
<td>.08</td>
<td>.33</td>
<td>-.01</td>
<td>.41</td>
<td>.22</td>
<td></td>
</tr>
<tr>
<td>$z_5^1$</td>
<td>1.00</td>
<td>.56</td>
<td>.30</td>
<td>.07</td>
<td>-.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$z_6^1$</td>
<td>1.00</td>
<td>.42</td>
<td>.23</td>
<td>-.29</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$z_7^1$</td>
<td>1.00</td>
<td>.22</td>
<td>-.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$z_4^1$</td>
<td>1.00</td>
<td>.06</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$z_4^3$</td>
<td></td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

aSee p. 102 for the meaning of these variables.
Table 22. Selected statistics from regression estimates of equation 5

<table>
<thead>
<tr>
<th>Variable&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Regression coefficient</th>
<th>Standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td>( x_1 )</td>
<td>.611</td>
<td>.063</td>
</tr>
<tr>
<td>( x_2 )</td>
<td>.145</td>
<td>.046</td>
</tr>
<tr>
<td>( x_3 )</td>
<td>.157</td>
<td>.047</td>
</tr>
<tr>
<td>( z_{11} )</td>
<td>-.141</td>
<td>.057</td>
</tr>
<tr>
<td>( z_{12} )</td>
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<td>.024</td>
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<tr>
<td>( z_{22} )</td>
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<td>.024</td>
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<td>( z_{77} )</td>
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</tr>
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<td>.036</td>
</tr>
<tr>
<td>( u_{11} )</td>
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<td>.036</td>
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<td>( u_{22} )</td>
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<tr>
<td>( u_{33} )</td>
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<sup>a</sup>See p. 102 for the meaning of these variables.
Table 22. (Continued)

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<th>Variable(^a)</th>
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<th>Standard error</th>
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<td>(.033)</td>
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<tr>
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<td>(.114)</td>
<td>(.049)</td>
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<tr>
<td>( u_5^2 )</td>
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<tr>
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<tr>
<td>( u_6^2 )</td>
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<tr>
<td>time</td>
<td>(.004)</td>
<td>(.024)</td>
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Table 23. Selected statistics from regression estimates of equation 6 and equation 7

<table>
<thead>
<tr>
<th>Variable</th>
<th>Equation 6</th>
<th>Equation 7</th>
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<td>.033</td>
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</table>

*See p. 102 for the meaning of these variables.*
Table 23. (Continued)

<table>
<thead>
<tr>
<th>Variable</th>
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<th></th>
<th>Equation 7</th>
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<td>Regression coefficient</td>
<td>Standard error</td>
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