Errors-in-Variables analysis of cooperative organizational effectiveness

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Muhammad Amin Aziz

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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER ONE. INTRODUCTION</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Further Steps</td>
<td>8</td>
</tr>
<tr>
<td>CHAPTER TWO. THEORETICAL MODEL FOR ORGANIZATIONAL EFFECTIVENESS</td>
<td>10</td>
</tr>
<tr>
<td>Compliance Typology</td>
<td>10</td>
</tr>
<tr>
<td>Farmer Cooperatives as Utilitarian Organizations</td>
<td>15</td>
</tr>
<tr>
<td>Compliance Variables</td>
<td>18</td>
</tr>
<tr>
<td>Socialization</td>
<td>18</td>
</tr>
<tr>
<td>Communication</td>
<td>19</td>
</tr>
<tr>
<td>Selectivity</td>
<td>20</td>
</tr>
<tr>
<td>Scope</td>
<td>21</td>
</tr>
<tr>
<td>Pervasiveness</td>
<td>21</td>
</tr>
<tr>
<td>Saliency</td>
<td>22</td>
</tr>
<tr>
<td>Tension</td>
<td>22</td>
</tr>
<tr>
<td>Organizational Size</td>
<td>23</td>
</tr>
<tr>
<td>Organizational Effectiveness</td>
<td>25</td>
</tr>
<tr>
<td>Causal Models of Organizational Effectiveness</td>
<td>30</td>
</tr>
<tr>
<td>CHAPTER THREE. METHODS AND PROCEDURES</td>
<td>41</td>
</tr>
<tr>
<td>Source of Data</td>
<td>41</td>
</tr>
<tr>
<td>Measurements of Variables</td>
<td>42</td>
</tr>
<tr>
<td>Measurement Errors</td>
<td>49</td>
</tr>
<tr>
<td>CHAPTER FOUR. ERRORS-IN-VARIABLES MODEL</td>
<td>55</td>
</tr>
<tr>
<td>A Review</td>
<td>55</td>
</tr>
<tr>
<td>A Single Independent Variable Errors-in-Variables Model</td>
<td>58</td>
</tr>
<tr>
<td>Adaptive Bivariate Approaches to Measurement Errors</td>
<td>67</td>
</tr>
<tr>
<td>Correction for attenuation</td>
<td>67</td>
</tr>
<tr>
<td>Path analysis approach</td>
<td>70</td>
</tr>
<tr>
<td>Fuller's Errors-in-Variables Approach for the General Linear Model</td>
<td>73</td>
</tr>
</tbody>
</table>
CHAPTER ONE.
INTRODUCTION

This study provides a test of some of the relationships among key concepts in Etzioni's formulation of compliance theory by taking into account the errors of measurement resulting from the use of observed variables to represent the theoretical concepts. Path analysis and multiple linear regression are often used techniques in Sociology for testing relationships and constructing sociological models (Duncan, 1966; Blau and Duncan, 1967; Blalock, 1971; Heise, 1970).

The causal model of organizational effectiveness in business organizations was developed and tested by using Ordinary Least Squares by Warren et al. (1973a, 1976). However, path models represent the relationships among true values of the concepts being considered. Although several articles point out the influence of specification errors and measurement errors on the estimation process (Heise, 1969; Bohrnstedt and Carter, 1971; Blalock et al., 1970), only limited empirical studies have used estimating procedures that take into account measurement errors. Correction for attenuation has been used in the bivariate case but in the multivariate case the sampling distributions of the estimates have not been developed (Bohrnstedt and Carter, 1971, p. 142).

Only recently work has been completed for Errors-in-Variables approach which provides not only estimates of parameters but also the standard errors for testing the estimators (DeGracie and Fuller, 1972; Fuller and Battese, 1973; Fuller, 1971; Warren et al., 1974a). Even more recently a computer program has been developed to reduce the time
and energy necessary to use a procedure taking into account the measurement errors (Hidiroglou, Fuller, and Hickman, 1977).

The major emphasis of this study will be a discussion of the Errors-in-Variables approach, a comparison of the results from Ordinary Least Squares versus Errors-in-Variables, and an attempt to utilize the Errors-in-Variables approach in a structural equations model. With the present emphasis in Sociology on causal models and reliability, the Errors-in-Variables approach provides information on the procedure as well as the influence that the measurement errors may have on generalizations and inferences from testing causal models. Since the estimates and inferences of the two procedures will be compared for a given path model, it will be necessary to present and discuss the causal model as well as the procedure used for testing.

Etzioni (1975, p. xv) defines compliance as "...a relationship consisting of the power employed by superiors to control subordinates and the orientation of the subordinates to this power." Etzioni has developed his classification scheme of coercive, utilitarian, and normative organizations. Etzioni (1975) does not postulate his compliance correlates in causal analysis, but he has been impressed by the causal work of "Iowa State Compliance Studies"\(^1\). This causal analysis contributes one chapter of Etzioni's book (1975). Tukey

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\(^1\)Etzioni (1975) has referred to a group of 15 different reports and publications dealing with compliance variables whose authors are or were in Ames, Iowa as "Iowa State Compliance Studies." In the late 1950's Drs. George M. Beal and Joe M. Bohlen began assembling a research team to study the interface of individual and organizational phenomena. In 1960 Gerald Klonglan and Richard Warren became team members. And in 1965 Charles Mulford joined the other four as co-principal investigators of several studies (Etzioni, 1975, p. 142).
argues that theories with causal elements have been of the greatest importance in semiquantitative, as well as in all quantitative, branches of sciences (Tukey, 1954, p. 40). Tukey also presents the difficulties in arriving at causal analysis if it is stated in terms of regression. One of these difficulties is the situation where the determining variable is measured with errors.

Heise (1969) and Bohrnstedt and Carter (1971) have discussed the assumptions of the path analysis and the consequences if some of these assumptions were violated. As Heise (1969) pointed out, the assumptions of linearity and no reciprocal relationships are relatively easy to bypass. Assumptions about model specification, the correlation among disturbances, and the assumption about measurement are quite highly interrelated. If measurement error exists, or if relevant variables have been omitted from the model, the disturbance terms will be correlated. More specifically about measurement errors, Bohrnstedt and Carter (1971, p. 139) say "... when measurement errors are present in the observed values, we guarantee that the disturbance terms will be correlated with the independent variables and with themselves. Further, this insures that our estimates of the path coefficients themselves will be biased."

1These assumptions are that: (1) the specification of the causal model in the population is correct, (2) the relations linking the variables are linear, (3) no reciprocal causation exists among the variables, (4) the disturbances of each equation are uncorrelated with each other and with the independent variables in the equation in which the disturbance appears, (5) the variables are measured without error, and (6) that there are assumptions with regard to normality of disturbances and heteroscedasticity of the independent variables.
When measurement error is present, the application of standard least-squares estimating procedures produces distortions of the estimates (Blalock et al., 1970; Cochran, 1970; Wiley, 1973). Given random measurement errors in the independent variables of a simple regression equation, the regression coefficient is attenuated (reduced in absolute value) when compared with the coefficient computed in the absence of measurement error (Johnston, 1972; Malinvaud, 1966). The multiple correlation coefficient will be smaller, on the average, in the presence of measurement error (Cochran, 1970; Fuller, 1977), but the nature of the bias of the individual regression coefficients is a function of the reliability and the intercorrelation of the variables (Bohnstedt and Carter, 1971). Fuller's Errors-in-Variables procedure makes it possible to estimate the portion of the variation in the dependent variable associated with the error of measurement, and associated with the variation in the true values of the dependent variable explained by the true values of the independent variables. Fuller has also suggested a modification of the Errors-in-Variables approach which reduces the bias and mean square error of the estimators (Warren et al., 1974a, p. 886).

Bohnstedt and Carter (1971) also pointed out that the estimation of the parameters of a hypothesized multiple linear-regression model involves not only the recognition of the existence of measurement error, but also the recognition of the existence of specification
They showed that the specification errors can seriously affect the estimates of the true structural parameters operating in the structural equations. This situation is further complicated by the fact that a correction factor cannot be applied to the estimates to re-establish their unbiased property. Fuller's Errors-in-Variables procedures provide the estimate of the portion of the variation in the dependent variable associated with the error in the equation (Warren et al., 1974a, p. 886).

Since the portions of variation in the true values of the dependent variable explained by the true values of the independent variables, error in the equation, and measurement error which are associated with the variation in the dependent variable can be estimated, the Fuller's Errors-in-Variables procedure enables a researcher to estimate the true coefficient of determination. Since the procedure also provides an estimator of the covariance matrix of the parameter estimators, a test of significance can be made using the estimated coefficients. This Errors-in-Variables approach also facilitates a check on the assumed nonsingularity of the variance—covariance matrix of the

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Malinvaud (1966, pp. 250-273) describes two types of specification errors: Incorrect specification of the distribution of errors is concerned with their normality, heteroscedasticity, independence with respect to the exogeneous variables, and the existence of the variance of the errors. Incorrect specification of the relation deals with the omission of the exogeneous variables, linearity of the relations, and additivity of the errors. Until recently, sociological methodologists have been mostly concerned with the omission of relevant variables. Specification error relies heavily on the substantive discipline to postulate the system (Johnston, 1972, p. 352; Goldberger and Duncan, 1973, p. 23). "It is a function of sociological theory to specify that some of the coefficients of the exogeneous and the endogeneous variables are zero" (Goldberger and Duncan, 1973, p. 23).
independent variables. Hence, it is possible to modify the model during the analysis if it seems that more than one variable is measuring a common concept (Warren et al., 1974a, p. 886).

Fuller's Errors-in-Variables procedures will be applied to the analysis of organizational effectiveness as compared to the Ordinary Least-Squares procedures which had been applied to the analysis by Warren et al. (1976). The need for empirical studies of organizational effectiveness has been explicit in the works of Georgopoulos and Tannenbaum (1957), Mahoney (1967), Yuchtman and Seashore (1967), Ghorpade (1970), Price (1972), Mulford et al. (1972), Warren et al. (1973a). Even though Etzioni (1975) discusses other correlates with his compliance structures, the organizational effectiveness has been central to his analysis. Etzioni defines effectiveness as "the extent to which a goal is realized, ..." (Etzioni, 1975, p. 133). Organizational goals are the state of affairs which the organization is attempting to realize. A goal is an image of a future state, which may or may not be brought about (Parsons, 1937, p. 44). Once it is realized it becomes part of the organization or its environment, but it ceases to be an image that guides organizational activities and hence ceases to be a goal (Etzioni, 1975, pp. 133-134).

Etzioni's basic propositions are that the organizations that have similar compliance structures tend to have similar goals, and organizations that have similar goals tend to have similar compliance structures (Etzioni, 1975, p. 103). This is another way of saying that goals relate to compliance structures. Since effectiveness is the extent
to which the goal is realized, then effectiveness must somehow relate to compliance structures.

Each organization has a cultural system which includes sets of values and cognitive perspectives (Parsons, 1951, pp. 326 ff.). Participants in a given organization differ in their orientation to this cultural system. Two processes considered by Etzioni (1975, pp. 231-232) modify the position of the lower participants to this cultural system. These are the communication and socialization processes. Organizations should never be treated as sociological islands (Etzioni, 1975, p. 148). External linkages should be taken into account. Etzioni (1975, pp. 255-278) has explored the ways in which an organization's compliance structure is related to several aspects of its articulation with its environment. Selectivity is the means by which it recruits new participants from outside its boundaries; scope is the number of activities the participants carry out in groups; and pervasiveness is the number of activities inside or outside the organization sets norms. Salience and levels of tension have been discussed in relation to scope.

Two types of organizations have been the area of research of Iowa State University in relation to compliance studies. The first is the Civil Defense Preparedness Agency as a normative organization, and the second is the farmer cooperatives as utilitarian organizations. This study will focus on the utilitarian organization.

Effectiveness is what organization is all about (Etzioni, 1975, p. 133). According to Etzioni, it is wiser to define organizational effectiveness not merely as a level of a goal realization but as a pattern of relationships among the elements of an organizational system.
which enhances its service of one or more goals. In this realm, this study will utilize four measures of organizational effectiveness, i.e.: Adaptive Performance, Manager Salary, Net Operating Revenue, and Savings. This study will relate those cultural integration and environment articulation variables of compliance structure to these four measures of organizational effectiveness in farmer cooperatives as utilitarian organization.

To summarize, the specific objectives of this study are:

a. To discuss and present a causal model of organizational effectiveness including Size as one of the exogeneous variables,
b. To discuss and present the Errors-in-Variables approach and its application, and
c. To test a causal model of organizational effectiveness using Errors-in-Variables and compare the results to Ordinary Least-Squares regression procedures.

Further Steps

In Chapter Two, the theoretical framework will be presented for the empirical work in following chapters. Initially, Etzioni's compliance typology is discussed. Farmer cooperatives are discussed in relation to this typology. Further, Etzioni's cultural integration and environment articulation compliance variables are presented. Organizational effectiveness is reviewed in relation to farmer cooperatives as utilitarian organizations. Organizational Size is discussed, and different views about this variable are presented. Causal models of
organizational effectiveness are postulated which relate the compliance variables, organizational size, and organizational effectiveness.

In Chapter Three, the methods and procedures of empirical work are reviewed. The source of data is presented. The measurement of variables utilized in this study, the procedures of estimating error variances and reliability are discussed.

In Chapter Four, the Errors-in-Variables models are presented, especially Fuller's approach to this procedure. The models are discussed conceptually and are exemplified by presenting the bivariate case and multivariate case and are compared to Ordinary Least-Squares approaches. In the bivariate case, alternative approaches, i.e. correction for attenuation and path analysis approaches, are discussed by utilizing the same example. Lastly, a note on structural equation models is reviewed.

In Chapter Five, the results and discussion are presented. The results of Ordinary Least-Squares and Errors-in-Variables analyses are compared. The significant Errors-in-Variables relationships are reviewed and diagrammed for the ease of interpretation. Substantively theoretical discussion follows the results.

In the last chapter, Chapter Six, this study is summarized.
CHAPTER TWO.

THEORETICAL MODEL FOR ORGANIZATIONAL EFFECTIVENESS

In this chapter a discussion on organizational classification, particularly Etzioni's compliance typology, will be presented. A discussion about farmer cooperatives follows this typology. Relevant compliance variables of Etzioni's theory, organizational size, and organizational effectiveness will be used for the presentation of a causal model for cooperative organizational effectiveness. This model will be used in an application of Errors-in-Variables analysis.

Compliance Typology

The focus of this study is organizational effectiveness. However, organizational effectiveness may be viewed differently depending on how a theorist or a researcher sees the classification of social organization. Parsons (1960, pp. 44-47) utilizes functional imperatives as the fundamental problem confronting society. These imperatives are pattern-maintenance, integration, goal-attainment, and adaptation. Many people feel that Parson's typology lacks syntax, because the concepts are not linked together in such a fashion as to generate testable hypotheses. However, Scott (1959, p. 386) argues that Parson's general theory of action and social system approach "provides a theoretical framework for research on social organization which offers an alternative to ad hoc studies." Evers (1973) and Warren et al. (1975) have utilized Parsons' functional imperatives in analyzing cooperative organizational goals.
Blau and Scott (1962, pp. 45-58) utilize Cui Bono — who benefits — as the basis to classify organization. This classification can be used to determine whether the members, owners or managers, clients, or public at large is the prime beneficiary of the operations of the organization. Likert (1961) arrives at four management systems or systems of organization. These are: exploitative authoritative, benevolent authoritative, consultative, and participative system of organization.

Ghorpade (1970) classifies the views of organization as rational and system views. The rational group views organization as rational instruments or machined designed for the attainment for the expressly announced group goals (Gouldner, 1959, p. 401). The organization represents an economy whose main task is the systematic manipulation of scarce resources for the attainment of specified goals (Selznick, 1948, p. 26). Employees are considered either as inert instruments or as entities whose behavior can be controlled to suit organizational purposes.

According to Ghorpade (1970, pp. 34-36), the social system model organizational analysis is an outgrowth of the structural functional school of sociology, notably the works of Robert K. Merton, Talcot Parsons, and Philip Selznick (Inkeles, 1964, pp. 34-37). Azumi and Hage (1972, pp. 11-14) see the system analysis as having three major assumptions. The system analysts view organization as a set of variables that are interrelated in such a way that changes in one variable effect changes in the other variables. The system is viewed as part of an environment and in turn the system has particularly key components.
The last assumption is crucial since these scholars assume that there are various regulatory processes besides the production process that involve feedback of information.

This study follows Etzioni's compliance classification of social organization. Compliance is a relationship consisting of the power employed by superiors to control subordinates and the orientation of the subordinates to this power. Thus, Etzioni claimed, the study of compliance combines a structural and a motivational aspect; structural, since it is concerned with the kinds and distribution of power in organization; motivational, since it is concerned with the differential commitments of actors to organizations (as a unit which exercises power over them) (Etzioni, 1975, p. xv).

Etzioni claims that his approach differs from Weber's "class, status, and power" approach in three ways.

"First, we see all three as powers, not just one. Class is one expression of economic power; status is an expression of normative power. Our more inclusive treatment of power permits us to engage in a more extensive analysis of the correlates and effects of power than many studies conducted in the Weberian and related sociological traditions. Second, force is a power central to our schema, but it is not a part of Weber's typology of the foundation of social order. Finally, Weber does not apply his threefold typology to the study of bureaucracies but uses instead the distinction between legitimate and illegitimate power." (Etzioni, 1975, p. xvii).

Etzioni thinks that compliance is universal, exists in all social units, and is the central element of organizational structure. According to Etzioni, compliance is systematically related to other central organizational variables such as specificity, size, complexity,
and effectiveness (Etzioni, 1975, pp. 3-4). Thereby, compliance has been taken as an analytical base for the classification of organizations.

Compliance relationship is constituted by the associations of the types of power and the types of involvement. Borrowing from Parsons, power is defined as an actor's ability to induce or influence another actor to carry out his directives or any other norms he supports. Based on the means employed to make the subject comply, power is classified into coercive, remunerative, and normative power. Coercive power is based on the application, or the threat of application, of physical sanctions such as infliction of pain, deformity, or death; generation of frustration through restriction of movement; or controlling through force the satisfaction of needs such as those for food, sex, comfort, and the like. Remunerative power is based on control over material resources and rewards. Normative power rests on the allocation and manipulation of symbolic rewards and deprivations (Etzioni, 1975, pp. 4-6).

Involvement is the cathectic-evaluative orientation of an actor to an object. Three zones of involvement are named; these are alienative, calculative, and moral involvements. Alienative involvement designates an intense negative orientation; it is predominant in relations among hostile foreigners. Calculative involvement designates either negative or positive orientation of low intensity which are predominant in relationships of merchants who have continuous business contacts. Moral involvement designates a positive orientation of high intensity. There are two kinds of moral involvement, pure and social. Pure moral commitments are based on internalization of norms and identification
with authority. Social commitment rests on sensitivity to pressures of primary groups and their members (Etzioni, 1975, pp. 8-11).

It is obvious that there are two parties to a compliance relationship: an actor who exercises power, and an actor subject to this power who responds to the subjection with either more or less alienation or more or less commitment. Etzioni classifies organization according to their predominant compliance pattern as coercive, utilitarian, or normative organization. Coercive organizations are organizations in which coercion is the major means of control over lower participants and high alienation characterizes the orientation of most lower participants to the organization (Etzioni, 1975, p. 27). Normative organizations are organizations in which normative power is the major source of control over most lower participants, whose orientation to the organization is characterized by high commitment (Etzioni, 1975, p. 40). Utilitarian organizations are organizations in which remuneration is the major means of control over lower participants and calculative involvement (i.e., mild alienation to mild commitment) characterizes the orientation of the large majority of lower participants (Etzioni, 1975, p. 31).

Hall et al. (1967) have examined the utility of Blau-Scott and Etzioni typologies in differentiating between organizations on a series of variables such as goal specificity, power structure, and the like. They conclude that "the Blau-Scott typology has the organization itself as the dependent variable, as does the Parson typology based on organizational goals. The Etzioni typology has the power-compliance structure as its dependent variable" (p. 138).
Iowa State University's studies of social organization have been labelled by Etzioni as "Iowa State Compliance Studies." These studies have mainly utilized Etzioni's theory in normative and utilitarian organizations. The studies on farmer cooperatives have been considered as studies of utilitarian organizations.

Farmer Cooperatives as Utilitarian Organizations

The chronological development of farmer cooperatives in the United States was described by Abrahamsen (Farmer Cooperative Service Bulletin 1, 1965, pp. 50-51) in the following:

"The first period, beginning shortly after 1800 and ending about 1870, was one of experimentation; the second from about 1870 to about 1890 resulted from early encouragement by general farm organizations; the third from around 1890 to 1920 saw the rapid organization of business cooperatives; the fourth from 1920 to 1933 was characterized as orderly cooperative marketing; the fifth from 1933 to 1945 may be described as one emphasizing sound business principles; and the sixth from 1945 to the present (1969) is characterized by adjustment to profound national and international events affecting agriculture."

During 1969-70, some 7,719 farmer cooperatives handled a total volume of over 19 billion dollars (FCS Report No. 22, 1973). The Farmer Cooperative Service estimates that "five farmers out of six are members of one or more cooperative associations." And, "on the average a cooperative member belongs to between two and three associations" (USDA, 1972).

According to Warren et al. (1973b) the State of Iowa's cooperatives handled the third highest volume in the country with only California
and Minnesota having a higher net volume. Iowa ranked first in the value of farm supplies handled in the period 1969-1970.

McCabe's study (1966) in Iowa identified twelve objectives of the cooperatives as the following:

1. Increasing the area served by the cooperative,
2. Maximizing the income of the members,
3. Increasing the sales volume of the cooperative,
4. To provide products and services at lowest prices,
5. To be a business leader in the area,
6. To serve members by providing a policing type of competition to the other agribusiness firms,
7. To maintain the present policies and practices and avoid risk in the operation of the cooperative,
8. Maximum operational efficiency of the cooperative,
9. To build a good public image for the cooperative,
10. To make satisfactory net savings each year,
11. To expand and update the facilities of the cooperatives,
12. Maximum net savings of the cooperative.

The above twelve objectives were ranked by board presidents and managers of farmer cooperatives in Iowa. The objective "to make a satisfactory net savings each year" was ranked first by both the managers and the board presidents. Net saving is a measure of profit.

Roy views the cooperative purpose as the following:

"The primary purpose of a cooperative is to make a profit for its patrons or users of the cooperative, not for its investors. The members of a cooperative serve themselves. They are both the owners and users of the services" (1964, pp. 27-28).
However, it should be noted that the selection was satisfactory net savings as compared to maximum net savings.

The Farmer Cooperative Service (Bulletin No. 1, 1965) listed the responsibilities of the patron-members, the directors, and the managers of the cooperatives. The responsibilities of the patron members include the election (and removal) of members. Election of a Board of Directors; approval of major changes in physical plant, services and of product lines recommended by the Board of Directors; the adoption and amendment of by-laws and articles that may be required for legal incorporation.

The responsibilities of the directors may generally be described as strategic management that would include, for example, the making of decisions as to overall business policies, selecting the manager, raising of funds, by borrowing if necessary, and determining the expenditure of these funds. The directors represent the interest of the patron-members.

The responsibilities of the hired management include the planning and coordinating of day-to-day business activities, executing policy decisions of the Board of Directors, selecting and supervising the employees, and the efficient use of materials, equipment, and personnel.

The study of farmer cooperatives has been Iowa State University emphasis before the "Iowa State Compliance Studies" which contributed one whole chapter of Etzioni (1975). Some of these studies include Beal (1956), Bohlen (1955), Bohlen and Beal (1961), Bohlen et al. (1968), McCabe (1966), Warren (1965), and Warren et al. (1967).
According to Etzioni (1975, p. 393) farmer cooperatives are not typical utilitarian organizations. He pointed out to Sampson (1973, p. 14):

"profit making for the organization is not the primary reason for the existence of farm cooperatives.... In a sense, farm cooperatives may be classified as rural voluntary associations in which the membership is based on economic motivation.... Not only are economic needs met by farm cooperatives, but they also perform important communicational, educational and bargaining functions for their member-patrons."

Eventually Etzioni concludes that the high pressures under which farmer cooperatives are placed to operate efficiently and economically make them utilitarian in character, and suggest the "secondary" status of their normative features.

Compliance Variables

Socialization

Etzioni (1975, p. 245) defines socialization as "the acquisition of the requisite orientations for satisfactory functioning in a role." Socialization is concerned with the period before or shortly after new participants join the organization, when efforts to induce consensus between newcomers and the rest of the organization are comparatively intensive.

Etzioni is interested in the substance and the amount of socialization. The substance is the concerns with the degree to which socialization prepares for participation in the instrumental system or in the expressive one. The amount of socialization of each type required
for effective participation could be assessed by the length of education required to prepare for the participation (Etzioni, 1975, p. 246).

Formal socialization refers to socialization by office holders, as opposed to informal socialization by lower participants. In utilitarian organization, formal socialization is more extensive than it is in coercive organizations. It is mainly instrumental in nature and consists of giving the work force technical training and a few hours of orientation. Expressive socialization in utilitarian organizations is limited. Some corporations engage in more extensive expressive socialization, but these are not purely utilitarian organizations (Etzioni, 1975, p. 246 and 248).

Communication

Communication is "a symbolic process by which the orientations of lower participants to the organization are reinforced or changed" (Etzioni, 1975, p. 241). By substance, instrumental communication distributes information and knowledge, and affects cognitive orientation, and expressive communication changes or reinforces attitudes, norms, and values. By direction, communications may flow vertically or horizontally in the rank structure, and vertical communication may flow upward or downward (Etzioni, 1975, p. 242).

Since utilitarian organization is the most rational type of the three, and since coordination, planning, and centralized decision-making are emphasized here more than in the two other types, upward instrumental communication, especially of information, is required in utilitarian organization as much as downward instrumental communication.
Vertical expressive communication is limited in utilitarian organizations, although less than in coercive ones, because of the calculative orientation of lower participants to the organization and their tendency to develop an independent (horizontal) expressive communication network (Etzioni, 1975, p. 245).

Selectivity

Participants of an organization are clearly not identical; they differ according to potential productivity, trainability, and expected tenure in a utilitarian organization. The utilitarian organization prefers to have those participants who will be the most productive, the most easily trainable, and the least likely to quit (Salop and Salop, 1976, p. 619). Thereby, selectivity "the ratio of actual participants over potential ones" becomes an important determinant of organizational effectiveness (Etzioni, 1975, p. 258 and 260). Selectivity is a linkage where the organization interacts with its environment (Etzioni, 1975, p. 255).

In his flow model, Etzioni views socialization as substitutable with selectivity (p. 252). The criteria of selection and the degree of selectivity affect the initial involvement of new lower participants. Initial involvement may be modified by formal and informal socialization. The state of involvement which stabilizes after the operation of these processes, or "established involvement," is the one affecting the power which can be effectively applied to lower participants (Etzioni, 1975, p. 261).
Scope

Scope is another process of social organizations. By using this process the organization interacts with and penetrates the environment. Organizations differ in their scope, that is, in the number of activities in which the participants are jointly involved. Scope is determined by discovering the extent to which activities of the participants of an organization are limited to other participants of the same organization, as against the degree to which activities of participants involve nonparticipants as well. Organizations whose participants share many activities are broad in scope. Organizations whose participants share few activities are narrow in scope (Etzioni, 1975, pp. 264-265).

Typical utilitarian organizations are narrow in scope; that is, they are mainly instrumental groupings. Etzioni suggests that the more coercive utilitarian organizations are, the broader their scope (Etzioni, 1975, pp. 269 and 271).

Pervasiveness

In addition to selectivity and scope, pervasiveness is used by the organizations to penetrate the environment (Etzioni, 1975, p. 255). The range of pervasiveness is determined by the number of activities in or outside the organization for which the organization sets norms. Pervasiveness is small when such norms cover only activities directly controlled by organizational elites; it is larger when it extends to other activities carried out in social groups composed of organizational participants (Etzioni, 1975, p. 167).
Typically utilitarian organizations are narrow in pervasiveness. Etzioni expects that the more coercive utilitarian organizations are, the higher their pervasiveness. The more normative utilitarian organizations are, the higher their pervasiveness tends to be (Etzioni, 1975, pp. 271-272).

**Saliency**

Saliency refers to the relative emotional significance of participation in one collectivity compared to that in others. It refers not to the intensity of commitment or alienation an individual may feel for the organization, but to the importance of this involvement compared to his involvement in other collectivities (Etzioni, 1975, p. 265).

Etzioni suggests that utilitarian organizations have lower saliency than the expressive collectivities (Etzioni, 1975, pp. 265-266). Warren et al. (1976, p. 333) consider job satisfaction or identification with the organization similar to saliency.

**Tension**

The level of tension experienced by the average lower participant because of his activities in the organization is also directly affected by the organizational scope. Tension refers to the personal role tension, or emotional strain, created by participation in an organization (Etzioni, 1975, pp. 266, 390-391; Warren et al., 1976, 333).
Etzioni has recognized the importance of size (Etzioni, 1975, pp. 3 and 241). He indicates that size, as well as other characteristics, may enhance the need for compliance and adds that compliance may be systematically related to these variables (p. 3). He also says that a large sized organization requires extensive communication networks and roles and mechanisms especially devoted to the flow of communications (p. 241). He has not, however, developed specific propositions about size and other compliance variables.

Recent development in organizational research continues to point out the importance of the size variable, especially in the new attempts to relate size and technology. Blau's (1970) formal deductive theory of organizational structure is better known for his attempt to relate size and structural differentiation. According to Blau, size produces effects on structural differentiation. However, Hummon et al. (1975) challenge Blau's causal ordering by arguing that structural differentiation is one which produces the effect on organizational size. Meyer's (1972) longitudinal study (at two points in time) found that organizational size determined the development of structural differentiation.

Based on their research carried out at the Industrial Administration Research Unit of the University of Aston in Birmingham, the Aston group of Pugh, Hickson, Hinigs, MacDonald, Turner, and Lupton (1963), argued for the model that organizational size influences organizational structure. Aldrich (1972) applying the same data (Aston data) suggested a more causal treatment in the analysis of social phenomena and argued
for the evidence of a causal network in which organizational structure influenced the organizational size. Applying the same Aston data and by incorporating with the two-stage least squares in simultaneous equations, Hilton (1972) tried to resolve the problem by postulating that organizational size and organizational structure had a reversible effect; both variables affecting each other.

Aldrich's conclusions clearly denied Blau's theory of organizational size. In a very recent study, Peter M. Blau et al. (1976) examined data on 110 New Jersey manufacturing concerns and found that Aldrich's conclusions were not supported.

Unfortunately, researchers view size differently. Hall et al. (1967), Child (1973), Blau et al. (1976) measure size by the number of employees. Aldrich (1972), Hilton (1972), utilize Pugh et al.'s data (1963) which measures size by the number of employees, net assets utilized, and the number of employees in the parent organization. Mulford et al. (1977) measure size by the total number of paid hours per week devoted to the organization by the participants.

Hall et al. (1967) have stated that the Etzioni classification scheme does not clearly differentiate between organizations in terms of structural characteristics. Azumi and McMillan (1973) have pointed out that size correlates significantly with objective and subjective measures of organizational structure. Since the Etzioni compliance model covers both the motivational and structural aspects of organizational life (Etzioni, 1975, p. xv), Azumi and McMillan's findings suggest that organizational size would have some correlates with compliance variables. Mulford et al.'s study (1977) strongly suggests
that size should be taken into account when Etzioni's compliance model is considered. In a suggestive realm, they state "because size not only seems relevant for Etzioni's classification scheme, but also for his compliance model, we suggest that its role can no longer be ignored. We hope those interested in compliance theory consider this problem as one with high priority."

This study postulates size as a variable which determines organizational structure and processes. Organizational size is assumed to determine endogeneous compliance variables, and in turn determines the organizational effectiveness variables.\(^1\)

Organizational Effectiveness

The need for empirical studies of organizational effectiveness is stated in the works of many authors or researchers (for examples, Georgopoulos and Tannenbaum, 1957; Yuchtman and Seashore, 1967; Ghorpade, 1970; Mulford et al. 1972; Klonglan et al. 1969, 1974; Warren et al., 1973a, 1974b, 1975; Price, 1971). Georgopoulos and Tannenbaum (1957, p. 540) see that a considerable gap exists between theoretical and empirical approaches. They say: "because there is little theory that adequately treats this concept, research efforts have generally proceeded unsystematically, without sufficient consideration of the conceptual aspects of the phenomenon, and in terms of ad hoc

\(^1\)This relation will be discussed further in the causal model of organizational effectiveness.
criteria not systematically related to theoretical frameworks consistent with our knowledge of organizations."

Ten and thirteen years after Georgopoulos and Tannenbaum's claim of little theory, Yuchtman and Seashore (1967) and Ghorpade (1970) had seen many theories related to organizational effectiveness so that they needed to classify them. Yuchtman and Seashore (1967) observed that there were two approaches in studying organizational goals; these were the "prescribed" approach and "derived" or "operative goal" approach. Functional approach to effectiveness, according to Yuchtman and Seashore, lies in the "derived" approach.

Ghorpade (1970) observed there were two approaches of organizational effectiveness: the rational and the system approach. The rationalist approach derived the effectiveness from organizational goals which were based on a wide variety of formal data such as official documents, organizational outputs, and statements by organizational spokesmen. Ghorpade sees the advantages of this approach as having the merit of focusing upon the rational, purposive aspects of organization value "free," and its overt simplicity. The disadvantages are that the approach neglects the balanced evaluation of organization from an alternative frame-of-reference; it neglects the multiple consequences, some functional and others dysfunctional, for the public; the stated results generally may neglect the hidden, the implicit and the latent potential of organizational phenomena. The goal approach may be impractical (Ghorpade, 1970, p. 33), meaningless and misleading (Etzioni, 1960, p. 257).
Social system criteria of organizational effectiveness are essentially based on Parsons' four basic functional requirements, i.e. Adaptation, Goal Attainment, Integration, and Latent Maintenance. Hage (1965), for example, modifies the functional requirements to adapt into organizational analysis by formulating them into Adaptiveness, Production, Efficiency, and Job Satisfaction (p. 292). Bennis (1966, pp. 52-55) proposed Adaptability, Sense of Identity, and Capacity to test reality as criteria of organizational effectiveness. The merits of systemic approach have been seen as enabling a balanced evaluation of the organization. From the alternative frame-of-reference the task of studying effectiveness can be approached by noting the contribution of a particular unit under consideration; and a global assessment of the organization's functioning can be done. The major roadblock of this systemic approach, according to Ghorpade, is the perplexing variability of organizational forms; the feasibility of developing systemic criteria of effectiveness hinges largely upon the availability of a catalogue of needs for the unit under consideration. Theoretical orientation to structural-functionalism, according to Ghorpade, hampered this systemic approach. Functional requirement and system survival are two major concepts which contribute to this roadblock.

Etzioni (1975, pp. 133-136) has discussed the goal models and system models with respect to organizational effectiveness. Etzioni's goal models seem similar to what Ghorpade labels as the rational model; its advantages and disadvantages have been discussed above. Etzioni (1975), pp. 136-138) classifies the system models into survival models and effectiveness models. Survival models require the functional
requirements to be fulfilled in order for the system to exist. In this survival model each relationship specified is a prerequisite for the functioning of the system. The effectiveness model is a pattern of interrelations among the elements of the system which would make it most effective in the service of a given goal.

In the analysis of organization, Etzioni is concerned chiefly with the mobilized effective systems model. By mobilized systems, he means the organizational systems which differ from others in that they give primacy to goal attainment rather than integration, tension management, or some other subsystem. Organization, according to Etzioni, treats all subsystems other than goal attainment as instrumental to goal attainment (1975, p. 136). Mobilized system models call for the observer to judge where the organization, as a system, is headed and how effectively it is progressing toward the realization of its goals.

Georgopoulos and Tannenbaum (1957, pp. 535-536) assume that organizational systems maintain themselves. The most general and most common objectives of organizations are: (a) high output; (b) ability to absorb and assimilate relevant endogeneous and exogeneous changes, or the ability of the organization to keep up with the times without jeopardizing its integrity; and (c) the preservation of organizational resources and of human and material facilities. From these objectives they came out with the following criteria of organizational effectiveness: (1) organizational productivity; (2) organizational flexibility in the form of successful adjustment to internal organizational changes and successful adaptation to externally induced change; and (3) absence of
intraorganizational strain, or tension, and of conflict between organizational subgroups.

According to Etzioni (1975, p. 141) the four universal functional problems can be paired into instrumental and expressive. The system's need to control the environment and the gratification of the system's goals are instrumental, while the maintenance of solidarity among the system units and the reinforcement of the integrity of the value system and its institutionalization are expressive.

This study follows Warren et al. (1973b, 1976) concepts of effectiveness (see Etzioni, 1975, p. 149). Warren et al.'s (1973a, 1976) classification of cooperative effectiveness can be interpreted as typology which was based on "source of determination" and "type of social action" as follows:

<table>
<thead>
<tr>
<th>source of determination</th>
<th>type of social action</th>
</tr>
</thead>
<tbody>
<tr>
<td>sociological</td>
<td>economic</td>
</tr>
<tr>
<td>adaptive</td>
<td>manager's salary</td>
</tr>
<tr>
<td>performance</td>
<td>net operating revenue</td>
</tr>
<tr>
<td></td>
<td>savings</td>
</tr>
</tbody>
</table>

Adaptive Performance is the organizational ability to use a given environment or its changes well, by capturing resources and by manipulating internal and external factors to facilitate goal-attainment activity. The sociological social action is characterized by its processes involved such as decision making, evaluation, and other processes. A manager's salary is organizationally determined, but its nature of social action is economic: the transfer of reward in exchange
for the manager's performance. Net Operating Revenue and Saving are determined not only by the action of the organization's members, but also by "the competitive economic situation and the purchasing decisions of customers" (Warren et al., 1973a, p. 19).

Thus Warren et al.'s typology (1973a, 1976), according to Etzioni (1975, p. 149) has been worked into the context of the farmer cooperatives as utilitarian organization. The application to the other two types of organizations has yet to be observed.

Causal Models of Organizational Effectiveness

As noted in Chapter One, this study emphasizes the analysis of Errors-in-Variables in cooperative organizational effectiveness. Warren et al. (1974b, p. 891) pointed out that the Errors-in-Variables analysis provided the estimate of the structure, as well as the prediction. The least squares equation might be called a prediction equation. If one selected an individual at random and made determinations on the independent variables in exactly the same way as the determinations were made in a certain study, the least squares equation furnishes the estimate of the dependent variable. If one did not make the same determinations, the least squares equation would no longer provide the best estimator of the dependent variable. The Errors-in-Variables estimate, on the other hand, is an estimate of the structure, in that the coefficients estimate the relation between the true values of the concepts being considered.
When we take the errors of measurement into account, Tukey (1954) said: "we pass from 'prediction regression' where the regression line desired is the line of best prediction — the line which describes a good prediction of the measured $y$ given the measured $x$ — to 'structural regression'; ...." According to Tukey (1954), almost any causal theory comes sooner or later to deal with 'structural regression' rather than 'predictive regression.'

Errors of measurement is one crucial problem in social science study which involves structural estimation. Bohrnstedt and Carter (1971, pp. 142-143) observe that the measurement error produces the most serious distortions in the regression estimates. They plead for the sociologists who engage in substantive research to confront the reliability of their measurements and to take into account the measurement error in their analysis.

The Errors-in-Variables equation can also be used as a prediction equation. As the determination made for an individual selected at random, the average prediction error will be larger than the least squares equation. Since, however, the Errors-in-Variables estimator is the estimate of the structure, it may be used to predict for the individuals that have not been randomly selected and may be used as a prediction equation in situations where the concepts were measured with different ways. In the former situation, it will be unbiased only if the selection criterion is independent of errors of measurement. In the later situation, the items should be strictly parallel to those used in the former study (Warren et al., 1974b, p. 891).
The cooperative organizational effectiveness theoretical model has been discussed and presented by Warren et al. (1976). The organizational effectiveness model in normative organization had also been conceptualized and tested by Mulford et al. (1972). Both Warren et al. (1976) and Mulford et al. (1972) utilized Etzioni's compliance variables on organizational effectiveness. Thereby, this study is benefitting from both sources. This study follows completely the theoretical model which had been conceptualized by Warren et al. (1976) in utilitarian organization. By this way, the Errors-in-Variables analysis can be compared directly with the least-squares analysis utilizing the same theoretical model and the set of data.

The relevant proposition to this study was developed by Etzioni in his compliance model discussed by Warren et al. (1976, p. 334) in the following:

"(1) the greater the socialization, the greater will be the organizational effectiveness; (2) the greater the communication, the greater will be the organizational effectiveness; (3) an organization that is highly selective of its members is more likely to be effective than an organization with few, if any, criteria for membership; (4) scope increases the impact of socialization upon effectiveness; (5) pervasiveness is related to organizational effectiveness; (6) tension is related to organizational effectiveness; and (7) salience is related to organizational effectiveness."

Etzioni (1975) did not originally claim causality for his propositions. However, he has been enthusiastic about postulating the causal models by saying "the causal analysis 'worked,' that is, it yielded theoretically significant results" (p. 395). With respect to causal analysis, Etzioni's view can be observed in the following excerpt:
"In principle, causal analysis should preferably be based on longitudinal rather than lateral data, that is, on observations of organizational processes over time rather than on comparison of data from different organizations, collected at the same point in time. The Iowa State group, which is quite aware of the theoretical and methodological problems involved in their approach (see, for instance, the concluding remarks in Mulford, Klonglan, and Warren, 1972, p. 79), themselves make the point that longitudinal data are urgently needed because they 'will permit more appropriate applications of multivariate causal techniques.' But, even without such data, the causal analysis 'worked,' that is, it yielded theoretically significant results" (pp. 394-395).

The causal ordering of the variables is diagrammed in Figures 1 and 2. Figure 1 shows the causal ordering of compliance variables and the organizational effectiveness without the inclusion of organizational size, while Figure 2 presents the ordering with the inclusion of organizational size into the causal model. The solid lines indicate relationships indicated by Etzioni and the dashed lines those relationships being hypothesized (Warren et al., 1976, p. 335). The first causal model of Figure 1 shows that three variables, socialization, communication, and selectivity, logically precede all other variables. These three variables are not viewed as causally interrelated in the model. They are, however, bidirectionally interrelated as represented by the curved, double-headed arrows in the figures.

All compliance variables are causally linked to organizational effectiveness as indicated by the straight lines with the arrows showing the direction of causation. The three exogeneous variables, socialization, communication, and selectivity are also causally linked to scope and pervasiveness, but only selectivity is causally linked to salience and tension. Scope is causally linked to
Figure 1. Theoretical model of variables affecting organizational effectiveness (size not included). Dashed line indicate inferred causal relations involving propositions not specifically discussed by Etzioni (see Warren et al., 1976, p. 335).
Figure 2. Theoretical model of variables affecting organizational effectiveness (size included). Dashed lines indicate inferred causal relations involving propositions not specifically discussed by Etzioni.
pervasiveness, and these two variables, in turn, are causally linked to salience and tension. Salience is causally linked to tension.

Scope may be viewed as the extent of interaction among the members (Warren et al., 1976, p. 336). It seems reasonable to expect the amount of interaction to be a function of the efforts expanded to socialize the members and that socialization temporally precedes scope. Also, by the same reasoning, increased communication among members leads to increased scope. Selectivity also is causally linked to scope because, in utilitarian organizations, participants are likely to be selected because they will "fit in well" with other participants (Warren et al., 1976, p. 336).

In his original statement of the compliance theory (Etzioni, 1961), Etzioni did not specify hypotheses involving either scope or pervasiveness with socialization, communication, and selectivity. Mulford et al. (1972) found that socialization and communication significantly increased scope, while communication significantly increased pervasiveness in normative organization. Warren et al. (1976) found that selectivity significantly increased both scope and pervasiveness, while socialization significantly increased pervasiveness. In his retrospect, Etzioni (1975, p. 410) raised the possibility that scope (and perhaps pervasiveness) of an organization actually determines the amount of socialization and communication. Using his flow model (1975, p. 261), Etzioni makes the statement that scope and pervasiveness seem to approximate established involvement and this involvement follows socialization, communication, and selectivity processes temporally in the flow model. Based on this Mulford et al. (1977, pp. 4-5) conceptualizes
that socialization, communication, and selectivity will have direct effects on scope and pervasiveness. This conception is, of course, consistent with the earlier causal models (Mulford et al., 1972; Warren et al., 1973a, 1976).

Pervasiveness implies the degree to which norms have been internalized. Both socialization and communication were hypothesized to enhance the internalization process. Further, the more highly selective the recruitment, the more likely is the individual to internalize the organization's norms.

Mulford et al. (1972)'s model of organizational effectiveness was developed for local disaster (normative) organizations, and they did not postulate the causal linkage between selectivity and scope, and pervasiveness. While this study concerns organizational effectiveness in utilitarian organization, the present theoretical model postulates the causal relationships between selectivity and both scope and pervasiveness.

Etzioni (1975, pp. 269-271) suggests that scope and pervasiveness are positively related. In this theoretical model, scope causally precedes pervasiveness because as the breadth and frequency of interaction increases, the participants will be more likely to accept an organization's norms (Warren et al., 1976, p. 336).

Salience is the emotional significance associated with participation and is similar to job satisfaction or identification with the organization. Because utilitarian organizations provide members with a source of income, it is hypothesized that high selectivity will produce a higher level of emotional significance: selectivity will
causally be related to salience. Scope and pervasiveness are positively related; scope, according to Etzioni, is directly related to the salience of participation. Thereby, this model postulates that pervasiveness is causally related to salience.

When selectivity into an organization is high, high role tension may result, because in utilitarian organizations, someone else may always be hired (Warren et al., 1976, p. 336). Role tension is the emotional strain arising for participants because of their being a member of the organization. As has been postulated, selectivity has a causal linkage to scope, scope to pervasiveness, and pervasiveness to salience. In consequence, this model hypothesizes that the scope, pervasiveness, and salience have causal linkages to role tension.

The theoretical model discussed so far can be described in the following statistical equations:

(1) $SCO = \beta_{01} + \beta_{11}SOC + \beta_{21}COM + \beta_{31}SEL + u_1$

(2) $PERV = \beta_{02} + \beta_{12}SOC + \beta_{22}COM + \beta_{32}SEL + \beta_{42}SCO + u_2$

(3) $SAL = \beta_{03} + \beta_{13}SEL + \beta_{23}SCO + \beta_{33}PERV + u_3$

(4) $TEN = \beta_{04} + \beta_{14}SEL + \beta_{24}SCO + \beta_{34}PERV + \beta_{44}SAL + u_4$

(5) $EFF_i = \beta_{05i} + \beta_{15i}SOC + \beta_{25i}COM + \beta_{35i}SEL + \beta_{45i}SCO$

$+ \beta_{55i}PERV + \beta_{65i}SAL + \beta_{75i}TEN + u_{5i}$

where: SOC: Socialization,
COM: Communication,
SEL: Selectivity,
SCO: Scope,

PERV: Pervasiveness,

SAL: Salience,

TEN: Tension:

\( \text{EFF}_i \): Effectiveness variables of type \( i \), where \( i = 1, 2, 3, 4 \),

\( u_j \): error terms, and

other terms are coefficients.

Figure 2 shows the diagram of the causal ordering of compliance variables to organizational effectiveness, by including organizational size as an exogeneous variable. As has been discussed in the last section of this chapter, Etzioni does not develop specific propositions about organizational size and compliance variables. It has also been discussed that the role of size in the organizational structure and processes is viewed differently by different researchers.

In this model, for example, suppose that the socialization, communication, and selectivity are termed as exogeneous compliance variables and the scope, pervasiveness, salience, and tension as endogeneous compliance variables, then a large number of possible or potential causal networks can be argued. These numbers increase tremendously if reversible causal linkages are introduced into the model. For example, it is potentially arguable that the organizational size as well as the effectiveness is dependent on the compliance variables. Or, that the organizational size is the effect of both compliance variables and the effectiveness; and it still could be argued that organizational size is the effect of endogeneous compliance variables.
but not the effect of the exogeneous compliance variables; and other potential networks.

This theoretical model assumes that organizational size together with the exogeneous compliance variables is causally linked to the endogeneous compliance variables and the organizational effectiveness. By this assumption, the following statistical equations are formulated:

(1) \[ \text{SCO} = \beta_0 + \beta_{11}\text{SOC} + \beta_{21}\text{COM} + \beta_{31}\text{SEL} + \beta_{41}\text{SIZE} + u_1 \]

(2) \[ \text{PERV} = \beta_0 + \beta_{12}\text{SOC} + \beta_{22}\text{COM} + \beta_{32}\text{SEL} + \beta_{42}\text{SIZE} + \beta_{52}\text{SCO} + u_2 \]

(3) \[ \text{SAL} = \beta_0 + \beta_{13}\text{SEL} + \beta_{23}\text{SIZE} + \beta_{33}\text{SCO} + \beta_{43}\text{PERV} + u_3 \]

(4) \[ \text{TEN} = \beta_0 + \beta_{14}\text{SEL} + \beta_{24}\text{SIZE} + \beta_{34}\text{SCO} + \beta_{44}\text{PERV} + \beta_{54}\text{SAL} + u_4 \]

(5) \[ \text{EFF}_i = \beta_0 + \beta_{15}\text{SOC} + \beta_{25}\text{COM} + \beta_{35}\text{SEL} + \beta_{45}\text{SIZE} + \beta_{55}\text{SCO} + \beta_{65}\text{PERV} + \beta_{75}\text{SAL} + \beta_{85}\text{TEN} + u_5 \]

where the notations and symbols referred to the ones described under the equations of the last model.
CHAPTER THREE,

METHODS AND PROCEDURES

Source of Data

This study utilizes a portion of data of the Managerial Success Study of 1971 conducted by the Department of Sociology and Anthropology at Iowa State University. The Managerial Success Study of 1971\(^1\) was conducted under the direction of Drs. Richard Warren, George Beal, and Joe M. Bohlen.

The population of this study was composed of all farmer cooperatives in Iowa that met the following criteria:

1. A bona fide patron-member cooperative.

   In the State of Iowa, a business association may apply for and be classified as a legal cooperative if 51 percent or more of its business is with member customers.

2. The manager had occupied his present position for at least two years.

   This criterion was used to insure that the general manager (of the cooperative at the time of interviewing) had sufficient time in his position to have affected the economic and organizational functioning of the cooperative.

3. All branch operations were excluded.

   The purpose of this study was to investigate the impact of the top administrative person upon the organization. Branch managers are

\(^1\)Other theses which utilized this same source of data Evers (1973) and Yetley (1974). Summary of data was presented in Warren et al. (1973a). Warren et al. (1976) also utilized the same source of data. This part of Chapter Three is heavily dependent on the above reports and studies.
administratively under the supervision of the general manager.

4. The manager should not have been in a similar pilot study conducted in 1966 prior to the present study, where the field work was done in 1971.

5. The cooperative had at least 25 percent of its gross sales in grain.

These criteria limited the population to 175 local farmer grain cooperative associations. Of these, 159 personal interviews were completed with the general managers. Complete information was obtained from 153 cooperatives.

In addition to the personal interview\(^1\), questionnaires were left with each manager. The nature of the questions contained in these was judged to be a personal type and determined to be better done by the manager alone.

Measurements of Variables

An attempt was made to develop system measures (Warren et al., 1976, p. 338). Thus, data concerning employees, the managers, and directors of the local cooperative are included in the measures developed. The items used in each of the compliance variable composites were determined on the basis of the conceptual framework used in

\(^1\)Mervin Yetley interviewed in both 1966 and 1971 studies. Drs. Beal, Warren, and Bohlen served as supervisors in both data collections.
developing the original field instrument, content validity, and general factor analysis of selected items from collected data.

The complete list of the items of each variable composite is presented in Appendix A. The items of each composite were split randomly into two parts: A and B. SOC3 on the Appendix A list, for example, is referred to as "Socialization composite, split B," and "item number 3." The list clearly shows that Socialization utilizes 3 items in split A and 3 items in split B.

Except for salience and tension, all other compliance variables were standardized. The variance of individual items of salience and tension were approximately equal. The standardization was done for each item in each composite. Further, the average standard score for each split (A and B), and the average of each composite were computed. This procedure can be described as the following:

1. The standardized score of each individual item in each composite was computed by

\[ X_{ijkt} = \frac{(W_{ijkt} - \bar{W}_{ijk})}{S_{ijk}} \]

where

\[ X_{ijkt} = \text{standardized score of individual } t, \text{ for item } k, \]

split j, variable i, and

\[ t: \ 1, 2, \ldots \ldots \ 153, \]

\[ k: \ \text{item } 1, 2, \ldots \ldots m_j \]

\[ \bar{W}_{ijk} \]

\[ S_{ijk} \]

1Reliability for each variable will be discussed in the next section of this chapter.
j: split A, or B,
i: composite Socialization, Communication, Selectivity, Scope, Pervasiveness, Adaptive Performance, and Organizational Size.

\[ W_{ijkt} = \text{raw scores of individual } t, \text{ for item } k, \text{ split } j, \text{ and variable } i, \]

\[ \bar{W}_{ijk} = \frac{\sum_{t=1}^{153} W_{ijkt}}{153} \]

\[ S_{ijk} = \text{Standard deviation of } W_{ijkt}. \]

For example, \( W_{SOCA3t} \) the standardized score of \( t \)-th individual for item 3, split A, of Socialization composite is

\[ W_{SOCA3t} = (3.588)/2.470 \]

where 3.588 is the mean of that item for all individuals and 2.470 is its standard deviation.

2. The average standard scores of each split in each composite for each individual was computed by:

\[ X_{ij.t} = \frac{\sum_{k=1}^{m_j} X_{ijkt}}{m_j} \]

where \( m_j \) is the number of items in the split \( j \) (A or B). For example, \( X_{SOCA.t} \) the average standard score of split A of Socialization composite is \( (X_{SOCA1t} + X_{SOCA2t} + X_{SOCA3t})/3.0 \)

for each individual \( t \), since the number of items in split A \( (m_j) \) is 3.

3. The average standard score of each variable composite was computed by simply averaging the two split scores for each individual \( t \), i.e. \( X_{i..t} = (X_{iA.t} + X_{iB.t})/2.0 \) since there are two splits in each composite. The standard score of Socialization composite is \( (X_{SOCA.t} + X_{SOCB.t})/2.0 = X_{SOC..t}. \)
The splits of Salience, and of Tension are assumed to have equal means and variances\(^1\). Thereby, the standard score of each item is not computed. Rather, the equivalent step 2 and 3 of the above procedures have been done for these two variables.

The items of socialization composite\(^2\) assessed the amount of job orientation and job-related training received by the employees and the orientation of employees regarding cooperative philosophy.

Communication was measured by a 14-item composite. Nine of these items dealt with the manager's perception of influence of communication on employee production, three obtained factual information regarding communication between employees and customers, and two related to the employees' potential for communicating relevant information to customers.

Selectivity was measured by a 13-item composite based on (1) the reported criteria for determining the number and qualifications of employees needed by the organization and (2) items related to the manager's economic knowledge, I.Q., educational level, and four indicators of his self-reported rank as compared with his peers. It was assumed that these variables reflect some of the criteria used by the board in selecting a manager.

Scope was operationalized by an 11-item composite. Seven items related to the involvement of employees in seven decision-making areas for the cooperative. The other items dealt with where the

\(^1\)Salience A and B have sample means 10.17 and 10.21, and variances 3.74 and 3.76, respectively. Tension A and B have sample means 5.22 and 5.70, and variances 2.83 and 2.24, respectively.

\(^2\)The description of this and the following variables follows precisely what Warren et al. (1976, pp. 338-340) presented.
manager sought advice on difficult decisions, influence of the employees on organizational goals, and meetings attended jointly by the manager and one or more board members.

An attempt was made to determine both internal and external pervasiveness of the organization. Five items involved the extensive-ness of codification of work norms. External pervasiveness was measured as the number of product lines handled and the number of community organizations to which the manager belonged.

Salience was measured by a 13-item composite. Eleven items relating to the manager's job satisfaction and two items relating to the salience of the organization to employees were used.

Tension was measured by a composite of six items. This composite involved both the difficulty in achieving, and pressure to achieve, organizational goals. It was assumed that a goal that is difficult to attain, and for which there is a great pressure to achieve, produces role tension. This role tension was seen as affecting all participants because, in a small business such as the local cooperative, all participants are incumbents of boundary positions (Thompson, 1967, Chapter Two, in Warren et al., 1976, p. 339). Thus, the subsystem tension score is the sum of "difficulty" plus "pressure" over the goals.

Adaptive performance was measured by a composite of nine items. Two aspects of adaptive performance included in this composite were (1) the organization efforts to capture resources from the environment and (2) its efforts to manipulate internal and external factors to facilitate goal-attainment activity.
Efforts to capture resources from the environment were measured by inquiring about the use of field representatives and specialized outside help in the operation of the business. Efforts to manipulate various internal factors to facilitate goal attainment were measured by inquiring about (1) decision-making steps or processes used, (2) evaluation procedures used, (3) criteria used to organize the business into departments and functions, (4) criteria for selection of wholesale sources, and (5) procedures used to protect the business against market price changes. The manager's recorded verbal responses to each of these questions were randomly presented to judges for scoring on the basis of performance leading to successful management of retail businesses. For each question, the raw scores of the judges were transformed to normal deviates, and an average score for judges was obtained.

There seems to be a common assumption made in management sciences as well as in formal organization that an effective system is dependent upon an effective manager. Etzioni (1975, p. 148), however, says that individual and organizational effectiveness could be expected to be correlated but certainly not in a one-to-one association. Organizational effectiveness may be higher or lower than an aggregation of all individual efforts. To the Iowa State Compliance Studies, Etzioni observes that individual and organizational, at least sub-organizational, effectiveness are coextensive (Klonglan et al., 1969;
The salaries of decision-makers within business firms are often considered a global measure of managerial performance in terms of their effectiveness as managers (Hulin, 1963; Kavanagh et al., 1971). This study included the manager's salary as a measure of the manager's performance and effectiveness in the analysis because (1) the manager in this size of cooperative is a major decision maker, (2) to some extent the manager's salary reflects the board's evaluation of his performance and effectiveness, (3) the manager's salary reflects performance evaluation in economic terms and to some extent is influenced by environmental conditions similar to economic measures of organizational effectiveness, and (4) because we wish to examine the relationship between compliance variables, organizational effectiveness variables, and manager's salary.

Productivity of a cooperative was measured by averaged net operating revenue for the years 1969 and 1970. Net operating revenue was calculated by taking gross commodity sales minus cost of commodity goods plus service revenue (see Appendix A) for 1969 as split A and 1970 as split B. Since profits are often viewed as the primary goal Appendix A) and 1970 (split B in Appendix A) are included in the analysis. Although cooperatives do not view net savings in the same manner as other business organizations, they do make an effort to return dividends.
(through net savings) to their patron-members; they also have capital needs for purchasing facilities and equipment.

Some researchers measure size by the total number of employees in the organization (Hall et al., 1967; Child, 1973). Pugh et al. (1969) measure size as the number of employees, net assets utilized, and number of employees in the parent organization. In this study, organizational size was measured by the number of employees (split B, standardized) and dollar value of fixed assets (split A, standardized).

Measurement Errors

Measurement errors were computed utilizing the split halves procedure\(^1\) for all variables except Manager Salary. As has been discussed in the last section of this chapter, the individual items of each composite had been randomly assigned to split A and split B of each variable.

Split half procedure assumes that the halves are equivalent measures (Guilford, 1939; Werts, Linn, and Joreskog, 1974). Since both splits are equivalent, the average difference between them are consequently the error of measurements. If we define \(z_{ui..t} = \frac{(X_{iA.t} - X_{iB.t})}{2.0}\) as the average differences between split A and split B, where \(t\) stands for individual 1, 2, . . . . . . 153; \(i\) is variables Socialization, Communication, Selectivity, Scope, Pervasiveness,

\(^1\) About various formulae for split half coefficients see Cronbach (1951), Guilford (1939), and Stanley (1971). Cronbach (1951) also facilitates some criticisms on the split half procedures.
Adaptive Performance, or Organizational Size, the variance of the measurement errors can be estimated from the variance of $z_{ui..t}$.

\[ s^2_{ui..} = \frac{\text{Summation } t \text{ from 1 to 153 of } (z_{ui..t} - \bar{z}_{ui..})^2}{152}, \]

where

\[ s^2_{ui..} = \text{the estimated variance of the error of measurement of variable } i \text{ as defined above}, \]

\[ \bar{z}_{ui..} = \frac{1}{153} \sum_{t=1}^{153} z_{ui..t}/153 \]

The variance of error of measurement of Salience, Tension, Net Operating Revenue, and Savings was computed by the equivalent procedures, except $z_{ui..t}$ was derived from the raw scores rather than from standardized scores of each individual $t$. That is $z_{ui..t} = (W_{iA.t} - W_{iB.t})/2.0$ as the average differences between split A and split B, where $t$ stands for individual $1, 2, \ldots, 153$; $W$ stands for raw scores; $i$ is the variables Salience, Tension, Net Operating Revenue, and Savings. The next procedures in finding $s^2_{ui..}$ are the same as has been done for the standardized scores. Thereby, $s^2_{ui..}$ can now be referred to variance of error of measurement of all variables in the analysis.

To estimate the $s^2_{uSOC..}$, the variance of error of measurement of Socialization for example, $z_{uSOC..t}$ is firstly computed which is

\[ = (X_{SOCA.t} - X_{SOCB.t})/2.0 \text{ for every individual } t = 1, 2, \ldots, 153. \]

Mathematical justification about this estimate is given in Appendix B.
This is the average difference between split A and split B Socialization. The mean average of Socialization splits is the summation of $z_{uSOC..t}$ divided by 153. The estimated $s^2_{uSOC...}$ is

$$\sum_{t=1}^{153} (z_{uSOC..t} - \overline{z}_{uSOC...})^2/152$$

and found to be 0.1000.

The variances of error of measurements for all variables utilized in this study are presented in Table 1. This table also shows the number of items, the sample means, and sample variances in each split and each total measure. The $F$ test of the hypothesis that the variance of the true value of a variable is zero is $F = \frac{s^2_{xSOC}}{s^2_{uSOC}}$, and comparison with the tabular value of $F$ for $(n - 1)$ and $(n - 1)$ degrees of freedom. For Socialization, for instance, $F = \frac{s^2_{xSOC}}{s^2_{uSOC}} = 0.4017/0.1000 = 4.02$. A comparison with the tabular value $F(152, 152; 0.05) = 1.27$ leads to the rejection of the hypothesis. This result suggests that a portion of observed variation is true variation for Socialization and no observed value of Socialization is made up solely of measurement error. Testing for the rest of the variables, the $F$'s are 2.90, 4.55, 3.07, 2.63, 4.70, 2.50, 3.00, 36.73, 5.03, 7.89 for Communication, Selectivity, Scope, Pervasiveness, Salience, Tension, Adaptive Performance, Revenue, Savings, and Organizational Size, respectively. All the results lead to the rejection of the hypothesis; in other words, a portion of observed variation is true variation for each of the variables stated above and no observed variable is made up solely of measurement error.
Table 1. Error variance and reliability of each measure, number of items, means and variance of each split and total measure

<table>
<thead>
<tr>
<th>Measures</th>
<th>No. of items</th>
<th>Means</th>
<th>Sample variance</th>
<th>No. of items</th>
<th>Means</th>
<th>Sample variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOC Socialization</td>
<td>3</td>
<td>0</td>
<td>0.4531</td>
<td>3</td>
<td>0</td>
<td>0.5502</td>
</tr>
<tr>
<td>COM Communication</td>
<td>7</td>
<td>0</td>
<td>0.2584</td>
<td>7</td>
<td>0</td>
<td>0.2233</td>
</tr>
<tr>
<td>SEL Selectivity</td>
<td>6</td>
<td>0</td>
<td>0.2820</td>
<td>7</td>
<td>0</td>
<td>0.2628</td>
</tr>
<tr>
<td>SCO Scope</td>
<td>5</td>
<td>0</td>
<td>0.2890</td>
<td>6</td>
<td>0</td>
<td>0.2218</td>
</tr>
<tr>
<td>PERV Pervasiveness</td>
<td>3</td>
<td>0</td>
<td>0.4631</td>
<td>4</td>
<td>0</td>
<td>0.3683</td>
</tr>
<tr>
<td>SAL Salience</td>
<td>7</td>
<td>10.172</td>
<td>3.7439</td>
<td>6</td>
<td>10.208</td>
<td>3.7560</td>
</tr>
<tr>
<td>TEN Tension</td>
<td>3</td>
<td>5.217</td>
<td>2.8382</td>
<td>3</td>
<td>5.709</td>
<td>2.2397</td>
</tr>
<tr>
<td>ADPF Adaptive</td>
<td>5</td>
<td>0</td>
<td>0.4197</td>
<td>4</td>
<td>0</td>
<td>0.3337</td>
</tr>
<tr>
<td>Performance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REV Net Operating</td>
<td>1</td>
<td>25.643</td>
<td>272.1613</td>
<td>1</td>
<td>29.724</td>
<td>364.1826</td>
</tr>
<tr>
<td>Revenue (10^-4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAV Savings</td>
<td>1</td>
<td>4.111</td>
<td>25.6027</td>
<td>1</td>
<td>5.781</td>
<td>48.3801</td>
</tr>
<tr>
<td>SIZE Size</td>
<td>1</td>
<td>0</td>
<td>1.0000</td>
<td>1</td>
<td>0</td>
<td>1.0000</td>
</tr>
<tr>
<td>SRY Manager Salary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REV* Revenue/Size</td>
<td>1</td>
<td>16.835</td>
<td>14.727</td>
<td>1</td>
<td>19.804</td>
<td>43.705</td>
</tr>
</tbody>
</table>

Reliability = 1 - \( \frac{S_{ui}^2}{S_{xi}^2} \) where \( S_{ui}^2 \) is error variance of measure \( j \), \( S_{xi}^2 \) is sample variance of total measure, \( i \) is measure from SOC to SRY.

\(^a\)The original number of dollars of REV and SAV is divided by 10,000.
Table 1. Continued

<table>
<thead>
<tr>
<th>Measures $X_i$ or $W_i$</th>
<th>No. of items</th>
<th>Means</th>
<th>Sample variance</th>
<th>$s^2_{ui}$</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOC Socialization</td>
<td>6</td>
<td>0</td>
<td>0.4017</td>
<td>0.1000</td>
<td>0.7511</td>
</tr>
<tr>
<td>COM Communication</td>
<td>14</td>
<td>0</td>
<td>0.1790</td>
<td>0.0618</td>
<td>0.6547</td>
</tr>
<tr>
<td>SEL Selectivity</td>
<td>13</td>
<td>0</td>
<td>0.2233</td>
<td>0.0491</td>
<td>0.7802</td>
</tr>
<tr>
<td>SCO Scope</td>
<td>11</td>
<td>0</td>
<td>0.1925</td>
<td>0.0627</td>
<td>0.6744</td>
</tr>
<tr>
<td>PERV Pervasiveness</td>
<td>7</td>
<td>0</td>
<td>0.3011</td>
<td>0.1146</td>
<td>0.6193</td>
</tr>
<tr>
<td>SAL Salience</td>
<td>13</td>
<td>10.190</td>
<td>3.0918</td>
<td>0.6581</td>
<td>0.7872</td>
</tr>
<tr>
<td>TEN Tension</td>
<td>6</td>
<td>5.463</td>
<td>1.8143</td>
<td>0.7247</td>
<td>0.6006</td>
</tr>
<tr>
<td>ADFP Adaptive Performance</td>
<td>9</td>
<td>0</td>
<td>0.2825</td>
<td>0.0942</td>
<td>0.6666</td>
</tr>
<tr>
<td>REV Net Operating Revenue ($10^{-4}$)</td>
<td>2</td>
<td>27.684</td>
<td>309.7385</td>
<td>8.4334</td>
<td>0.9728</td>
</tr>
<tr>
<td>SAV Savings ($10^{-4}$)</td>
<td>2</td>
<td>4.946</td>
<td>30.8584</td>
<td>6.1329</td>
<td>0.8013</td>
</tr>
<tr>
<td>SIZE Size</td>
<td>2</td>
<td>0</td>
<td>0.8875</td>
<td>0.1125</td>
<td>0.8733</td>
</tr>
<tr>
<td>SRY Manager Salary</td>
<td>1</td>
<td>13.808</td>
<td>11.0900</td>
<td>1.109</td>
<td>0.9000</td>
</tr>
<tr>
<td>REV* Revenue/Size</td>
<td>2</td>
<td>18.319</td>
<td>22.907</td>
<td>6.309</td>
<td>0.725</td>
</tr>
</tbody>
</table>
The F values can be read as the ratio of the variance of observed values of a variable to the variance of error of measurement of that variable. It is observed that the larger the F-values, the larger the reliability of the measure. Net operating Revenue with F-value 36.73 shows the reliability of 0.9728; while Tension with F-value 2.50 shows the reliability 0.6006. This is because the reliability is defined as the ratio of the variance of the true scores to the variance of observed scores, or $1 - \frac{s^2_{ui}}{s^2_{Xi}}$. The last term is actually the inverse of the F-value.

Socialization, Selectivity, and Salience have a reliability of about 0.70s, while the rest of the compliance variables have a reliability of about 0.60s. Savings and Organizational Size have a reliability of about 0.80s.
CHAPTER FOUR.

ERRORS-IN-VARIABLES MODEL

A Review

The classical linear regression model with one independent variable is defined by

\[ y_t = \beta_0 + \beta_1 x_t + e_t, \quad t = 1, 2, \ldots, n, \quad (4.1) \]

which consists of two different forms. The first form is the functional models in which it is assumed that \((x_1, x_2, \ldots, x_n)\) is fixed in repeated sampling and \(e_t\) are independent normal with mean zero and variance \(V(e)\), or \((0, V(e))\), random variable. The structural models, in the other form of regression model, assume \((x_1, x_2, \ldots, x_n)\) to be independently drawing from a normal distribution with means \(\mu_x\) and variance \(V(x)\), or \((\mu_x, V(x))\). It is also assumed that the vector \((e_1, e_2, \ldots, e_n)\) is independent of the vector \((x_1, x_2, \ldots, x_n)\).


Sociologists almost always rely on fallible measuring instruments in attempting to estimate parameters. The instruments are likely to be erroneous and inaccurate (Heise and Bohrnstedt, 1970, pp. 104-105). In their discussion on the robustness of regression analysis, Bohrnstedt and Carter (1971, pp. 130-132) note the continuing debate on the use of parametric statistics for sociological data since the 1950's. The
debate is relevant since these statistics assumed the existence of an underlying interval or ratio scale, something which is rarely, if ever, obtained in sociology. The present focus is not on that debate. However, considering the various scales applied in measuring sociological concepts and various data collecting techniques, errors of measurement obviously exist in most variables used by sociologists in data analysis. Psychometricians and econometricians acknowledged the problem with error of measurement earlier than sociologists.

For analysis purposes, \( x_t \) in (4.1) is commonly assumed to be without errors of measurement in order to apply standard statistical procedure; \( X_t \), which was observed and measured, is assumed equivalent to \( x_t \), the true value of the concept. A more tenable assumption would be that we cannot or are unable to observe \( x_t \) directly. Instead of observing \( x_t \), we observe \( X_t \) which is composed of \( x_t \) and the measurement error \( u_t \). Or

\[
X_t = x_t + u_t, \quad t = 1, 2, \ldots n \tag{4.2}
\]

where \( u_t \) is distributed with mean zero and variance \( V(u) \), or \((0, V(u))\), random variable. With this new assumption, it has been shown that the ordinary least squares estimates will not only be biased but will also be inconsistent\(^1\) (Johnston, 1972, p. 281; Malinvaud, 1966, p. 332;

\[1\text{If } \theta \text{ is a vector of parameters to be estimated, then } \hat{\theta} \text{ is an unbiased estimator of } \theta \text{ if and only if Expectation of } \hat{\theta} = \theta. \hat{\theta} \text{ is said to be consistent if its sampling distribution tends to become concentrated on the true value of the parameter } (\theta) \text{ as sample size increases. Mathematically, it is expressed that } \hat{\theta} \text{ is a consistent estimator of } \theta \text{ if plim } \hat{\theta} = \theta, \text{ where plim is the probability limit (Kmenta, 1971, pp. 13 and 165).}\]
Among econometricians, the errors-in-variables problems have been recognized since the later part of the nineteenth century. In 1879, Kummell proposed a method to solve the errors-in-variables problem which has been known as "weighted regression." The method of "instrumental variables" was first introduced as a solution to the structural relationship problem by Reiersol. This method requires finding a set of variables, say \( z \), such that each element of \( z \) is correlated with the corresponding element of \( x \) in (4.1), but is not correlated with element of \( e \) in (4.1) and \( u \) in (4.2).

Fuller (1971) investigated the properties of the errors-in-variables estimators. He considered several structures for the covariance matrix. He modified the usual weighted regression estimators, in such a way that the existence of finite moments is guaranteed. For each of the different covariance structures, he presented the asymptotic distribution of his estimators, assuming that only an estimate of the covariance structure is available. He also demonstrated that his estimators have smaller mean square errors than the weighted regression estimators.

This analysis of organizational effectiveness utilizes Fuller's approach to the errors-in-variables analysis. The approach will first be introduced by the one independent variable equation. Alternative approaches to measurement errors in the bivariate case will be briefly discussed. Fuller's errors-in-variables approach to the general linear model will be presented. And lastly, a recursive structural equation model in relation to errors of measurement will be noted.
A Single Independent Variable
Errors-in-Variables Model

The following discussion will be exemplified by presenting the relationship between Adaptive Performance \( (Y_5) \) and Selectivity \( (X_3) \). Table 2 facilitates the discussion.

Table 2. Correlation matrix, X'X corrected, and Measurement error covariance matrix between Selectivity \( (X_3) \) and Adaptive Performance \( (Y_5) \)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Selectivity</th>
<th>Adaptive performance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Correlation matrix</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selectivity</td>
<td>1.0000</td>
<td>0.5426</td>
</tr>
<tr>
<td>Adaptive performance</td>
<td>0.5426</td>
<td>1.0000</td>
</tr>
<tr>
<td><strong>X'X (corrected)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selectivity</td>
<td>33.9416</td>
<td>20.7176</td>
</tr>
<tr>
<td>Adaptive performance</td>
<td>20.7176</td>
<td>42.9400</td>
</tr>
<tr>
<td><strong>Measurement error covariance</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selectivity</td>
<td>0.0491</td>
<td>0</td>
</tr>
<tr>
<td>Adaptive performance</td>
<td>0</td>
<td>0.0942</td>
</tr>
</tbody>
</table>

Equation (4.3) is the adapted equation (4.1) to the example,

\[
Y_{5t} = \beta_{53}X_{3t} + e_{5t}, \quad t = 1, 2, \ldots, 153 \quad (4.3)
\]

where:
- \( Y_{5t} \): Adaptive Performance,
- \( X_{3t} \): Selectivity,
\( e_{5t} \): disturbances,
\( \beta_{53} \): true population coefficient.

It is assumed that \( x_{3t} \) was independently drawn from a \( (\mu_{x3}, V(x_3)) \) distribution, and \( e_{5t} \) are independent normal with \( (0, V(e)) \). The vector \( (e_1, e_2, \ldots, e_{153}) \) is independent of the vector \( (x_{3,1}, x_{3,2}, \ldots, x_{3,153}) \). If \( x_{3t} \) is also assumed measured without error, or \( x_{3t} \) the true values of Selectivity is equivalent to its observed values, Ordinary Least Squares can be applied to find the estimators. If the estimating equation is

\[
Y_{5t} = b_{53} x_{3t} + v_{5t},
\]

where \( v_{5t} \) is a vector of residuals, the least squares estimator is

\[
b_{53} = \frac{\sum_{t=1}^{153} (x_{3t} - \overline{x}_3)(Y_{5t} - \overline{Y}_5)}{\sum_{t=1}^{153} (x_{3t} - \overline{x}_3)^2}
\]

\[
= \frac{(20.7176)/33.9416}{0.6104}.
\]

However, the more realistic assumption is that the \( x_{3t} \), the observed values of Selectivity, contain measurement error \( u_{3t} \), or

\[
x_{3t} = x_{3t} + u_{3t}
\]

(4.3a)

It is assumed that \( x_{3t} \) distributed as independent \( (\mu_{x3}, V(x_3)) \) random variables, and that the measurement error \( u_{3t} \) are distributed as normal independent \( (0, V(u_3)) \) random variables, and that the vector \( (u_{3,1}, \ldots, u_{3,153}) \),
\( u_3, 2, \ldots, u_{3,153} \) is independent of \( (x_{3,1}, x_{3,2}, \ldots, x_{3,153}) \) and of \( (e_{5,1}, e_{5,2}, \ldots, e_{5,153}) \). That is, it is assumed that

\[
\begin{pmatrix}
 x_{3t} \\
 u_{3t} \\
 e_{5t}
\end{pmatrix} \sim \text{NID} \begin{pmatrix}
 u_x \\
 0 \\
 0
\end{pmatrix}, \begin{pmatrix}
 V(x_3) & 0 & 0 \\
 0 & V(u_3) & 0 \\
 0 & 0 & V(e_5)
\end{pmatrix}
\] (4.4)

Variance \( X_3 \) is no longer variance \( x_3 \), but

\[
V(X_3) = V(x_3 + u_3) = V(x_3) + V(u_3).
\]

And

\[
V(Y_5) = V(\beta_{53} x_3 + e_5) = \beta_{53}^2 V(x_3) + V(e_5)
\]

\[
\text{Cov}(X_3 Y_5) = \text{Cov}(x_3 + u_3)(\beta_{53} x_3 + e_5)
\]

\[
= \beta_{53} V(x_3).
\]

where \( \beta_{53} \) is true slope.

The least squares regression coefficient is an unbiased estimator of the ratio \( \text{Cov}(X_3 Y_5)/V(X_3) \). The regression coefficient computed from the observed variable \( b_{53} \) has expected value \( \text{Cov}(X_3 Y_5)/V(X_3) \), or

\[
E(b_{53}) = \text{Cov}(X_3 Y_5)/V(X_3).
\]

In the presence of error of measurement this expected value will be

\[
= \beta_{53} V(x_3)/(V(x_3) + V(u_3)) = \frac{\beta_{53}}{1 + \frac{V(u_3)}{V(x_3)}}
\]

where \( \beta_{53} \) is true slope.
It is concluded that in the bivariate model with independent measurement error in X the least squares regression coefficient is biased towards zero. This condition can be easily observed in the example.

Fuller (1977, p. 8) shows how to estimate the regression coefficient in bivariate Errors-in-Variables model. In order for the estimator be the maximum likelihood estimator, the estimated covariance matrix must be positive definite\(^1\). By our example, we show that\(^2\) the determinant

\[
\begin{vmatrix}
V_y & V_{yx} \\
V_{xy} & V_{xx} - V(u_3)
\end{vmatrix}
\]

is

\[
\begin{vmatrix}
0.2825 & 0.1363 \\
0.1363 & 0.2233 - 0.0491
\end{vmatrix} = 0.0306
\]

which is positive definite.

The estimate of the regression coefficient of Errors-in-Variables model is

\[
b_{yx}^* = \frac{V_{xy}}{V_{xx} - V(u_3)}
\]

\[
= \frac{0.1363}{0.2233 - 0.0491}
\]

\[
= 0.7824
\]

\(^1\) Matrix A is said to be positive definite if the determinant of A is strictly positive, or \( |A| > 0 \).

\(^2\) \( m_{XX} = (X'X \text{ corrected})/152 \).
It is recalled that $b_{53}$, the least squares regression coefficient, is 0.6104 which is smaller than the Errors-in-Variables regression coefficient (0.7824).

Variance of the Ordinary Least Squares estimator, $b_{53}$, is

$$v(b_{53}) = s^2_{v5} / \sum (X_{3t} - \bar{X}_3)^2,$$

where

$$s^2_{v5} = \sum_{t=1}^{153} (Y_5 - b_{53}X_{3t})^2 / 151$$

$$v(b_{53}) = 0.20066/33.9416 = 0.0059117,$$

or

Standard error ($b_{53}$) = 0.07689.

Because the bias in $b_{53}$ is multiplicative, the test of the hypothesis that $\beta_{53} = 0$ remains valid in the presence of measurement error (Fuller, 1977, p. 4). That is, if $\beta_{53} = 0$ the population correlation between $X_{3t}$ and $Y_{5t}$ is zero for all values of $V(u_3)$. Therefore, the hypothesis that $\beta_{53} = 0$ is equivalent to the hypothesis that $Y_{5t}$ and $X_{3t}$ are independent. It follows that the usual regression "t-test" of the hypothesis that $\beta_{53} = 0$ has Student's t distribution when $\beta_{53} = 0$, whether or not $X_{3t}$ is measured with error (Fuller, 1977, p. 8). To perform the test that $\beta_{53} = 0$,

$$t = (b_{53} - \beta_{53}) / \text{s.e.}(b_{53}), \text{ for } \beta_{53} = 0$$

$$t = 0.6104/0.07689 = 7.95$$

The sampling behavior of the Errors-in-Variables estimator, $b^*_5$, is not easily obtained. The procedure involves mathematical statistics
and methods of statistical differentials\textsuperscript{1}. The variance of the estimator is presented in Fuller (1977, p. 17). Adapting to our bivariate problem,

\[
V(b_{53} - \beta_{53}) = \frac{s_{v5*}^2}{152 s_{x3}^2} + \frac{s_{u3}^2 s_{v5*}}{152 s_{x3}^4} + \frac{b_{53}^2 s_{u3}^4}{2d(152)s_{x3}^4}
\]

where \(d\) is the degree of freedom, and \(s_{v5*}^2 = \sum_{t=1}^{153} (Y_{5t} - b_{53}^* X_{3t})^2 / 151\).

It was calculated that \(s_{v5*}^2 = 0.2071629\).

\[
V(b_{53}^* - \beta_{53}) = \frac{0.2071629}{152(0.2233 - 0.0491)}
+ \frac{0.0491 x 0.2071629 + 0.7824^2 x (0.0491)^2}{152 x (0.2233 - 0.0491)^2}
+ \frac{0.7824^2 x (0.0491)^2}{2 x 151 x 152 x (0.2233 - 0.0491)^2}
\]

\[
= 0.0078237 + 0.0025251 + 0.000001
\]

\[
= 0.0103498
\]

Standard error of \(b_{53}^* = 0.1017339\). Performing t-test for the hypothesis that \(\beta_{53} = 0\),

\[
t = 0.7824/0.1017339 = 7.69
\]

Note that the variance of the limiting distribution of the Errors-in-Variables estimator, \(b_{53}^*\), is considerably larger than the variance of the Least Squares regression coefficients (0.0103 vs 0.0059).

\textsuperscript{1}It is assumed that this study does not have to present the procedures of obtaining the sampling behavior of the estimator. The result will be discussed. For interested persons, see Fuller (1971, 1977). For statistical differentials methods, see Fuller (1976, Chapter 5).
The condition can be attributed to three sources. First, the Errors-in-Variables estimates use an estimate of the variation in the true independent variables, $s^2_{x^2}$, smaller than the variation in the observed variable, $s^2_x$. $s^2_x$ is the denominator in the first term of (4.7) which contributes to the larger result of the term. Second, $V(x_3)$ must be estimated, and the presence of errors, $u_3$, in the estimate leads to the second term of (4.7). Finally the estimation of $V(u_3)$ by $s^2_{u_3}$ leads to the final term in the variance expression which is a function of the degrees of freedom (Fuller, 1977, p. 16; Warren et al., 1974a, p. 391).

Fuller's Errors-in-Variables analysis permits the possibility of an error in the equation and denotes this error by $q$. In this example, Adaptive Performance ($y_5$) is permitted to be a function of $x$-variables not measured and (or) not included in the analysis. Model (4.3) may be better expressed as

\[
y_{5t} = b_{53}x_{3t} + q_{5t}, \quad t = 1, 2, \ldots, 153 \tag{4.8}
\]

\[
y_{5t} = y_{5t} + u_{y5t},
\]

\[
x_{3t} = x_{3t} + u_{x3t},
\]

where $q_{5t}$ is the error in the equation and is assumed to be a vector of normal independent errors with variance $V(q_{5t})$, distributed independently of $x_{3t}$. The measurement error $u_{y5t}$ and $u_{x3t}$ are assumed to be independently distributed as bivariate normal with mean zero and covariance matrix $\Sigma$, where
It is also assumed that $u_{y5t}$ and $u_{x3t}$ are independent of $x_{3t}$ and of $q_{5t}$.

To examine if there seem to be other $x$-variables that influence Adaptive Performance, the fraction of variation in the true values of Adaptive Performance associated with the variation in the true values of $x$-characteristics can be estimated. Because replication permits estimating $V(u_{y5})$, the estimate of $V(q_5)$ can also be estimated. For the example model

$$V(v_5) = V(q_5) + V(u_{y5}) + b_{53}^2 V(u_{x3}).$$

An estimate of $V(q_5)$ is

$$s_{q5}^2 = s_{v5}^2 - s_{u5}^2 - b_{53}^2 s_{u3}^2$$

$$= 0.2071629 - 0.0942 - (0.7824)^2 (0.0491)$$

$$= 0.0829069.$$

Thus, we have the following estimated decomposition of the variance of Adaptive Performance. Of the total variance, $s_{y5}^2$, of 0.2825, 0.0942 ($s_{u5}^2$) is associated with measurement error. This means that the variance associated with true variation of Adaptive Performance is 0.2825 - 0.0942 = 0.1883, named as $s_{y5}^2$. Of this 0.1883, 0.08291 is associated with the variation of the errors in the equation. The true variation of Adaptive Performance, which is explained by the variation of the true values of Selectivity, is 0.1883 - 0.08291 = 0.10539.
\[ R^2 \text{ is the ratio of the explained variation to the variation of the true values of Adaptive Performance, or } \frac{s_{y_5}^2 - s_{q_5}^2}{s_{y_5}^2}. \text{ Or,} \]

\[ R_{\text{eiv}}^2 = \frac{0.10539}{0.1883} = 0.5597. \]

In other words, of 0.1883, 0.10539 (56\%) is explained by Selectivity, and 0.08291 (44\%) is unexplained.

Assuming \( x_{3t} \) were measured without errors, the squared correlation between \( x_{35} \) and \( Y_{5t} \) is

\[ R^2_{x_{3}Y_{5}} = \frac{(\text{Cov}(x_{3},Y_{5}))^2}{V(x_{3})V(Y_{5})} = \frac{s_{53}^2}{s_{x_{3}Y_{5}}^2}. \]

Its estimate is

\[ R_{\text{ols}}^2 = b_{53}^2 \frac{s_{x_{3}}^2}{s_{y_{5}}^2} = 0.61003^2 \times \frac{0.2233}{0.2825} = 0.2944. \]

The least squares \( R^2 \) of 0.2944 is the fraction of the variation in observed Adaptive Performance explained by the observed Selectivity. This may be compared with 0.5597, which is the estimated fraction of variation in true Adaptive Performance, \( y_5 \), explained by the true values of Selectivity \( (x_3) \).
Alternative Bivariate Approaches to Measurement Errors

In the presence of measurement errors, the relationship between variables are attenuated. Thereby the relationship should be corrected for attenuation (Guilford, 1939, p. 366). Since the emergence of path analysis (Wright, 1934), sociological path analysts have tried to work with measurement errors (Duncan, 1966; Blalock, 1971; Costner, 1969). Both approaches will be discussed briefly utilizing the bivariate example.

Correction for attenuation

The correlation between two fallible measures will generally be less than the correlation between the two true values of the variables providing that the errors of measurements are uncorrelated. The traditional procedure for correcting for this attenuation is to divide the correlation between the two variables by the square root of the product of their reliabilities (Guilford, 1939, p. 367).

Bringing the example into causal language, the relationship may be described as follows
Figure 3. Correction for attenuation for the relationship between $X_3$ and $Y_5$ postulated in causal form.

In bivariate relationship, the correlation coefficient is equivalent to the standardized regression coefficient. Thereby the bidirectional relationship which is commonly applied by correction for attenuation method is changed to causal form in Figure 3. Here, $x_3$ is postulated as determining $y_5$. Path analysts will read the diagram as the following

$$r_{X_3Y_5} = r_{x_3x_3}^{1/2} p_{53CA} r_{y_5y_5}^{1/2}$$

or,

$$p_{53CA} = r_{x_3y_5} / r_{x_3x_3}^{1/2} r_{y_5y_5}^{1/2}$$

In other words, the standardized regression coefficient of $x_3$ to $y_5$ is the ratio of the correlation between the observed values of the two variables to the square root of the product of their reliabilities. This is the correction for attenuation procedure.

Applying this formula to the example where $X_3$ is the observed value of Selectivity and $Y_5$ is the observed value of Adaptive Performance,
the reliabilities of Selectivity \( r_{x_3 x_3} \) and Adaptive Performance \( r_{y_5 y_5} \) as shown in Table 1 are 0.7802 and 0.6666, respectively. The path coefficients between the true values of Selectivity and Adaptive Performance can be estimated as the following:

\[
P_{53CA} = \frac{r_{x_3 y_5}}{\left( r_{x_3 x_3} r_{y_5 y_5} \right)^{1/2}}
\]

\[
= \frac{0.5426}{(0.7802^{1/2} \times 0.6666^{1/2})}
\]

\[
= 0.75239
\]

The correction for attenuation regression coefficient of \( x_3 \) to \( y_5 \) can be estimated as follows

\[
b_{53CA} = \frac{p_{53CA} s_{y_5}}{s_{x_3}}
\]

\[
= p_{53CA} \left( s_{y_5}^2 - s_{uv_5}^2 \right)^{1/2} / \left( s_{x_3}^2 - s_{uX_3}^2 \right)^{1/2}
\]

\[
= 0.75329 \times (0.2825 - 0.0942)^{1/2} / (0.2233 - 0.0491)^{1/2}
\]

\[
= 0.7822.
\]

\[
b_{50CA} = \bar{Y} - b_{53CA} \bar{X} = 0.0 - 0.7822(0) = 0.0
\]

It can be noted that the correction for attenuation estimate of the regression coefficients between the true values of Selectivity and Adaptive Performance, \( b_{53CA} = 0.7822 \), is equivalent to the Errors-in-Variables estimate, \( b_{53eiv} = 0.7824 \). The difference of 0.0002 is caused by a rounding error. This can be seen by the following derivation.

The correction for attenuation estimate is
\[ b_{53CA} = r_{X_3Y_5} (r_{X_3X_3} r_{Y_5Y_5})^{-1/2} (s_{Y_5}^2 - s_{uy5}^2)^{1/2} (s_{X_3}^2 - s_{ux3}^2)^{-1/2} \]

Since \[ r_{X_3Y_5} = \frac{s_{X_3} s_{Y_5}}{s_{X_3} s_{Y_5}}, \]
and \[ r_{X_3X_3} = \frac{(s_{X_3}^2 - s_{ux3}^2)}{s_{X_3}^2}, \]
\[ r_{Y_5Y_5} = \frac{(s_{Y_5}^2 - s_{uy5}^2)}{s_{Y_5}^2}, \]
then
\[ b_{53CA} = \frac{s_{X_3} s_{Y_5}}{s_{X_3} s_{Y_5}} \times \frac{(s_{Y_5}^2 - s_{uy5}^2)^{1/2} (s_{X_3}^2 - s_{ux3}^2)^{-1/2} \times s_{X_3} s_{Y_5}}{1} \]
\[ = \frac{s_{X_3} s_{Y_5}}{(s_{X_3}^2 - s_{ux3}^2)} \]
which is equivalent to the Errors-in-Variables estimate of regression coefficient as described in (4.6).

As stated above, however, the correction for attenuation approach is traditionally applied to the correction for the bidirectional correlation relationships. Although Werts and Linn (1972) applied the Joreskog's congeneric test model (1968) to the correction for attenuation problem, the emphasis was still on the bidirectional relationships.

Path analysis approach
Path analysis approach to measurement error is mostly based on Blalock (1964, pp. 143-171) and Costner (1969). This approach manipulates the correlations among items or observed values of the true variables to obtain estimates of the parameters. These estimates are path coefficients which relate the true variable as a cause of the observed values, and as a cause of other unobserved variables.

Utilizing the variable example, with two observed variables for each concept the model may be represented as follows:
\[ y_{5t} = \beta_{53} x_{3t} + q_{5t}, \quad t = 1, 2, \ldots, 153 \]  

\[ x_{3At} = p_{1A} x_{3t} + p_{u3A} u_{3At}, \]

\[ x_{3Bt} = p_{2B} x_{3t} + p_{73B} u_{3Bt}, \]

\[ x_{5At} = p_{3A} x_{5t} + p_{u5A} u_{5At}, \]

\[ x_{5Bt} = p_{4A} x_{5t} + p_{u5B} u_{5Bt}. \]

It is assumed that \( q_{5t} \) is uncorrelated with \( x_{3t} \), the errors of measurement are uncorrelated to each other, and to their unobserved variables.

The estimation procedure is described in Appendix C. Two sets of path coefficients between the observed values and the unobserved variables result. The set of path coefficients which related the unobserved variables \( x_3 \) and \( y_5 \) were found. The first set consists of 6 path coefficients which are equivalent to each other (except for rounding errors, ranging from 0.72418 to 0.72430) is 0.7242. The other set is composed of two coefficients with values 0.80499 and 0.80493. Utilizing one set of the estimators, the result may be diagrammed as follows:
The regression coefficient of $x_3$ to $y_5$ can be estimated as

$$b_{53\text{path}} = p_{y_5 x_3} \left( \frac{s^2_{y_5} - s^2_{u_5}}{s^2_{x_3} - s^2_{u_3}} \right)^{1/2}$$

$$= 0.7243(0.2825 - 0.0942) \left(0.2233 - 0.0491\right)^{1/2}$$

$$= 0.7530$$

which is smaller than the Errors-in-Variables estimate, $b_{53}^*$. However, if $p_{y_5 x_3}$ were selected as 0.8049, $b_{53\text{path}}$ would be 0.8360 which is larger than the Errors-in-Variables estimate.

As has been observed, the path analyst approach leads to more than one estimate for one parameter. This is because this approach works with an overidentified model. This model has more observable quantities of the correlation among items than the number of unknown parameters to be estimated. Costner (1969) said that by dealing with the overidentified model, the consistency of the model could be checked.
Costner (1969) suggests three desiderata to be gained from this approach, i.e. (1) that it is possible to arrive at an estimate for each of the specified unknown coefficients; (2) that it is possible to test for some types of differential bias, if present; and (3) that it is possible to test the implications of the causal model outlined in the main theory. Jacobson and Lalu (1974), however, observe some problems raised in this approach. First, this approach requires for its analysis an explicit statement of "cause" and "effect" relationship between the measured and the unmeasured variables. Second, as the number of indicators and unmeasured variables increases, the number of estimates for each parameter increases, and it is extremely difficult, if not impossible, to consider all logical combinations of relationships. Third, criteria are needed for selecting a single estimate among the number of possible estimates for an overidentified model.

Fuller's Errors-in-Variables Approach for the General Linear Model

The ordinary least squares general regression situation will precede the discussion of the Errors-in-Variables model. An example to demonstrate the estimate of the model parameters will also be presented.

If we assume that the observed value of the dependent variable, Y, is a linear function of K independent variables, plus error, the model may be written as
\[
Y_t = \sum_{i=1}^{K} \beta_i X_{it} + e_t, \quad t = 1, 2, \ldots, n
\]  
(4.9)

or in matrix notation

\[
Y = XB + e
\]  
(4.10)

where \(Y\) is an \(n \times 1\) vector, \(X\) is an \(n \times K\) matrix, \(B\) is \(K \times 1\), and \(e\) is \(n \times 1\). It is assumed that \(e\) has mean 0 and variance \(\sigma_e^2\), so that the elements of \(e\) are uncorrelated. It is also assumed that \(e\) is uncorrelated with \(X\).

The well-known ordinary least squares solution is

\[
b = (X'X)^{-1}X'Y
\]

with variance \(b\) as

\[
V(b) = (X'X)^{-1}V(e), \text{ and estimated by}
\]

\[
V(b) = (X'X)^{-1} \sigma_e^2
\]

An example is given to present Scope as \(Y_1\), and Socialization \((X_1)\), Communication \((X_2)\), and Selectivity \((X_3)\) as \(X\). The solution to this example is that \(b = (b_{10}, b_{11}, b_{12}, b_{13}) = (-0.00003, 0.03236, 0.09778, 0.19476)\). Variance of \(b_{11}, b_{12}, b_{13}\) are 0.0040, 0.0087, and 0.0061.

The estimated model can be written as

\[
Y_{1t} = -0.00003 + 0.03236X_1 + 0.09778X_2 + 0.19476X_3 + e_t
\]

\[
(0.068) \quad (0.093) \quad (0.078)
\]

\[
(0.513) \quad (1.050) \quad (2.503)
\]  
(4.11)
where the first row of numbers under the coefficients are the standard error, and the second row are the t-values of the respective coefficient. Based on this least squares solution, only $X_3$, Selectivity has significant effect on $Y_1$, Scope. The $R^2$ is 0.0759.

The more realistic assumption is that the variables were measured with errors. So that the $t$th value of the dependent variable, $y$, is a linear function of $K$ true value of independent variables, plus an error. Thus

$$y_t = \sum_{i=1}^{K} \beta_i x_{it} + q_t, \quad t = 1, 2, \ldots, n$$  \hspace{1cm} (4.12)

or in matrix notation

$$y = XB + q$$  \hspace{1cm} (4.13)

And we also have

$$Y = y + U_y$$

$$X = x + U_x$$  \hspace{1cm} (4.14)

where $Y$ and $y$ are $n \times 1$ vectors of observed and true value dependent variables, respectively; $X$ and $x$ are $n \times K$ matrix of each observed and true values of independent variables, respectively; and $q$ is $n \times 1$ errors in the equation. It is assumed that $q$ is a normal independent error with variance $V(q)$, distributed independently of $x$. $B$ are unknown parameters that are to be estimated.
The errors of measurement $u_i$ (where $i$ stands for each variable) are assumed to be independently and identically distributed as a multivariate normal with mean zero and covariance matrix $V$, i.e.

$$u_i \sim \text{NID}(0, V)$$

where

$$V = \begin{pmatrix} V(y) & C(u_i u_j) \\ C(u_i u_j) & V(x) \end{pmatrix} = \begin{pmatrix} V(y) & 0 \\ 0 & V(x) \end{pmatrix}$$

and $V(x)$ is assumed to be diagonal. It is also assumed that $u_i$ are independent of $x$ and $q$. Likewise it is assumed that $V(u_i)$ which is estimated by $s^2_{u_i}$, and $V(u_j)$ which is estimated by $s^2_{u_j}$, are available. These estimators are also assumed to be independent of $x$, $q$, and $u_i$.

Taking the example that the dependent variable is Scope ($Y_1$), and the independent variables, $x$, are Socialization ($x_1$), Communication ($x_2$), and Selectivity ($x_3$) the model may behave as the following:

$$Y_{1t} = \beta_{10} + \beta_{11}x_{1t} + \beta_{12}x_{2t} + \beta_{13}x_{3t} + q_{1t},$$

$$t = 1, 2, \ldots, 153$$

(4.15)

and,

$$Y_{1t} = y_{1t} + u_{yt}$$

$$X_{1t} = x_{1t} + u_{x1t}$$

$$X_{2t} = x_{2t} + u_{x2t}$$
\[ X_{3t} = x_{3t} + u_{3t}. \]

It is assumed that \( q_1 \) are distributed independently of \( x_1, x_2, \) and \( x_3. \) The variance of \( u_i \) can be described as

\[
V = \begin{pmatrix}
V(u_{y1}) & 0 \\
0 & V(u_x)
\end{pmatrix}
\]

which was estimated by

\[
S_{uu} = \begin{pmatrix}
s_{uyl}^2 & 0 & 0 & 0 \\
0 & s_{ux1}^2 & 0 & 0 \\
0 & 0 & s_{ux2}^2 & 0 \\
0 & 0 & 0 & s_{ux3}^2
\end{pmatrix}
\]

\[
= \begin{pmatrix}
0.0627 & 0 & 0 & 0 \\
0 & 0.1000 & 0 & 0 \\
0 & 0 & 0.0618 & 0 \\
0 & 0 & 0 & 0.0491
\end{pmatrix}
\]

as shown in Table 1.

Fuller (1971) suggested the estimator of the Errors-in-Variables regression coefficients as follows:

\[
b_{eiv} = (\hat{H} + \frac{a}{n} S_{uu})^{-1} \hat{H}_{XY}
\]

where

\[
\hat{H} = \hat{H}_{XX} - S_{uu}
\]

if \( \hat{\gamma} \geq ((n + 1)/n), \)

\[
= \hat{H}_{XX} - (\hat{\gamma} - n^{-1}) S_{uu}
\]

if \( \hat{\gamma} < ((n + 1)/n), \)
\[ \hat{M}_{XX} = (1/n)X'X. \]

\[ \hat{M}_{XY} = (1/n)X'Y, \text{ and} \]

\[ \hat{Y} \text{ is the smallest root of } |M_{XX} - YS_{uu}| = 0. \]

The constant \( \alpha, \alpha > 0, \) is introduced to reduce the bias and mean square error of the estimator. The choice of \( \alpha \) is somewhat arbitrary; Fuller (1971) suggests \( (K + 1) < \alpha < K + 4 + (2n/d) \), where \( d \) is the average of the finite valued \( d_i \)'s.

Returning to the example, \( \hat{M}_{XX} \) was found as follows

\[
\hat{M}_{XX} = \begin{pmatrix}
    0.4017 & 0.1237 & 0.0931 \\
    0.1237 & 0.1790 & 0.0537 \\
    0.0931 & 0.0537 & 0.2233
\end{pmatrix}
\]

The first step is to test whether the \( M_{XX} \) is not a nonsingular matrix by computing the \( \hat{Y} \), the eigenvalue. \( \hat{Y} \) is the smallest root of

\[
|M_{XX} - S_{uu} \hat{Y}| = 0 = \begin{vmatrix}
    0.4017 - 0.1000 \hat{Y} & 0.1237 & 0.0931 \\
    0.1237 & 0.1790 - 0.0618 \hat{Y} & 0.0537 \\
    0.0931 & 0.0537 & 0.2233 - 0.0491 \hat{Y}
\end{vmatrix}
\]

\( \hat{Y} \), the smallest root of the eigenvalues, was found to be 1.7749.

\[(n/(n - K + 1) \hat{Y} = 152 \times 149^{-1} \times 1.7749 = 1.81 \text{ is approximately distributed as Snedecor's } F \text{ (Fuller, 1971, pp. 17-20) with } n - K \text{ and } d \text{ degrees of freedom. Since the } F \text{-value is greater than the table } F \text{-value at the 5 percent level of significance, the value of } \hat{Y} \text{ supports}\]
the original assumption that the true values of $M_{xx}$ is nonsingular.
Or, it seems that the true values of the three independent variables
are measuring three different concepts.

The SUPER CARP program (by Hidiroglou, Fuller, and Hickman, 1977)
provides the estimate of the Errors-in-Variables estimators. Moreover,
the SUPER CARP provides the standard errors, the t-values, the test of
singularity (if requested), and the estimated covariance matrix of the
regression coefficients.

The SUPER CARP, however, may provide a different estimate from
(4.16) above depending on the arbitrary choice of $\alpha$. If the choice of
$\alpha$ is equivalent and $\gamma \geq (n + 1)/n$, SUPER CARP would give the same
estimate as (4.16). The SUPER CARP estimate is based on the following
formula:

$$b_{eiv} = (X'X - (n - K - 1)S_{uu})^{-1}(X'Y - (n - K - 1)S_{ue}). \quad (4.17)$$

In the example, $S_{ue}$ is assumed to be zero. For $\gamma \geq (n + 1)/n$ and
$\alpha = (K + 1)$, and expressing $X'X$ and $X'Y$ as $nM_{xx}$ and $nM_{xy}$, respectively,
(4.16) is equal to (4.17).

SUPER CARP provides the following estimated covariance matrix for
$b_{eiv}$ (Hidiroglou et al., 1977, p. 28)

$$\text{Var}(b_{eiv}) = (X'X - (n - K - 1)S_{uu})^{-1}\hat{G}_{eiv}(X'X - (n - K - 1)S_{uu})^{-1}$$

(4.18)

where the $(rs)\text{th}$ element of $\hat{G}_{eiv}$ is

$$g_{eiv}(r, s) = \frac{n}{(n - K)} \sum_{t=1}^{n} (\hat{d}_{tr} - \bar{d}_r)(\hat{d}_{ts} - \bar{d}_s)$$
\[ \hat{d}_{tr} = \begin{cases} \hat{v}_t & X_{tr} = 1 \\ (X_{tr} - \bar{X}_r)\hat{v}_t & \text{otherwise}, \end{cases} \]

\[ \hat{v}_t = (Y_t - \bar{Y}_r) - \sum_{r=1}^{K} b_r (X_{tr} - \bar{X}_r), \]

\[ \bar{d}_r = \frac{1}{n} \sum_{t=1}^{n} \hat{d}_{tr} \]

\[ \bar{d}_s = \frac{1}{n} \sum_{t=1}^{n} \hat{d}_{ts} \]

The Errors-in-Variables estimate behaves as follows:

\[
Y_1 = -0.00002 + 0.00421x_1 + 0.15395x_2 + 0.24602x_3 \\
\begin{array}{c}
(-0.035) \\
(0.128)
\end{array} \\
\begin{array}{c}
(0.220) \\
(0.113)
\end{array} \\
\begin{array}{c}
(4.19) \\
(0.698)
\end{array} \\
\begin{array}{c}
(2.179)
\end{array}
\]

where the first row numbers under the coefficients are the standard errors of the coefficients, and the second row numbers are the t-values of the corresponding coefficients.

For the ease of comparison, the Least Squares solution to the equation is rewritten below

\[
Y_1 = -0.00003 + 0.03236x_1 + 0.09778x_2 + 0.19476x_3 \\
\begin{array}{c}
(0.068) \\
(0.093)
\end{array} \\
\begin{array}{c}
(0.078)
\end{array} \\
\begin{array}{c}
(2.503)
\end{array}
\]

The coefficients of Selectivity are significant at the 5 percent level for both Errors-in-Variables and Least Squares solutions. The Errors-in-Variables coefficients are larger than the Least Squares
coefficients for Communication and Selectivity, but not for Socialization. The condition was also found by Warren et al. (1974a, p. 891) in their analysis of Role Performance. As Bohrnstedt and Carter (1971) noted, errors of measurement in a multivariate case may lead least squares to either overestimate or underestimate the coefficients. As was found for the bivariate case, the Errors-in-Variables standard errors were consistently shown larger than the least squares estimated standard errors.

To examine if there might be other x-variables that influence Scope, the fraction of variation in the true value of Scope associated with the variation in the true values of x-characteristics can be estimated. Replication permits estimating \( V(y_1) \), thereby \( V(q_1) \) can also be estimated. For the example model

\[
V(v_1) = V(q_1) + V(u_1) + \sum_{i=0}^{3} b_i^2 V(u_{xi})
\]

an estimate for \( V(q_1) \) is

\[
s_{q1}^2 = s_{v1}^2 - s_{u1}^2 - \sum_{i=0}^{3} b_{i}^2 s_{u_{xi}}^2
= 0.182604 - 0.0627 - (0.00421)^2(0.1000) \\
- (0.1539)^2(0.0618) - (0.24602)^2(0.0491)
= 0.1154661
\]

We have the following estimated decomposition of the variance of Scope. Of the total variance, \( s_{y1}^2 \), 0.1925, 0.0627 \( (s_{u_{y1}}^2) \) is associated with measurement error (see Table 1). This means that the variance associated with true variation of Scope is \( 0.1925 - 0.0627 = 0.1298 \),
labelled as $s^2_{y1}$ with lower case $y$. Of this 0.1298, 0.11546 is associated with the variation of errors in the equation. Thereby, the true variation of Scope which is explained by the true variations of Socialization, Communication, and Selectivity is $0.1298 - 0.11546 = 0.014334$. $R^2$ is the ratio of the explained variation to the true variation of Scope, or $(s^2_{q1} - s^2_{e_{y1}})/s^2_{y1}$. Or,

$$R^2_{e_{y1}} = 0.014334/0.1298 = 0.1104.$$  

About 11 percent of true variation of Scope was explained by the true variation of Socialization, Communication, and Selectivity. This can be compared to the 7-1/2 percent variation in Scope explained by those variables by the least square estimate.

It can be questioned whether the true value of Scope is perfectly explained by the true value of the three independent variables.

Statistically, we ask if 0.11 could be estimating 1.00. This is equivalent to the hypothesis that $V(q_1)$ in (4.15) equals zero.

To test the hypothesis that $V(q_1)$ is zero, the smallest root of $|M_{ZZ} - \lambda S_{uu}| = 0$ is utilized, where

$$M_{ZZ} = (1/n)Z'Z$$

and $Z' = (Y_1, X_1, X_2, X_3)$

$$S_{uu} = \text{diag}(s^2_{y1}, s^2_{x1}, s^2_{x2}, s^2_{x3})$$

The computation results $\hat{\lambda} = 1.6698$. Or, $F = (n/n - K)\hat{\lambda} = 1.70$.

Comparing this value with tabular value of $F$ with 148 and 152 degrees of freedom, the hypothesis that $V(q_1) = 0$ is rejected and it is
concluded that characteristics other than those included in the model influence the true value of Scope.

The estimate shows that both Socialization and Communication do not have significant coefficients. To test if both coefficients are zero, an F-test completely analogous to the test statistics used in multiple regression is constructed. This is

$$F_{n-K} = (1/2) \begin{pmatrix} 0.0042 & 0.1539 \\ -0.0223 & 0.0486 \\ \hline 0.1539 & \end{pmatrix}^{-1} \begin{pmatrix} 0.0164 \\ -0.0223 \\ \hline 0.0042 & \end{pmatrix} = 0.6942$$

where the $2 \times 2$ matrix is that portion of $V(b_{eiv})$ associated with the two coefficients being tested. Since the computed statistic is less than the 5 percent tabular value of Snedecor's $F$ with 2 and 149 degrees of freedom, the hypothesis that the true coefficients of both variables are zero at 5 percent level is accepted.

With the acceptance of the hypothesis, Selectivity is left as the only significant variable. A new Errors-in-Variables analysis was done where only Selectivity was entered as the independent variable. The result is

$$y_1 = -0.00002 + 0.29652x_3$$

\begin{align*}
(0.034) & \quad (0.094) \\
(-0.000) & \quad (3.145)
\end{align*}

It was calculated that $s^2_{y_1}$ for the above estimate equation is 0.1827. Following the equivalent computation, $s^2_{q_1}$ is found to be 0.115683. Further, the $k_{eiv1}^2$ was recomputed as 0.1088 which is not much
reduced compared to the equation when Socialization and Communication were included.

A Note on Structural Equations

Structural equations and simultaneous equations are termed interchangeable by sociological methodologists. Blalock, who learned much from econometricians, used the term simultaneous equations (1964, 1969, 1971). The term simultaneous equations is used by Johnston (1972) and Malinvaud (1966). Duncan (1975), a sociologist, Goldberger in collaboration with Duncan (1973), Wiley (1973), and Joreskög (1973) use the term structural equations.

Geraci (1976, p. 263) pointed out that much of the empirical work in the social sciences consisted of structural estimation. Goldberger (1973, pp. 3 and 5) says that in a structural equation model each equation represents a causal link rather than a mere empirical association. In a regression model, on the other hand, each equation represents the conditional mean of a dependent variable as a function of explanatory variables. The regression parameters are a mixture of the structural parameters. In structural parameters, if one parameter changes, all regression coefficients in the structure may change.

This note on structural equations begins with an example of a study of organizational effectiveness adapted from Warren et al. (1976, p. 343). Three equations were adapted and presented as the following:
\[ Y_1 = 0.053X_1 + 0.083X_2 + 0.215X_3 + 0.961v_1 \]
\[ Y_2 = 0.199Y_1 + 0.225X_1 + 0.067X_2 + 0.203X_3 + 0.880v_2 \quad (4.20) \]
\[ Y_3 = 0.046Y_1 + 0.026Y_2 + 0.169X_3 + 0.980v_3 \]

In the following discussion, the variables are observed values assumed to be measured without errors. The variables are

\[ Y_1 = \text{Scope}, \]
\[ Y_2 = \text{Pervasiveness}, \]
\[ Y_3 = \text{Salience}, \]
\[ X_1 = \text{Socialization}, \]
\[ X_2 = \text{Communication}, \]
\[ X_3 = \text{Selectivity}, \]
\[ v_i = \text{vector of residuals of equation } i \ (i = 1, 2, 3). \]

The recursivity of these structural equations derives from the nature of causal processes that are assumed to govern the process of organizational compliance. That is, \( X_1, X_2, X_3 \) determine \( Y_1 \), then these three variables together with \( Y_1 \) determine \( Y_2 \), and finally, \( X_3, Y_1 \), and \( Y_2 \) determine \( Y_3 \).

The variables which are independently determined outside of the model are called exogeneous variables (Land, 1973, p. 22). In the example above, Socialization, Communication, and Selectivity were assumed determined outside of the model; thus they are exogeneous. Scope, Pervasiveness, and Salience were considered to be determined by phenomenon expressed by the model; they are endogeneous. In the example, the endogeneous were labelled as \( Y \) variables and the
exogeneous were labelled as X variables. Predetermined variables refer to all independent variables in each equation (Duncan, 1975, pp. 26-28). In the above example, all exogeneous and endogeneous $Y_1$ are predetermined variables in the second equation.

One aspect of structural equations is that they can be transformed into a reduced form. In the reduced form each endogeneous variable is stated as a function of exogeneous variables and the error terms (Duncan, 1975, pp. 57-58). The above structural equations (4.20) can be transformed in the following procedures:

\[
Y_1 = 0.053X_1 + 0.083X_2 + 0.215X_3 + 0.961v_1
\] (4.21)

\[
Y_2 = 0.199(0.053X_1 + 0.083X_2 + 0.215X_3 + 0.961v_1) + 0.225X_1 + 0.067X_2 + 0.203X_3 + 0.880v_2
\]
\[
= 0.033X_1 + 0.0835X_2 + 0.2458X_3 + 0.880v_2 + 0.191v_1
\]

\[
Y_3 = 0.046(0.953X_1 + 0.083X_2 + 0.215X_3 + 0.961v_1)
\]
\[
+ 0.026(0.199(0.053X_1 + 0.083X_2 + 0.215X_3 + 0.961v_1))
\]
\[
+ 0.026(0.225X_1 + 0.067X_2 + 0.203X_3 + 0.880v_2)
\]
\[
+ 0.169X_3 + 0.980v_3
\]
\[
= 0.009X_1 + 0.006X_2 + 0.1853X_3 + 0.980v_3 + 0.023v_2 + 0.045v_1
\]

Each of $Y_1$, $Y_2$, $Y_3$, is now expressed in terms of the exogeneous $X_1$, $X_2$, and $X_3$, and the combination of error terms. Malinvaud (1966, p. 111) said that fitting based on reduced form was also justified from the point
of view of predictions which can be made from the model. In the cited example, Scope, Pervasiveness, or Salience can be directly predicted from the change of Socialization, Communication, and Selectivity in the sense of structural form rather than from a separate regression equation. The prediction is more meaningful if the exogeneous are manipulatable variables.

The structural equations in (4.20) can be concisely presented in the following

\[ Y = \hat{A}Y + \hat{b}X + \hat{c}V \]  

(4.22)

where

\[
\hat{A} = \begin{pmatrix}
0 & 0 & 0 \\
0.199 & 0 & 0 \\
0.046 & 0.026 & 0 \\
0.053 & 0.083 & 0.215
\end{pmatrix},
\]

\[
\hat{b} = \begin{pmatrix}
0.225 & 0.067 & 0.203 \\
0 & 0 & 0.169
\end{pmatrix},
\]

\[
\hat{c} = \text{diag}(0.961, 0.880, 0.912),
\]

\[
Y' = (Y_1, Y_2, Y_3)
\]

\[
X' = (X_1, X_2, X_3)
\]

\[
V' = (v_1, v_2, v_3)
\]

The estimate of the reduced form (4.21) can also be calculated by the following (Wiley, 1973, p. 79)

\[ Y = (I - \hat{A})^{-1}\hat{b}X + (I - \hat{A})^{-1}\hat{c}V \]  

(4.23)
In terms of population, estimated structural equation (4.22)
originates from

\[ Y = AY + BX + V \]  \hfill (4.24)

that is

\[
\begin{align*}
Y_{1t} &= \beta_{11}X_{1t} + \beta_{12}X_{25} + \beta_{13}X_{3t} + v_{1t} \\
Y_{2t} &= \alpha_{21}Y_{1t} + \beta_{21}X_{1t} + \beta_{22}X_{2t} + \beta_{23}X_{3t} + v_{2t} \\
Y_{3t} &= \alpha_{31}Y_{1t} + \alpha_{32}X_{25} + \beta_{33}X_{3t} + v_{3t}
\end{align*}
\]

\[ t = 1, 2, \ldots, 153 \]  \hfill (4.24a)

It is observed that the matrix A in (4.24a) is a triangular matrix,
which is also shown by its estimate \( \hat{A} \) in (4.22). That situation is
one characteristic of the recursive structural equation models. Another
characteristic of the recursive structural equation is that V should
be diagonal, i.e.

\[
V = \begin{pmatrix}
V(v_1) & 0 & 0 \\
0 & V(v_2) & 0 \\
0 & 0 & V(v_3)
\end{pmatrix}
\]

In other words, \( v_i (i = 1, 2, 3) \) in (4.24a) are uncorrelated to each
other (Johnston, 1972, pp. 368-369).

By the recursive characteristics, Johnston (1972, pp. 377-378)
proved that the equations in the recursive structure can be estimated
by a straightforward application of ordinary least squares. Malinvaud
(1966, p. 514) says "Recursive models have a certain advantage for
the econometrician, since they can be estimated by simple methods, each equation being treated independently of the others." Warren et al. (1976) used the separate least squares estimation on each equation in the above example precisely as Johnston and Malinvaud suggested above.

So far, structural equations have been discussed by assuming that the endogeneous and the exogeneous variables were measured without errors. If the variables are measured with errors, however, the ordinary least squares solution is no longer valid. The Errors-in-Variables model becomes

\[ y = Ay + Bx + Q \]  \hspace{1cm} (4.25)

and

\[ Y = y + u_y \]
\[ X = x + u_x \]

where

- \( y \) is the \( g \times 1 \) vector of true value endogeneous variables included in the equation; the capital case refers to its observed values,
- \( x \) is the \( g \times k \) matrix of true value exogeneous variables included in the equation (including a column of ones if an intercept is required); \( X \) is its observed value,
- \( A \) is \( g \times g \) matrix of coefficients associated with \( y \),
- \( B \) is \( g \times k \) matrix of coefficients associated with \( x \),
- \( Q \) is a \( g \times g \) diagonal matrix of errors in the equation,
- \( u_i \) is the error of measurement of variable \( i \).
In the above example (4.24), \( g = 3, k = 3 \). Applying the example of (4.24) into the Errors-in-Variables model, the structural equations are:

\[
y_{lt} = \beta_{11}y_{1t} + \beta_{12}y_{2t} + \beta_{13}y_{3t} + q_{1t} \quad (4.26)
\]

\[
y_{2t} = \alpha_{21}y_{1t} + \beta_{21}y_{1t} + \beta_{22}y_{2t} + \beta_{23}y_{3t} + q_{2t}
\]

\[
y_{3t} = \alpha_{31}y_{1t} + \alpha_{32}y_{2t} + \beta_{33}y_{3t} + q_{3t}
\]

and

\[
y_{gt} = y_{gt} + u_{ygt} \quad (g = 1 = \text{Scope}, 2 = \text{Pervasiveness}, \quad 3 = \text{Salience}) \quad (4.26a)
\]

\[
x_{kt} = x_{kt} + u_{xkt} \quad (k = 1 = \text{Socialization}, 2 = \text{Communication}, \quad 3 = \text{Selectivity})
\]

\[t = 1, 2, \ldots, 153\]

Substituting (4.26a) into (4.26), the structural equations will behave as

\[
y_{lt} = \beta_{11}y_{1t} + \beta_{12}y_{2t} + \beta_{13}y_{3t} + v_{1t}^*
\]

\[
y_{2t} = \alpha_{21}y_{1t} + \beta_{21}y_{1t} + \beta_{22}y_{2t} + \beta_{23}y_{3t} + v_{2t}^*
\]

\[
y_{3t} = \alpha_{31}y_{1t} + \alpha_{32}y_{2t} + \beta_{33}y_{3t} + v_{3t}^*
\]

where

\[
v_{1t}^* = q_{1t} + u_{y1t} - \beta_{11}u_{1t} - \beta_{12}u_{2t} - \beta_{13}u_{3t}
\]

\[
v_{2t}^* = q_{2t} + u_{y2t} - \alpha_{21}u_{1t} - \beta_{21}u_{1t} - \beta_{22}u_{2t} - \beta_{23}u_{3t}
\]
It is observed that $A$ is still a $3 \times 3$ triangular matrix with 0 in the diagonal and the upper half. The situation fulfills the first characteristic of the recursive structural model. However, $V$ is no longer the diagonal matrix. In other words, $v_{g}^{*}$ are now correlated to each other. For example,

$$v_{3t}^{*} = q_{3t} + u_{y3t} - \alpha_{31} y_{1t} - \alpha_{32} y_{2t} - \beta_{33} x_{3t}.$$  

Wiley (1973) investigated the identification problem for structural equation models with measurement errors. He suggested general procedures to identify the parameters which, however, did not specify the details and did not show the application in actual data. Joreskog (1970) outlined the general method for the analysis of covariance structure which was concerned with the errors-in-variables but not the errors in the equation. The presentation of Joreskog's analysis seems too abstract and general to be digested by most sociological methodologists at this stage of development. Duncan (1975, Chapters 9 and 10) discussed the measurement errors and multiple indicators in structural equation models in a simple way which is more likely to be digestible by most sociologists.

This study's theoretical framework as outlined in Chapter Two suggested a concern with an Errors-in-Variables structural equations model. It has been discussed that the nature of the problem of the recursive structural equations model lies in the estimation of the
single regression equation which forms the structure (Malinvaud, 1966; Johnston, 1972). By introducing the error of measurement into the variables involved in the equation, it has been shown that Fuller's Errors-in-Variables methods have solved the estimation of the single equation. Thereby, our structural equations with measurement errors will be solved by solving every single equation involved in the structural model by utilizing Fuller's Errors-in-Variables methods.

The recursive nature of the structural equation in (4.26) is characterized by the triangular matrix A and the diagonal matrix Q because here it is assumed that $q_i^1 (i = 1, 2, 3)$ are independent to each other. These recursive characteristics support the procedure in solving the structural equation as outlined above.
CHAPTER FIVE.
FINDINGS AND DISCUSSION

Two Errors-in-Variables models of organizational effectiveness will be presented. The findings of the analysis of both Errors-in-Variables (EIV) and Ordinary Least Squares (OLS) procedures will be compared. Modified Errors-in-Variables models of organizational effectiveness will be developed. These modified models will be related to Etzioni's (1975) compliance theory, and to former (Warren et al., 1976) models of organizational effectiveness.

Findings

The theoretical framework discussed in Chapter Two suggested two theoretical models of organizational effectiveness. The first model did not postulate organizational size as the exogeneous variable, while the second model did. The structural equations of both models are given below.

Model 1

\[ y_{1t} = \beta_{110} + \beta_{111} x_{1t} + \beta_{112} x_{2t} + \beta_{113} x_{3t} + q_{11t} \]
\[ y_{2t} = \alpha_{121} y_{1t} + \beta_{120} + \beta_{121} x_{1t} + \beta_{122} x_{2t} + \beta_{123} x_{3t} + q_{12t} \]
\[ y_{3t} = \alpha_{131} y_{1t} + \alpha_{132} y_{2t} + \beta_{130} + \beta_{131} x_{1t} + \beta_{132} x_{2t} + \beta_{133} x_{3t} + q_{13t} \]
\[ y_{4t} = \alpha_{141} y_{1t} + \alpha_{142} y_{2t} + \alpha_{143} y_{3t} + \beta_{140} + \beta_{141} x_{1t} + \beta_{142} x_{2t} + \beta_{143} x_{3t} + q_{14t} \]
\[
y_{it} = \alpha_{i1}y_{1t} + \alpha_{i2}y_{2t} + \alpha_{i3}y_{3t} + \alpha_{i4}y_{4t} + \beta_{i0} + \beta_{i1}x_{1t} \\
+ \beta_{i2}x_{2t} + \beta_{i3}x_{3t} + q_{lit}; \quad i = 5, 6, 7, 8 \\
t = 1, 2, \ldots, 153
\]

**Model 2**

\[
y_{1t} = \beta_{21}y_{1t} + \beta_{21}x_{1t} + \beta_{22}x_{2t} + \beta_{23}x_{3t} + \beta_{24}x_{4t} + q_{21t}
\]

\[
y_{2t} = \alpha_{21}y_{1t} + \beta_{20} + \beta_{21}x_{1t} + \beta_{22}x_{2t} + \beta_{23}x_{3t} + \beta_{24}x_{4t} + \beta_{22}t
\]

\[
y_{3t} = \alpha_{23}y_{1t} + \alpha_{23}y_{2t} + \beta_{23}x_{1t} + \beta_{23}x_{2t} + \beta_{23}x_{3t} \\
+ \beta_{23}x_{4t} + q_{23t}
\]

\[
y_{4t} = \alpha_{24}y_{1t} + \alpha_{24}y_{2t} + \alpha_{24}y_{3t} + \beta_{24}x_{1t} + \beta_{24}x_{2t} \\
+ \beta_{24}x_{3t} + \beta_{24}x_{4t} + q_{24t}
\]

\[
y_{it} = \alpha_{2i}y_{1t} + \alpha_{2i}y_{2t} + \alpha_{2i}y_{3t} + \alpha_{2i}y_{4t} + \beta_{2i0} + \beta_{2i1}x_{1t} + \\
\beta_{2i2}x_{2t} + \beta_{2i3}x_{3t} + \beta_{2i4}x_{4t} + q_{2it}
\]

\[
i = 5, 6, 7, 8 \\
t = 1, 2, \ldots, 153
\]

where:

- \(x_1\): Socialization,
- \(x_2\): Communication,
- \(x_3\): Selectivity,
- \(x_4\): Organizational Size,
- \(y_1\): Scope,
- \(y_2\): Pervasiveness,
$y_3$: Salience,
$y_4$: Tension,
$y_5$: Adaptive Performance,
$y_6$: Manager's Salary,
$y_7$: Net Operating Revenue,
$y_8$: Savings,
$eta_{mn0}$: true slope of model $m$ ($m = 1, 2$), equation $n$ ($n = 1, 2, 3, 4, i; i = 5, 6, 7, 8$), and variable $o$ where $o$ represents $x_1$ to $y_4$ as described above,
$q_{mn}$: the errors in the equation $n$ of model $m$ ($m = 1, 2; n = 1, 2, 3, 4, i; i = 5, 6, 7, 8$),
and the lower case $x$ and $y$ refer to the true value of the variables, respectively.

In each equation $n$, the error in the equations, $q_{mnt}$, is assumed to be a vector of normal independent errors with variance $V(q_{mn})$, distributed independently of the predetermined variables. The true values $x_{it}$ and $y_{it}$ are not directly observed. However, the observed values are $X_{it}$, which is the sum of $x_{it}$ and the measurement error $u_{xit}$, and $Y_{it}$, which is the sum of $y_{it}$ and the measurement error $u_{yit}$, or

$$X_{it} = x_{it} + u_{xit}; \quad i = 1, 2, 3, 4$$

$$t = 1, 2, \ldots, 153$$

$$Y_{it} = y_{it} + u_{yit}; \quad i = 1, 2, \ldots, 8$$

$$t = 1, 2, \ldots, 153 \quad (5.2)$$
The measurement errors \( u_{yit} \) and \( u_{xit} \) are assumed to be independently and identically distributed as a multivariate normal with mean zero and covariance matrix \( V \), where

\[
V = \begin{pmatrix}
V(u_y) & 0 \\
0 & V(u_x)
\end{pmatrix}
\]

and \( V(u_y) \) and \( V(u_x) \) are assumed to be diagonal. It is also assumed that the measurement errors are independent of the true predetermined variables and of the errors in the equations.

The estimator of \( V(u) \) (for both \( u_y \) and \( u_x \)), denoted by \( s_u^2 \), are available. The estimator, \( s_{ui}^2 \), is a multiple of chi-square random variables with \( d_i \) degrees of freedom independent of \( s_{uj}^2 \), for \( i \neq j \). These estimators are also assumed to be independent of errors of measurement, errors in equation, and true predetermined variables.

The Ordinary Least Squares regression was estimated by utilizing the Statistical Package of the Social Sciences (SPSS) program. Other computations were done by applying the OMNITAB programming system. As has been noted, the Errors-in-Variables regressions were estimated by utilizing SUPER CARP program.

The EIV and OLS estimates compared

The estimated equations are presented below by placing the Ordinary Least Squares (OLS) and the Errors-in-Variables (EIV) estimates alternately. The number under either "OLS" or "EIV" is the \( R^2 \) with respect to the estimated equation. The number under the coefficients are the standard errors of the coefficients. The significant coefficient
is marked by (*), (**), or (***) to note that the coefficient is significant at ten, five, or one percent, respectively. More complete information about the estimates are given in Appendix D, Tables 1A, B through 8A, B. The estimated equations for model 1 are:

\[
\text{EIV } y_1 = 0.042x_1 + 0.1539x_2 + 0.2460x_3 + \bar{e}_{11}
\]

\[
\begin{array}{ccc}
0.1104 & 0.1283 & 0.2304 \\
0.2034 & 0.3012 & 0.1129 \\
\end{array}
\]

\[
\text{OLS } y_1 = 0.0324x_1 + 0.0978x_2 + 0.1948x_3 + \bar{e}_{11}
\]

\[
\begin{array}{ccc}
0.0758 & 0.0630 & 0.0931 \\
0.2304 & 0.1343 & 0.2053 \\
0.0780 & 0.1163 & 0.0900 \\
\end{array}
\]

\[
\text{EIV } y_2 = 0.3820y_1 + 0.2820x_1 + 0.0385x_2 + 0.2481x_3 + \bar{e}_{12}
\]

\[
\begin{array}{ccc}
0.4306 & 0.1630 & 0.1343 \\
0.2053 & 0.2053 & 0.1163 \\
\end{array}
\]

\[
\text{OLS } y_2 = 0.2698y_1 + 0.1962x_1 + 0.0951x_2 + 0.2348x_3 + \bar{e}_{12}
\]

\[
\begin{array}{ccc}
0.2384 & 0.0933 & 0.0718 \\
0.1064 & 0.1064 & 0.0900 \\
\end{array}
\]

\[
\text{EIV } y_3 = 0.1829y_1 + 0.1275y_2 + 10.1899 + 0.7755x_3 + \bar{e}_{13}
\]

\[
\begin{array}{ccc}
0.0370 & 0.6756 & 0.6653 \\
0.5266 & 0.5266 & 0.5266 \\
\end{array}
\]

\[
\text{OLS } y_3 = 0.1668y_1 + 0.1335y_2 + 10.1889 + 0.6113x_3 + \bar{e}_{13}
\]

\[
\begin{array}{ccc}
0.0397 & 0.3432 & 0.2833 \\
0.3225 & 0.3225 & 0.3225 \\
\end{array}
\]

\[
\text{EIV } y_4 = 0.3826y_1 + 0.1955y_2 - 0.0205y_3 + 0.7077
\]

\[
\begin{array}{ccc}
0.1009 & 0.3756 & 0.3461 \\
0.0766 & 0.0766 & 0.0766 \\
\end{array}
\]

\[
+ 0.3210x_3 + \bar{e}_{14}
\]

\[
\text{OLS } y_4 = 0.2758y_1 + 0.1496y_2 - 0.1673x_3 + 0.1767
\]

\[
\begin{array}{ccc}
0.0648 & 0.2605 & 0.2150 \\
0.0621 & 0.0621 & 0.0621 \\
\end{array}
\]

\[
+ 0.2581x_3 + \bar{e}_{14}
\]
For the model 2, the estimated equations are:
EIV $y_1 = -0.0151x_1 + 0.1602x_2 + 0.1325x_3 + 0.1958x_4 + \hat{\epsilon}_{21}$

OLS $y_1 = 0.0170x_1 + 0.0936x_2 + 0.1177x_3 + 0.1753x_4 + \hat{\epsilon}_{21}$

EIV $y_2 = 0.1393y_1 + 0.2424x_1 + 0.0834x_2 + 0.1929x_3$

OLS $y_2 = 0.1212y_1 + 0.1846x_1 + 0.1051x_2 + 0.1823x_3$

EIV $y_3 = -0.1006y_1 - 0.1704y_2 + 10.1899 + 0.8011x_3$

OLS $y_3 = -0.0066y_1 - 0.0109y_2 + 10.1899 + 0.5792x_3$

EIV $y_4 = 0.4896y_1 + 0.3089y_2 - 0.2111y_3 + 7.6138$

OLS $y_4 = 0.3147y_1 + 0.1820y_2 - 0.1638y_3 + 7.1216$

EIV $y_5 = 0.0666y_1 + 0.3379y_2 - 0.0501y_3 - 0.0038y_4 + 0.5314$

OLS $y_5 = 0.1122 + 0.1958 + 0.1353 + 0.0629$
OLS \[ Y_5 = 0.0743Y_1 + 0.1946Y_2 - 0.0316Y_3 + 0.0106Y_4 + 0.2637 \] 
\[ + 0.1886X_1 + 0.2085X_2 + 0.4210X_3 - 0.0319X_4 + \hat{e}_{25} \quad (5.15b) \]

EIV \[ Y_6 = -0.1987Y_1 - 0.0694Y_2 + 0.5444Y_3 + 0.2539Y_4 + 6.8766 \] 
\[ + 0.7268X_1 + 0.1554X_2 + 0.8751X_3 + 2.1572X_4 + \hat{e}_{26} \quad (5.16a) \]

OLS \[ Y_6 = 0.2330Y_1 + 0.2878Y_2 + 0.4273Y_3 + 0.1166Y_4 + 8.8174 \] 
\[ + 0.4851X_1 + 0.2960X_2 + 0.8260X_3 + 1.8063X_4 + \hat{e}_{26} \quad (5.16b) \]

EIV \[ Y_7 = -3.4882Y_1 - 6.9256Y_2 + 0.9714Y_3 - 0.1788Y_4 \] 
\[ + 18.7619 + 0.8564X_1 - 0.0951X_2 + 1.2670X_3 \] 
\[ + 22.0475X_4 + \hat{e}_{27} \quad (5.17a) \]

OLS \[ Y_7 = -0.0787Y_1 - 1.1518Y_2 + 0.9611Y_3 + 0.3041Y_4 \] 
\[ + 19.5512 - 0.2475X_1 - 0.7181X_2 + 1.7619X_3 \] 
\[ + 17.4893X_4 + \hat{e}_{27} \quad (5.17b) \]

EIV \[ Y_8 = -0.7971Y_1 - 5.0654Y_2 + 1.2035Y_3 + 0.0861Y_4 \] 
\[ + 7.7890 + 2.6787X_1 - 2.5884X_2 - 0.3918X_3 \] 
\[ + 4.7450X_4 + \hat{e}_{28} \quad (5.18a) \]
Equation (5.17a) of the Errors-in-Variables analysis has $R^2$ greater than unity. This equation has generated the specification problem, mostly because of the almost perfect relationship between $Y_7$, Net Operating Revenue, and $X_4$, Organizational Size. In other words, $Y_7$ and $X_4$ may have measured the same concept. An effort has been done to combine both measures to control Size of the Net Operating Revenue (see Warren et al., 1976, p. 340). The new measure is the ratio of

$$
\frac{\text{(Net Operating Revenue)}}{\text{Size}} = Y_9. \quad 3
$$

\(^1_{r_{Y_7X_4}}\) (the observed values) = 0.94.

\(^2\)Since the Size measure had been standardized, to avoid a zero denominator (or infinity values of the new measure, $Y_9$), the average ratio of both Size splits to their standard deviation, respectively, has been added to the Size measure. Therefore, the new Size measure is

$$
\text{Size}^* = \left(\frac{E - \bar{E}}{s_E} + \frac{A - \bar{A}}{s_A}\right)/2.0 + \left(\frac{E}{s_E} + \frac{A}{s_A}\right)/2.0
$$

where $X = (E, A)$ is the number of employees and the average total assets, $\bar{X}$ is its mean, and $s_X$ is its standard deviation.

\(^3\)The error variance of this new measure has also been estimated by utilizing the ratio of the Revenue splits to Size*. The reliability of $Y_9$ is 0.7266 which is much lower than the reliability of Revenue (0.97) and Size (0.87). The total sample variance of $Y_9$ is 22.9069, and the total error-variance of the measure is 6.3088.
The Errors-in-Variables and Ordinary Least Squares estimates of equations utilizing the ratio measure, $Y_9$, are as follows:

**EIV**
\[ Y_9 = 0.7729y_1 - 2.0750y_2 + 1.1467y_3 - 0.3152y_4 + 8.3570 - 0.5061x_1 - 0.3493x_2 + 1.0461x_3 + 0.4572 \ 
\text{and} \ 
0.3760 + 1.4186 + 1.8963 + 1.0460 \]
\[ (5.17aa) \]

**OLS**
\[ Y_9 = 0.2870y_1 - 0.9925y_2 + 0.9110y_3 - 0.2632y_4 + 10.4740 - 0.6239x_1 - 0.2373x_2 + 0.6783x_3 + 0.6881 + 0.0019 + 0.8721 \]
\[ (5.17bb) \]

The Errors-in-Variables estimates are consistently larger than the Least-Squares estimates if the Errors-in-Variables estimates are at least significant at the 10 percent level. This is presented in Appendix E, where none of the significant Errors-in-Variables estimates is smaller than the Least-Squares estimate. Therefore, in this case, the Bohrnstedt and Carter's (1971) statement that "errors of measurement in the multivariate case may lead least squares to either overestimate or underestimate the coefficients" can be stated more specifically.

It is shown in Appendix E that among 38 significant EIV coefficients, none of them is smaller than the OLS estimate and among 61 nonsignificant EIV estimates 40 of them are larger than the OLS estimates. The condition is associated with the ratio of the standard errors of the coefficient to the coefficient itself. If the nonsignificant EIV coefficients were distributed into the absolute t-values, the following figures can be observed.
Table 3. The distribution of the nonsignificant coefficients based on the absolute value EIV t-values and the greater or smaller EIV coefficient than the OLS coefficient

<table>
<thead>
<tr>
<th>Absolute EIV — t-values</th>
<th>$b_{eiv} &gt; b_{ols}$</th>
<th>$b_{eiv} &lt; b_{ols}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 0.50</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>0.50-1.00</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>Greater than = 1.00</td>
<td>14</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 3 shows the tendency that if the absolute t-value approaches zero or if the nonsignificant coefficient is relatively very small compared to its standard error, the EIV estimate is smaller than the OLS estimate. But, if the coefficient is greater than its standard error, the EIV estimate tends to be larger than the OLS estimate. It is suggested that when the EIV and OLS estimates are compared, the significance of the EIV coefficients and the ratio of the coefficient to its standard error should be taken into account.

The change of sign of the coefficients from the EIV estimate to the OLS estimate (from + to -, or the other way) were encountered at the coefficients $y_1$ of (5.7a), of $y_2$ of (5.10a), of $x_1$ of (5.11a), of $y_1$ and $y_2$ of (5.16a), of $x_1$ of (5.17a), and of $y_4$ of (5.18a). These conditions were consistently shown by the relatively larger standard error of the coefficients to the coefficients themselves. The absolute EIV t-values of those coefficients are 0.00, 0.21, 0.12, 0.06, 0.06, 0.47, and 0.18, respectively.
All the estimated standard errors for the Errors-in-Variables estimates are larger than the Least Squares estimated standard errors. This is shown between equations a and b from (5.3) to (5.18). The justification of this phenomena has been given in Chapter Four.

Table 4 presents the variables whose coefficient is at least significant at the 10 percent level and $R^2$ of both the OLS and the EIV solutions. Selectivity has a significant coefficient to Scope ($Y_1$), but this significance disappears when Size is included in the equation and Size becomes a significant variable in both the Least Squares and the Errors-in-Variables solutions.

Scope, Socialization, and Communication have significant effect on Pervasiveness ($Y_2$) in both solutions. Organizational Size replaces Scope in both solution when Size is included in the equation.

The coefficient of Selectivity is significant to explain Salience ($Y_3$) in Least Squares solution, but none of the variables appears significant in Errors-in-Variables solution. The condition stays the same when Size is included in the equation.

All the significant relationships discussed above are positive. Salience, however, has a negative highly significant relationship to Tension ($Y_4$) in both the OLS and the EIV solutions, and even when Size is included in the equation. None of the other predetermined variables appear significant.

Socialization, Communication, Selectivity, Pervasiveness and Salience have a significant effect on Adaptive Performance ($Y_5$) in the Least Squares solution in Model 1 and in Model 2. Only Salience has a negative relationship. By Errors-in-Variables solution,
Table 4. Comparison between Ordinary Least Squares and Errors-in-Variables estimates with respect to variables whose coefficients are significant in at least 10 percent level and $R^2$

<table>
<thead>
<tr>
<th>Equation 5</th>
<th>Y</th>
<th>Significant coefficients(^a)</th>
<th>OLS</th>
<th>EIV</th>
<th>OLS</th>
<th>EIV</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>$Y_1$</td>
<td>$X_3$</td>
<td></td>
<td></td>
<td>0.07</td>
<td>0.11</td>
</tr>
<tr>
<td>4</td>
<td>$Y_2$</td>
<td>$Y_1$, $X_1$, $X_3$</td>
<td></td>
<td>$y_1$, $x_1$, $x_3$</td>
<td>0.24</td>
<td>0.43</td>
</tr>
<tr>
<td>5</td>
<td>$Y_3$</td>
<td>$X_3$</td>
<td></td>
<td></td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>6</td>
<td>$Y_4$</td>
<td>$Y_3$</td>
<td></td>
<td></td>
<td>0.06</td>
<td>0.10</td>
</tr>
<tr>
<td>7</td>
<td>$Y_5$</td>
<td>$Y_2$, $X_3$, $X_1$, $X_2$, $X_3$</td>
<td></td>
<td>$y_2$, $y_3$, $x_3$</td>
<td>0.48</td>
<td>0.81</td>
</tr>
<tr>
<td>8</td>
<td>$Y_6$</td>
<td>$Y_1$, $Y_2$, $Y_3$, $X_3$</td>
<td></td>
<td>$y_2$, $y_3$</td>
<td>0.32</td>
<td>0.39</td>
</tr>
<tr>
<td>9</td>
<td>$Y_7$</td>
<td>$Y_1$, $Y_2$, $Y_3$</td>
<td></td>
<td>$y_1$, $y_2$, $y_3$</td>
<td>0.27</td>
<td>0.35</td>
</tr>
<tr>
<td>10</td>
<td>$Y_8$</td>
<td>$Y_1$, $Y_3$</td>
<td></td>
<td>$y_1$, $y_3$, $x_1$, $x_2$</td>
<td>0.16</td>
<td>0.21</td>
</tr>
</tbody>
</table>

\(^a\)OLS: Ordinary Least Squares, EIV: Errors-in-Variables:  
$X_1$: Socialization,  
$X_2$: Communication,  
$X_3$: Selectivity,  
$X_4$: Organizational Size  
$Y_1$: Scope,  
$Y_2$: Pervasiveness,  
$Y_3$: Salience,  
$Y_4$: Tension,  
$Y_5$: Adaptive Performance,  
$Y_6$: Manager's Salary,  
$Y_7$: Net Operating Revenue,  
$Y_8$: Savings.
Table 4. Continued

<table>
<thead>
<tr>
<th>Equation 5</th>
<th>Y</th>
<th>Significant coefficients</th>
<th>OLS</th>
<th>EIV</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>( Y_1 )</td>
<td>( X_4 ) ( x_4 )</td>
<td>0.20</td>
<td>0.32</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>( Y_2 )</td>
<td>( X_1, X_3, X_4 ) ( x_1, x_3, x_4 )</td>
<td>0.31</td>
<td>0.54</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>( Y_3 )</td>
<td>( X_3 ) ( - )</td>
<td>0.05</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>( Y_4 )</td>
<td>( Y_3 ) ( y_3 )</td>
<td>0.07</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>( Y_5 )</td>
<td>( Y_2, Y_3, X_1, X_2, X_3 ) ( y_2, y_3, x_3 )</td>
<td>0.48</td>
<td>0.82</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>( Y_6 )</td>
<td>( Y_3, X_3, X_4 ) ( y_3, x_4 )</td>
<td>0.50</td>
<td>0.74</td>
<td></td>
</tr>
<tr>
<td>17b</td>
<td>( Y_7 )</td>
<td>( Y_3 ) ( y_3 )</td>
<td>0.15</td>
<td>0.41</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>( Y_8 )</td>
<td>( Y_2, Y_3, X_4 ) ( y_2, y_3, x_1, x_4 )</td>
<td>0.41</td>
<td>0.63</td>
<td></td>
</tr>
</tbody>
</table>

bRepresented by equation (5.17aa) and (5.17bb) for OLS and EIV, respectively.
Socialization and Communication do not appear significant. Only Pervasiveness, Salience, and Selectivity have a significant effect on Adaptive Performance in both models.

In Model 1, Scope, Pervasiveness, Salience, and Selectivity have significant effects on Manager's Salary ($Y_6$) by the Least Squares solution. Only Pervasiveness and Salience appear significant by the EIV solution. When Size is included in Model 2, Salience, Selectivity, and Size have significant effect on Manager's Salary by the OLS solution; the significance of Selectivity drops out in the EIV solution. It is worth noting that the effect of Salience is negative to Adaptive Performance; its effect is positive to Manager's Salary.

In Model 1, Scope, Pervasiveness, and Salience have significant coefficients on Net Operating Revenue ($Y_7$) by both the OLS and the EIV solutions. When size is included, equation (5.17a) of Errors-in-Variables analysis shows $R^2$ greater than unity. Changing to equation (5.17aa) and (5.17bb), only Salience has significant effect on the ratio Net Operating Revenue/Size ($Y_9$) in both the Least Squares and the Errors-in-Variables equations.

In the Savings ($Y_8$) equation, more variables have significant coefficients in the EIV solution than in the OLS solution. In addition to Scope and Salience which have a significant effect in Model 1 by the OLS solution, Socialization and Communication also have significant coefficients to Savings, by the EIV solution. Communications, however, has a negative coefficient. When Size is included in Model 2, Scope is no longer significant; Pervasiveness replaces Scope as a significant
variable in addition to Size and Salience which are significant by
the OLS solution.

By the EIV solution, Socialization has a significant effect on
Savings in addition to Pervasiveness, Salience, and Size which were
significant by the OLS solution. Pervasiveness has a negative rela­
tionship to Savings in Model 2, and its coefficient is considerably
different between the two solutions.

Table 4 also shows that the EIV $R^2$ of each equation is considerably
larger than the OLS $R^2$, except for equation (5.5) and (5.13) where
Salience ($Y_3$) is the dependent variable. None of the variables appear
to be significant in the EIV solution. The computation of $R^2$ of the
EIV solution follows the procedure discussed in Chapter Four. This
computation may be examined in Appendix F.

With the exception of the equation (5.5) and (5.13) the EIV $R^2$'s
range from 1.3 to 1.7 times the OLS $R^2$'s. The fact is contributed
by at least two conditions. First, the denominator of the EIV $R^2$ is
the true variance in $y$ which is smaller than the total sample variance,
the denominator of the OLS $R^2$. Second, the explained variance in $y$ is
computed from the true variance in $y$ deducted by the error in the
equation. In the OLS this last term to be deducted is not only the
error in the equation but also compounded with the errors of measurement.

To test the hypothesis that the variance of error in the equation
$V(q_1)$ is zero, is to test whether the true value of the dependent
variable is perfectly explained by the true values of the predetermined
variables postulated in the equation. The F-values of this test for
the EIV equations are shown in Appendix D, Tables 1A, B through 8A, B.
Except for Appendix Tables 5A, 5B, and 7B all other F-values are greater than the tabular F-values. It is concluded that characteristics other than those included in each equation in Model 1 and Model 2 (except for Appendix Tables 5A, 5B, and 7B above) influence the true value of the dependent variable in each of those equations.

The F-value for testing the variance of error in the equation (5.17a) of Appendix Table 7B is 0.70. As has been discussed, this equation has generated the specification problem, mostly because of the almost perfect relationship between Net Operating Revenue and Organizational Size. The problem has been solved by postulating equations (5.17aa) and (5.17bb).

The F-values for testing the variance of error in the equations (5.7a) and (5.15a) of Appendix Tables 5A, and 5B, respectively, are 1.25. The F-tabular value at the 5 percent level of significance is 1.32. Here, the hypotheses that the variances of errors in the equations are zero were not rejected. In other words, there is no other characteristic than the ones which have been included in the equation (5.7a), i.e. Socialization, Communication, Selectivity, Scope, Pervasiveness, Salience, and Tension that influence the true value of Adaptive Performance. Adding the Organizational Size in equation (5.15a) creates the situation that the coefficient of the variable is not significant at the 10 percent level. Another circumstance is the very small $R^2$-change, i.e. from 0.8095 in equation (5.7a) to 0.8172 in equation (5.15a). Based on this condition, equation Adaptive Performance of Model 1 provides a more efficient estimation of the parameters (Fuller, 1971; Warren et al., 1974a).
Modified EIV models developed

An F-test has been constructed to determine whether the set of non-significant coefficients in each equation is zero. The F-values of this test for each equation are also presented in Appendix Tables 1A, B through 8A, B of Appendix D. The test of the Adaptive Performance equation of Model 1 (Appendix Table 7A) was done twice. The first test was to examine whether the Socialization, Communication, Scope, and Tension together had zero coefficients. According to the table the F-value was too great to accept zero for these coefficients. The second test was to examine whether only Scope and Tension (both having almost zero t-values had zero coefficients. The result suggests that the zero coefficients of Scope and Tension can be accepted.

Based on the test of all equations, new analyses of Errors-in-Variables which include only significant variables have been utilized on both Model 1 and Model 2.

The results are 1

Model 1

\[ y_1 = 0.2965x_3 + \hat{\epsilon}_{11} \]
\[ (0.1088) \quad 0.0926 \]

\[ y_2 = 0.3865y_1 + 0.2766x_1 + 0.2513x_3 + \hat{\epsilon}_{12} \]
\[ (0.4387) \quad 0.1604 \quad 0.1010 \quad 0.1166 \]

\[ y_3 = 10.1900 + 1.2675x_3 + \hat{\epsilon}_{13} \]
\[ (0.0319) \quad 0.5365 \]

1The number under the y at the left side of the equation is the \( R^2 \). The symbol (*), (**), (***) refer to significance at 10, 5 and 1 percent level, respectively. The number under the coefficient is its standard error.
\( y_4 = 7.3028 - 0.1806y_3 + \tilde{\alpha}_{14} \)

\((0.0624) \quad 0.0758\)

\( y_5 = 0.2609y_2 - 0.0553y_3 + 0.5629 + 0.1644x_1 \)

\((0.8209) \quad 0.1336 \quad 0.0269 \quad 0.1133\)

\( + 0.2960x_2 + 0.5195x_3 + \tilde{\alpha}_{15} \)

\((0.1945) \quad 0.1382\)

\( y_6 = 1.8231y_1 + 2.6753y_2 + 0.6514y_3 + 7.1702 + \tilde{\alpha}_{16} \)

\((0.3980) \quad 1.0058 \quad 0.9661 \quad 0.1647\)

\( y_7 = 14.2889y_1 + 12.0269y_2 + 2.3991y_3 + 2.2374 + \tilde{\alpha}_{17} \)

\((0.3362) \quad 5.3602 \quad 5.0419 \quad 0.8399\)

\( y_8 = 3.0630y_1 + 1.4109y_3 - 9.4308 - 2.1615x_2 + \tilde{\alpha}_{18} \)

\((0.2415) \quad 1.4590 \quad 0.2908 \quad 1.7236\)

**Model 2**

\( y_1 = 0.2214x_1 + \tilde{\alpha}_{21} \)

\((0.2847) \quad 0.0368\)

\( y_2 = 0.2809x_1 + 0.2230x_3 + 0.2258x_4 + \tilde{\alpha}_{22} \)

\((0.5427) \quad 0.0963 \quad 0.1095 \quad 0.0444\)

\( y_3 = 1.0562x_3 + 0.2345x_4 + 10.1899 + \tilde{\alpha}_{23} \)

\((0.0590) \quad 0.5909\)

\( y_4 = -0.1806y_3 + 7.3028 + \tilde{\alpha}_{24} \)

\((0.0624) \quad 0.0758\)

\( y_5 = 0.3511y_2 - 0.0502y_3 + 0.5111 + 0.1514x_1 + 0.2786x_2 \)

\((0.8402) \quad 0.1787 \quad 0.0281 \quad 0.1165 \quad 0.1981\)

\( + 0.5181x_3 - 0.0705x_4 + \tilde{\alpha}_{25} \)

\((0.1379) \quad 0.0559\)

\( y_6 = 0.5417y_3 + 8.2916 + 2.3385x_4 + \tilde{\alpha}_{26} \)

\((0.5654) \quad 0.1421 \quad 0.4425\)

\( y_9 = 1.1995y_3 + 6.0965 + \tilde{\alpha}_{27} \)

\((0.2117) \quad 0.4378\)
\[ y_8 = -5.8138y_2 + 1.0877y_3 - 6.1378 + 1.7531x_1 \\
(0.6388) \quad 1.2273 \quad 0.3455 \quad 1.1581 \]
\[ + 4.7574x_4 + \hat{q}_{28} \]
\[ 1.0235 \]

These significant relationships are structurally diagrammed into Figures 4 through 7 a and b. Figure a relates to Model 1 and the Figure b diagram to the relationships of Model 2 where Organizational Size is incorporated into the model. In both models, Tension \((Y_4)\) is not included because Tension does not have any significant relationship to any of the Organizational Effectiveness measures.

About 82 percent of the true variation in Adaptive Performance is explained by the true variation of Socialization, Communication, Selectivity, Pervasiveness, and Salience (Figure 4a). When Size is included, those variables and Size explain about 84 percent of the true variation in Adaptive Performance. In addition to its direct effect, Socialization also has an indirect effect on Adaptive Performance via Pervasiveness, in both models. Communication has only direct effect on Adaptive Performance in both models; in this study Communication does not show a significant effect on Compliance variables. In addition to its direct effect, Selectivity has indirect effects on Adaptive Performance through Scope, Pervasiveness, and Salience in Model 1. The same position of Selectivity effects are shown by Model 2, but Selectivity does not have an indirect effect via Scope in this model. This is because Scope does not have a direct effect on this Effectiveness variable, and also does not have significant effects on other predetermined variables of Adaptive Performance.
Figure 4a. The diagram of Modified Model of Adaptive Performance as measure of Organizational Effectiveness based on Model 1 and Errors-in-Variables solution.
Figure 4b. The diagram of Modified Model of Adaptive Performance measure of Organizational Effectiveness based on Model 2 and Errors-in-Variables solution.
Figure 5a. The diagram of Modified Model of Manager Salary as measure of Organizational Effectiveness based on Model 1 and Errors-in-Variables solution.
Figure 5b. The diagram of Modified Model of Manager Salary as measure of Organizational Effectiveness based on Model 2 and Errors-in-Variables solution.
Figure 6a. The diagram of Modified Model of Net Operating Revenue as measure of Organizational Effectiveness based on Model 1 and Errors-in-Variables solution.
Figure 6b. The diagram of Modified Model of Net Operating Revenue/Size as measure of Organizational Effectiveness in Model 2 and Errors-in-Variables solution
Figure 7a. The diagram of the Modified Model of Savings as measure of Organizational Effectiveness based on Model 1 and Errors-in-Variables solution
Figure 7b. The diagram of the Modified Model on Savings as measure of Organizational Effectiveness based on Model 2 and Errors-in-Variables solution
Organizational Size

Scope

Pervasiveness

Savings

Socialization

Selectivity

Salience

Communication

$q_{21}$

$q_{22}$

$q_{23}$

$q_{28}$

1.0562

0.6010

0.6762

4.7574

-5.8138

1.7531

0.9700

1.0877

0.2214

0.2258

0.2345

0.2809

0.2230

0.8456
Pervasiveness and Salience both have a direct effect on Adaptive Performance in both models. Organizational Size, in Model 2, has both direct effects and indirect effects through Pervasiveness and Salience on Adaptive Performance.

About 40 percent of the true variation in Manager Salary as a measure of Effectiveness is explained by Scope, Pervasiveness, and Salience in Model 1 (Figure 5a). When Size is included in Model 2, the effects of Scope and Pervasiveness are dropped out. Organizational Size and Salience explain about 57 percent of the variation in the true value of Manager Salary (Figure 5b). Socialization has an indirect effect via Pervasiveness on Manager Salary in Model 1. Communication does not show any significant direct or indirect effects on Manager Salary in either model. Selectivity has an indirect effect on Manager Salary through Scope, Pervasiveness, and Salience in Model 1. In Model 2, Selectivity has indirect effect on this Effectiveness measure via Salience. Organizational Size, in this model, has both direct and indirect effect on Manager Salary.

Scope, Salience, and Pervasiveness explain about 34 percent of the true variation in Net Operating Revenue in Model 1 (Figure 6a). In Model 2 (Figure 6b), Salience explains about 21 percent of the true variation in Net Operating Revenue/Size. Socialization has an indirect effect on Net Operating Revenue via Pervasiveness in Model 1. Socialization does not have significant direct or indirect effects on Net Operating Revenue/Size in Model 2, and Communication does not have the same effect on the Effectiveness measures in both models. Selectivity
has indirect effects in both models; through Scope, Pervasiveness, and Salience on the Net Operating Revenue, as well as via Salience on the Net Operating Revenue/Size.

In Model 1, about 24 percent of true variation in Savings is explained by Communication, Scope, and Salience (Figure 7a). In Model 2, about 64 percent of true variation in Savings is explained by Socialization, Organizational Size, Pervasiveness, and Salience (Figure 7b). Socialization does not have a significant indirect and direct effect in Model 1, but has direct and indirect effects in Model 2. Communication has a significant direct effect on Savings in Model 1, but this effect disappears when Size is incorporated in Model 2. Selectivity has an indirect effect on Savings through Scope and Pervasiveness in Model 1, and through Pervasiveness and Salience in Model 2. In addition to its direct effect, Organizational Size has indirect effects on Savings through Pervasiveness and Salience.

Discussion

A comparison of the models developed for utilitarian organization by utilizing Errors-in-Variables and the Ordinary Least Squares procedures may now be discussed. The organizational effectiveness models without Size, as discussed in the theoretical framework, are compared. This model is recalled as Model 1. Later, the Modified models will also be related. The independent variables of the Modified

1 The estimates of Model 1 are shown in equations (5.3) through (5.10) a and b.
models were postulated by excluding the set of variables of the organizational effectiveness models which when tested had zero coefficients. Further, the Modified models in their reduced form are reexamined.

The OLS versus EIV solutions

Socialization, Communication, and Selectivity have strong contributions to Adaptive Performance in Model 1 based on the OLS solution. By the EIV solution, among those three exogeneous variables only Selectivity shows a significant contribution to Adaptive Performance. The EIV coefficient for Selectivity is greater than the OLS coefficient. In the EIV Modified model, Selectivity remains a highly significant coefficient to the Adaptive Performance. When Size is considered in the Modified model, the Selectivity effect is still significant. This finding supports Etzioni's proposition that: "selectivity and not organizational socialization is a more important determinant of effectiveness" (Etzioni, 1975, p. 260) in utilitarian organization.

Examining the contributions of these three exogeneous variables among the economic measures of organizational effectiveness, Selectivity has a significant contribution at the 10 percent level to Manager Salary in Model 1 by the OLS solution, but it does not show that contribution by the EIV solution. The Modified model with or without Size also shows no significant contribution of Selectivity to Manager Salary. By the OLS solution, Communication does not have a significant effect on Savings in Model 1. But, the EIV solution shows that this Communication effect on Savings is significant. In the Modified model,
when the set of nonsignificant variables is excluded in the EIV Savings equation, the Communication effect is no longer significant. When Size is considered, Communication is not included in the Modified model. Socialization appears in the Modified model with size considered but does not have significant coefficient at this stage. Socialization, Communication and Selectivity do not have any significant relationships to revenue in any of the solutions. The situation tends to support the conclusion of Warren et al. (1976, p. 346) that "the causal model based on adaptation strongly supports Etzioni's propositions relating socialization, communication, and selectivity to organizational effectiveness, while the causal model based upon revenue or savings does not support these same propositions." In addition, the causal model based upon Manager Salary, as shown by the Modified model, also does not support the propositions.

The positions of Scope and Pervasiveness to the measures of organizational effectiveness are equivalent in both the OLS and the EIV solutions of Model 1. Pervasiveness, but not Scope, has a significant coefficient to Adaptive Performance. The EIV coefficient of Pervasiveness which is greater than the OLS coefficient is significant at the 5 percent level while the OLS counterpart is significant at less than 1 percent level. In the Modified model, the coefficient of Pervasiveness (0.261) is about the same as the EIV Model 1 coefficient (0.260) and is also significant at the 5 percent level. When Size is considered, the Pervasiveness coefficient of the Modified model is larger (0.3511) and is significant at the 5 percent level.
By the OLS solution of Model 1, both Scope and Pervasiveness have a significant contribution to Manager Salary and Net Operating Revenue. By the EIV solution, Scope has a greater coefficient (1.68) than its OLS counterpart (1.41) to Manager Salary, but the EIV coefficient is not significant. In the Modified model, when the nonsignificant variables are excluded from the Manager Salary EIV equation, Scope shows a larger coefficient (1.823) and is significant at the 10 percent level. In Model 1 Scope has a larger EIV coefficient to Net Operating Revenue than its OLS counterpart, and is significant at less than the 1 percent level. This situation is also shown by the Modified model.

For Manager Salary in Model 1, Pervasiveness has a larger EIV coefficient (2.058) which is significant at the 10 percent level than the OLS coefficient (1.303) which is significant at the 1 percent level. In the Modified model this coefficient is larger (2.675) and is significant at less than the 1 percent level. For Net Operating Revenue in Model 1, Pervasiveness also has a larger EIV coefficient (15.05) which is significant at the 5 percent level as compared to the OLS coefficient (8.678) which is significant at the 1 percent level.

Pervasiveness does not have a significant contribution to Savings in the Model 1 by either OLS or EIV solution. Scope, however, has a larger EIV coefficient (3.158) than its OLS counterpart (1.931) however, both are significant at the 10 percent level. The Modified model also shows the significant contribution of Scope to Savings.

The contributions of Salience to all four organizational effectiveness measures in Model 1 are significant by both the EIV and the OLS solutions. The EIV coefficient is larger in absolute value
than the OLS coefficient in each equation. The significant effects of
Salience to all measures of organizational effectiveness are also sup­
ported by the Modified model. However, these relationships are positive
except for the Adaptive Performance equation. In the Modified model
the contribution of Salience to Adaptive Performance is also significant
and negative when Size is considered. Warren et al. (1976, p. 347)
explains this relationship in relation to the tenure of the manager.
The longer the tenure of the manager, the more salient the organization
becomes to the manager and other participants, but at the same time,
the managers may become more reluctant or less able to adapt to the
environment.

Socialization and Communication do not have significant relation­
ships to Scope in Model 1 by both EIV and OLS solutions. This is also
shown by the Modified model. However, Scope has a significant direct
effect on all economic measures of organizational effectiveness by
both solutions. For these measures, it may be more important to care­
fully select the new participants rather than to increase Scope through
increased socialization or communication (Warren et al., 1976, p. 348).

Socialization and Selectivity have significant contributions to
Pervasiveness in Model 1 by both EIV and OLS solutions. The EIV
coefficients are larger (0.262 and 0.248 for Socialization and Selectivity,
respectively) than the OLS coefficients (0.196 and 0.235 for Socializa­
tion and Selectivity, respectively). The EIV coefficients, however,
are significant at the 5 percent level as compared to the OLS coefficients
which are significant at the 1 percent level. However, the Modified
model shows that Socialization is significant at the 1 percent level,
and Selectivity is significant at the 5 percent level. This situation is also supported when Size is considered in the Modified model. The measure of Socialization specifically includes the amount of training received by the participants on the philosophy of the cooperatives. By understanding and accepting the goals and policies of the cooperative movement, internalization of norms is facilitated, or Pervasiveness is enhanced.

It is worth recalling that all the coefficients of the EIV solutions are the estimates of the structure, in which the coefficients estimate the relation between the true values of the concepts being considered. The Modified models which were developed based on the significant relationships of EIV analysis are also the coefficients of the structure.

The Least-Squares equations might be called a prediction equation (Warren et al., 1974a, p. 891). If one selected an additional farmer cooperative at random and made determination on Socialization, Communication, Selectivity, Scope, Pervasiveness, Salience, and Size in exactly the same way as the determinations were made in this study, then the Least-Squares equations furnish the estimates of Adaptive Performance, Manager Salary, Net Operating Revenue, and Savings of that cooperative. If one did not make the determination in the same way (e.g. if one changed the number of items used to measure Selectivity), the Least-Squares equation would no longer provide the best predictor of those measures of effectiveness. The EIV estimates, on the other hand, provide consistent coefficients since they are the estimate of the structure, in that the coefficients are the true slopes.
The EIV equations are also used as prediction equations. For farmer cooperatives selected at random and determinations made as in this study, its average prediction error will be larger than the Least-Squares equations. But, because it is an estimate of the structure, it can be used to predict for farmer cooperatives that have not been randomly selected and can be used as a prediction equation in situations where the concepts are measured with a different number of items. If the cooperatives were not randomly selected, the estimate will be unbiased only if the selection criterion is independent of the errors of measurement. If the concepts were to be measured with a different number of items, the assumption that the items are strictly parallel to those used in the current study would be necessary.

The OLS $R^2$ is the fraction of the variation in the observed dependent variable explained by the observed independent variables. The unexplained variation in the observed dependent variables may be composed of the errors of measurement of the dependent and independent variables, and errors in the equation, assuming that there is no sampling error. The EIV $R^2$ is the estimated fraction of variation in the true values of the dependent variable explained by the true values of the independent variables. Assuming there is no sampling error, the unexplained variation of the true dependent variables is mainly composed of errors in the equation, since the errors of measurement have been taken into account in the analysis.

Based on that explanation, the considerable difference of $R^2$ between EIV solution and OLS solution is justifiable. In Model 1, the EIV versus OLS $R^2$'s are, respectively, 0.81 versus 0.48 for
Adaptive Performance, 0.39 versus 0.32 for Manager Salary, 0.35 versus 0.27 for Net Operating Revenue, and 0.21 versus 0.16 for Savings. In Model 2, these figures are, respectively, 0.82 versus 0.48 for Adaptive Performance, 0.74 versus 0.51 for Manager Salary, 0.42 versus 0.15 for Net Operating Revenue/Size, and 0.63 versus 0.41 for Savings for the EIV versus OLS solutions, respectively.

Modified models reexamined

Reduced-form structural equations have been discussed in Chapter Four. This reduced-form is also discussed by Alwin and Hauser (1975) in terms of decomposition of effects in path analysis utilizing Least-Squares estimates. Some additional substantive insights are expected to be provided by the following discussion of the reduced-form Modified model of organizational effectiveness.

Structurally, the determining variables of organizational effectiveness of the Modified model are of interest stated in the reduced-forms. Etzioni classifies Socialization and Communication as "cultural integration" variables, and Selectivity as "initial involvement of environment articulation" variable. In Model 1, these variables are considered as exogeneous variables. For application, since these variables are manipulatable, the effectiveness equations may be stated in terms of the exogeneous variables. For example,

\[ y_5 = 0.2609y_2 - 0.0553y_3 + 0.5629 + 0.1644x_1 + 0.296x_2 \\
+ 0.5139x_3 + 0.4232q_{15} \]
\[
\begin{align*}
&= 0.2609(0.2766x_1 + 0.3659x_3 + 0.3649q_{11} + 0.7492q_{12})^1 \\
&\quad - 0.0553(10.19 + 1.2675x_3 + 0.9843q_{13}) + 0.5629 \\
&\quad + 0.1644x_1 + 0.2960x_2 + 0.5139x_3 + 0.4232q_{15} \\
&= 0.0006 + 0.2366x_1 + 0.2960x_2 + 0.5393x_3 + w_{15}
\end{align*}
\]

where \( w_{15} = 0.095q_{11} + 0.200q_{12} - 0.054q_{13} + 0.4232q_{15} \)

The computed results of the reduced-form of structural equations for other measures of organizational effectiveness for the models with and without Size, are shown in Table 5. In a sense, this table shows the total direct and indirect effect of the exogeneous variable to each measure of organizational effectiveness. Table 5 shows the "universal role" of Selectivity as "initial involvement environment articulation" variable. Table 5 shows, for example, that the total effect of Selectivity to Adaptive Performance is 0.539. This is composed of direct effect 0.514 and the indirect effect of Selectivity through Scope and Pervasiveness 0.025. The total effects of Socialization and Selectivity to Manager Salary are mainly composed of the indirect effect of Socialization through Pervasiveness, and of Selectivity through Scope and Pervasiveness. Insofar as Manager Salary is a measure of effectiveness, the reduced-form shows that it may be important to carefully select the new participant rather than to increase socialization. This finding also supports Etzioni's propositions.

\[
^1_{y_2} = 0.3865(0.2965x_3 + 0.944q_{11}) + 0.2766x_1 + 0.2513x_3 + 0.7492q_{12}
\]
Table 5. Coefficients of the reduced-form equations of the Organizational Effectiveness measures

<table>
<thead>
<tr>
<th>Organizational effectiveness measures&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Exogeneous variables</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( x_1 ) Socialization</td>
<td>( x_2 ) Communication</td>
<td>( x_3 ) Selectivity</td>
<td>( x_4 ) Organizational Size</td>
</tr>
<tr>
<td>( y_5 ) Adaptive Performance</td>
<td>0.237*</td>
<td>0.296*</td>
<td>0.539</td>
<td>np&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>0.250*</td>
<td>0.279*</td>
<td>0.543</td>
<td>0.003*</td>
</tr>
<tr>
<td>( y_6 ) Manager Salary</td>
<td>0.740</td>
<td>0.0</td>
<td>2.345</td>
<td>np</td>
</tr>
<tr>
<td></td>
<td>0.0</td>
<td>0.0</td>
<td>0.572</td>
<td>2.466</td>
</tr>
<tr>
<td>( y_7 ) Net Operating Revenue</td>
<td>3.327</td>
<td>0.0</td>
<td>11.678</td>
<td>np</td>
</tr>
<tr>
<td>( y_9 ) (Net Operating Revenue)/Size</td>
<td>0.0</td>
<td>0.0</td>
<td>1.523</td>
<td>-</td>
</tr>
<tr>
<td>( y_8 ) Savings</td>
<td>0.0</td>
<td>-2.162*</td>
<td>0.908</td>
<td>np</td>
</tr>
<tr>
<td></td>
<td>0.120</td>
<td>0.0</td>
<td>-0.148</td>
<td>3.700</td>
</tr>
</tbody>
</table>

<sup>a</sup>The intercepts are 0.0, 13.9, 13.9, 26.7, 7.6, 4.9, 4.9 for \( y_5 \), \( y_6 \), \( y_7 \), \( y_9 \), \( y_8 \), respectively.

<sup>b</sup>np: not postulated.

*Not significant at the 10 percent level.
Etzioni suggests that Scope is the "action boundary established involvement environment articulation" variable, while Pervasiveness is the "normative boundary established involvement environment articulation" variable. Scope and Pervasiveness may then be considered as manipulatable variables. Scope may be manipulated by changing the activities in which the participants are jointly involved, and Pervasiveness may be manipulated by increasing or decreasing the number of activities in or outside the organization for which the organization sets norms. For application, the reduced-form structural equations may be stated in terms of these "environment articulation" variables in addition to the exogeneous variables. Since Salience is the only variable left out, Salience is considered as less (or un-) manipulatable. These reduced-form equations are presented in Table 6.

Table 6 shows that Pervasiveness has the reduced form coefficient 0.261 to Adaptive Performance. Selectivity has the reduced-form coefficient 0.444 to Adaptive Performance. Pervasiveness, however, can be manipulated by changing Selectivity and other characteristics which have not been specified in the Pervasiveness equation. Considering Manager Salary as a measure of effectiveness, this measure can be increased by increasing Pervasiveness, Scope, and Selectivity. Scope can also be increased by increasing Socialization as well as other characteristics which have not been specified in the Scope equation. Pervasiveness can also be increased by changing Selectivity and Socialization as well as other characteristics which have not been included in the Pervasiveness equation. The increase of Selectivity by one unit is expected to work through Salience which will increase
Table 6. Coefficients of the reduced-form equations of the Organizational Effectiveness measures

<table>
<thead>
<tr>
<th>Organizational effectiveness measures(^a)</th>
<th>(x_1) Socialization</th>
<th>(x_2) Communication</th>
<th>(x_3) Selectivity</th>
<th>(x_4) Organizational Size</th>
<th>(y_1) Scope</th>
<th>(y_2) Pervasiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>(y_5) Adaptive Performance</td>
<td>0.164(^*)</td>
<td>0.296(^*)</td>
<td>0.444</td>
<td>np(^b)</td>
<td>0.0</td>
<td>0.261</td>
</tr>
<tr>
<td></td>
<td>0.151(^*)</td>
<td>0.279(^*)</td>
<td>0.465</td>
<td>-0.082(^*)</td>
<td>0.0</td>
<td>0.351</td>
</tr>
<tr>
<td>(y_6) Manager Salary</td>
<td>0.0</td>
<td>0.0</td>
<td>0.826</td>
<td>np</td>
<td>1.823</td>
<td>2.675</td>
</tr>
<tr>
<td></td>
<td>0.0</td>
<td>0.0</td>
<td>0.572</td>
<td>2.466</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>(y_7) Net Operating Revenue</td>
<td>0.0</td>
<td>0.0</td>
<td>3.041</td>
<td>0.0</td>
<td>14.289</td>
<td>12.027</td>
</tr>
<tr>
<td>(y_9) (Net Operating Revenue)/Size</td>
<td>0.0</td>
<td>0.0</td>
<td>1.523</td>
<td>-</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>(y_8) Savings</td>
<td>0.0</td>
<td>-2.162(^*)</td>
<td>1.788</td>
<td>np</td>
<td>3.063</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>1.753(^*)</td>
<td>0.0</td>
<td>1.149</td>
<td>5.013</td>
<td>0.0</td>
<td>-5.814</td>
</tr>
</tbody>
</table>

\(^a\) The intercepts are 0.0, 0.0, 13.9, 13.9, 2.7, 3.6, 4.9, 4.9 for \(y_5\), \(y_6\), \(y_7\), \(y_9\), \(y_8\), respectively.

\(^b\) np: not postulated.

\(^*\) Not significant at the 10 percent level.
Manager Salary $826.00. When organization is considered at the same Size level, the model limits the manipulatable variable to Selectivity. This condition is also true for Net Operating Revenue.

The reduced-form of the Modified model shows that Savings can be changed by manipulating Scope and Selectivity. To increase Selectivity by one unit is expected to work through Salience and would increase Savings $17,880.00. In addition to the manipulation of Selectivity, Scope can be increased by manipulating other characteristics which have not been specified in the Scope equation. When Size is considered, Pervasiveness replaces Scope in decreasing Savings.

**Suggestion for further research**

As Etzioni (1975, p. 394) noted causal analysis should preferably be based on longitudinal rather than lateral data. That is, it should be based on observations of organizational processes over time rather than on comparisons of data from different organizations collected at the same point in time. With regard to compliance studies of organizational effectiveness, Mulford et al. (1972) and Warren et al. (1976) have already noted that longitudinal studies were needed for the study of organizational effectiveness. The writer is in agreement with this suggestion. There is also a need for empirical compliance studies in other types of utilitarian organizations. For instance, the findings of small retail businesses that are not cooperatives may be compared to the findings of this study.

Recently, Negandhi and Reimann (1972) tested the contingency theory of organizations within the context of a developing country.
Cooperatives have been recognized in developing countries as a means of organizing small business firms. Compliance studies of cooperatives, as well as other types of organizations, in developing countries are necessary.

In the present analysis all relationships were considered to be linear. However, some of these relationships may not be linear. One suggestion for future research would be analyses that examined possible nonlinear relationships. The incorporation of the nonlinear relationship in the analysis may improve this model. In general, the application of nonlinear relationships in Errors-in-Variables analysis is a necessity.

This study has placed emphasis on the errors of measurement and has argued for the application for the Errors-in-Variables analysis to sociological data. Earlier, some of the advantages were discussed. It is expected that more sociological studies will apply the techniques which take into account the errors of measurement so that efficient and consistent estimates will be found. Since path analysis is used on structure relationships, it seems extremely important that the estimates are on true values rather than on observed values.
CHAPTER SIX.
SUMMARY AND IMPLICATIONS

The major emphasis of this study was a discussion of the Errors-in-Variables approach, a comparison of the results from the OLS versus EIV and an attempt to utilize the EIV approach in a structural equations model. The specific objectives of this study were: (a) to discuss and present a causal model of organizational effectiveness including Size as one of the exogeneous variables; (b) to discuss and present the EIV approach and its application, and (c) to test a causal model of organizational effectiveness using the EIV and compare the results to OLS regression procedures.

For the theoretical framework, Etzioni's classification of organization was reviewed. Compliance was viewed as being universal, existing in all social units, and the central element of organizational structure. Therefore, compliance has been taken as an analytical base for the classification of organizations. Based on the predominant compliant patterns, organizations were classified as coercive, utilitarian, or normative. The organizational structure of farmer cooperatives was discussed. The primary character of the farmer cooperatives is utilitarian because of the high pressure on the farmer cooperatives are placed to operate efficiently and economically. The secondary character is based on their normative features.

Etzioni's compliance variables were also discussed. Socialization and Communication were discussed as cultural integration variables. Scope, Pervasiveness, and Selectivity are environmental articulation
variables. Salience and Levels of Tension were discussed in relation to Scope.

Etzioni also suggested that compliance variables may be systematically related to organizational size. The issue of causal inference of organizational size and organizational structure was presented.

Etzioni's chief concern was with a mobilized effective system model. This model applies to organizational systems which give primary to goal attainment rather than to integration, tension management, or some other subsystem. This position places effectiveness as central to Etzioni's organizational analysis. This study classified the cooperative effectiveness according to the source of determination (either internal or external) and the type of social action (either sociological or economic). Adaptive Performance, Manager Salary, Net Operating Revenue, and Savings were the measures of organizational effectiveness used on the basis of the above typology.

For testing the causal models of organizational effectiveness, the importance of the EIV approach was emphasized. Two causal models of organizational effectiveness were presented. Model 1 postulated Socialization, Communication, and Selectivity as exogeneous variables. Other predetermined variables which were endogeneous were Scope, Pervasiveness, Salience, and Tension. Model 2 postulated Organizational Size as an exogeneous variable in addition to Socialization, Communication, and Selectivity. These exogeneous variables affect the intervening endogeneous variables, and in turn, affect each of the organizational effectiveness measures.
This study utilized a portion of data of the Managerial Success Study of 1971 conducted by the Department of Sociology and Anthropology at Iowa State University. Utilizing personal interviews and questionnaires, complete information was obtained from 153 farmer cooperatives in Iowa.

Item scores in each split of Socialization, Communication, Selectivity, Scope, Pervasiveness, Size, and Adaptive Performance were standardized, summed and divided by the number of items. Therefore, each split represented the average standard score in that split. Each composite was measured by the average score of the two splits. Tension and Salience were assumed to have equal means and variances, and thereby were not standardized prior to summing and dividing.

Measurement error variances and reliability were computed utilizing the split halves procedure for all variables except Manager Salary. Manager Salary reliability was assumed to be 0.90, and its error variance was estimated based on that reliability. Socialization, Selectivity, and Salience had a reliability of about 0.70s, while the rest of the compliance variables had a reliability of about 0.60s. Savings and Organizational Size had a reliability of about 0.80s. Net Operating Revenue had a reliability of 0.97, and Tension had a reliability of 0.60. The F test had been done to test the hypothesis that the variance of the true value of a variable was zero. The result suggested that portions of observed variation were a true variation for each of the composites, and no observed value of each composite was made up solely of measurement error.
Errors-in-Variables model was discussed for the bivariate case, and simultaneously compared to the Ordinary Least-Squares procedure. The assumptions, the estimation of the estimates and the variance of the estimators, and the true variation explained were presented. The alternative procedure of using Correction for Attenuation in Path Analysis was described utilizing the same example. Later, Fuller's EIV approach for a general linear model was discussed. The SUPER CARP program was introduced for estimation and analysis. The test of singularity, the estimation of errors in the equation and the explained variation of true values, and the test of errors-in-the-equation were discussed and exemplified. An attempt was made to relate the EIV approach to the structural equations model.

The findings showed that the significant EIV coefficients are consistently larger than the OLS coefficients. There was also a tendency among the nonsignificant EIV coefficients that if the coefficient was greater than its standard error, the EIV estimate tended to be larger than the OLS estimate. All the estimated standard errors for the EIV estimates were consistently larger than the OLS estimated standard errors.

The specification error variances were estimated for all EIV equations. The equation of Net Operating Revenue, when Size was considered, generated the specification problem. Net Operating Revenue and Organizational Size were considered to measure the same concept. These two measures were combined by taking a ratio of Net Operating Revenue to Size.
The sets of nonsignificant coefficients of the EIV equations were tested to verify whether they were zero. Modified equations were developed by excluding the nonsignificant variables of the EIV equations.

The findings support Etzioni's proposition that Selectivity and not Organizational Socialization is a more important determinant of effectiveness in utilitarian organization. These findings also support the conclusion of Warren et al. that the causal model based on Adaptive Performance strongly supports Etzioni's propositions relating Socialization, Communication, and Selectivity, while the causal model based upon Net Operating Revenue and Savings does not support these same propositions. The EIV analysis, however, also shows that the causal model based upon Manager Salary does not support those same propositions. It can be generalized that the causal models based on economic measures of organizational effectiveness do not support Etzioni's propositions relating Socialization, Communication, and Selectivity to organizational effectiveness.

Based on the Modified model, Pervasiveness has a significant effect on Adaptive Performance, and Scope has a significant effect on Savings. Scope and Pervasiveness both have significant effects on Manager Salary and Net Operating Revenue, but these effects drop out when Size is considered. Salience has significant relationships to all measures of effectiveness, and these contributions are positive except to Adaptive Performance.

EIV estimates are the estimates of the structure, in which the coefficients estimate the relation between the true values of the
concepts being considered. In addition, they may be utilized for prediction. Thereby, the EIV coefficients of the predetermined variables of the measures of organizational effectiveness are the true slopes. These slopes are unbiased and consistent in the presence of measurement error, unlike the OLS estimates.

The EIV $R^2$ is the estimated fraction of variation in the true values of the dependent variable explained by the true values of the independent variables. Assuming there is no sampling error, the unexplained variation of the true dependent variables is mainly composed of errors in the equation, since the errors of measurement have been taken into account in the EIV analysis. In this way, the explained variation of EIV equations is considerably larger than the explained variation of the OLS equations. The $R^2$ of Adaptive Performance equations of Model 1, for example, is 0.81 and 0.48 for the EIV and the OLS solutions, respectively.

The Modified models were stated in the reduced-form. The measures of organizational effectiveness were expressed in terms of manipulatable variables for two situations: a) in exogeneous variables and b) in Scope, Pervasiveness, and exogeneous variables. Tables of reduced-form coefficients were provided. In the first instance, Selectivity was significantly manipulatable in all effectiveness measures in this utilitarian organization. Manager Salary and Net Operating Revenue can also be increased by increasing Socialization but this increase is not directly affected by Socialization. Socialization will increase Pervasiveness, and this Pervasiveness, in turn, will increase Net Operating Revenue and Manager Salary. In the second instance, Scope
and Pervasiveness were recognized as manipulatable variables. For the economic measures of effectiveness, the manipulation of "environmental articulation variables" (Selectivity, Scope, and Pervasiveness) will increase these measures by the true slopes presented in the Table 6. Adaptive Performance can be increased by manipulating Selectivity and Pervasiveness.

Longitudinal study of the causal model of organizational effectiveness was suggested. Empirical studies in other types of utilitarian organization and cross cultural studies of utilitarian organizations were also noted. The application of Errors-in-Variables analysis in sociological research was encouraged.
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Wiley, David E.

Wright, Sewall

Yetley, Mervin John

Yuchtman, Ephraim, and Stanley E. Seashore
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Thanks and appreciation are also extended to Mrs. Letha Osmundson for typing the drafts and this dissertation.
Finally, this dissertation would not be produced without the sacrifice of the author's wife, Nuri, and his children, Rizki and Meutia. Apology and appreciation are also extended to them.
APPENDIX A

Items Or Questions Used in the Measurement of Variables
1. Socialization

<table>
<thead>
<tr>
<th>Item/quest. #</th>
<th>Anal var. #</th>
<th>Schedule #</th>
<th>Item or question and code</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOCA1</td>
<td>404</td>
<td>46</td>
<td>What methods are used to train and develop your employees? Explain each of these.</td>
</tr>
<tr>
<td>SOCA2</td>
<td>267</td>
<td>129a</td>
<td>Total number of coop managers.</td>
</tr>
<tr>
<td>SOCA3</td>
<td>517</td>
<td>129b</td>
<td>Where do your directors obtain information they use in discharging their duties?</td>
</tr>
<tr>
<td>SOCB1</td>
<td>405</td>
<td>129a</td>
<td>Total number of management meetings attended.</td>
</tr>
<tr>
<td>SOCB2</td>
<td>271</td>
<td>129a</td>
<td>Where do you regularly obtain information to help in the management of this cooperative?</td>
</tr>
<tr>
<td>SOCB3</td>
<td>518</td>
<td>129c</td>
<td>Where do your employees obtain information in the nature and philosophy of cooperative?</td>
</tr>
</tbody>
</table>

2. Communication

<table>
<thead>
<tr>
<th>COMA1</th>
<th>033</th>
<th>B33</th>
<th>Under the right conditions workers will seek and accept responsibility.</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMA2</td>
<td>065</td>
<td>B65</td>
<td>If a man wants a thing done right, he must do it himself.</td>
</tr>
<tr>
<td>COMA3</td>
<td>106</td>
<td>33</td>
<td>Employee production can be increased by consulting employees on decisions that affect them.</td>
</tr>
</tbody>
</table>
2. Continued

<table>
<thead>
<tr>
<th>Item/question #</th>
<th>Analy file var. #</th>
<th>Schedule #</th>
<th>Item or question and code</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMA4</td>
<td>113</td>
<td>40</td>
<td>Employee production can be increased by informing workers when a change is coming up that will affect their jobs.</td>
</tr>
<tr>
<td>COMA5</td>
<td>115</td>
<td>42</td>
<td>Employee production can be increased by telling employees that they're doing good work whether they are or not.</td>
</tr>
<tr>
<td>COMA6</td>
<td>229</td>
<td>48</td>
<td>Most businesses attempt to create a favorable image with their customers. What are the essential features or ingredients in the image you are trying to create for this business?</td>
</tr>
<tr>
<td>COMA7</td>
<td>471</td>
<td>129e</td>
<td>Total number of product meeting manager.</td>
</tr>
<tr>
<td>COMB1</td>
<td>047</td>
<td>B47</td>
<td>You can really get farther by talking with and cooperating with people.</td>
</tr>
<tr>
<td>COMB2</td>
<td>105</td>
<td>32</td>
<td>Employee production can be increased by periodically informing employees of their progress on jobs.</td>
</tr>
<tr>
<td>COMB3</td>
<td>111</td>
<td>38</td>
<td>Employee production can be increased by being interested in the personal well-being of your employee.</td>
</tr>
<tr>
<td>COMB4</td>
<td>114</td>
<td>41</td>
<td>Employee production can be increased by telling employees why their work is important.</td>
</tr>
<tr>
<td>COMB5</td>
<td>103</td>
<td>28</td>
<td>Which one of these statements best describes the way you feel about key employee relationships with patron-members?</td>
</tr>
</tbody>
</table>
2. Continued

<table>
<thead>
<tr>
<th>Item/quest.</th>
<th>Analysis file var.</th>
<th>Schedule #</th>
<th>Item or question and code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>a. They have a responsibility to keep themselves well informed and make recommendations on all our major product lines ................. = 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. They have a responsibility to pass on only that information about our major product lines which is requested by customer ................. = 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c. They should be extremely cautious in making recommendations about our major product line since a poor recommendation results in a loss of customers .............................................. = 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>d. They should provide the products requested by customers, but should make no recommendations about their uses ............................................. = 1</td>
</tr>
<tr>
<td>COMB6 233 29</td>
<td>As you think of merchandising your products, do you classify your farmer customers into different groups and use different selling approaches on them? No = 1, Yes = 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMB7 519 129e</td>
<td>You mentioned classifying. What are the major factors you take into consideration in classifying them?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Selectivity

| SELA1 184 | I.Q. Judgment Raw Score. |
### Item/Anal. quest. Anal. file var. # Sched. var. # Item or question and code

<table>
<thead>
<tr>
<th>Item</th>
<th>Anal. quest.</th>
<th>Anal. file var. #</th>
<th>Sched. var. #</th>
<th>Item or question and code</th>
</tr>
</thead>
<tbody>
<tr>
<td>SELA2</td>
<td>241</td>
<td>81</td>
<td></td>
<td>Keeping in mind your high school experience, how would you rank yourself as a student?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>a. ____ in the best 5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>b. ____ in the best 10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>c. ____ in the best 25%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>d. ____ in the upper half</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>e. ____ in the lower half</td>
</tr>
<tr>
<td>SELA3</td>
<td>244</td>
<td>84</td>
<td></td>
<td>Where would you belong in a list of 100 typical people in the kind of job you do best?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>a. ____ in the best 5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>b. ____ in the upper third</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>c. ____ in the middle third</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>d. ____ in the lowest third</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>e. ____ I don't know</td>
</tr>
<tr>
<td>SELA4</td>
<td>234</td>
<td>44</td>
<td></td>
<td>What methods do you use to determine the number and qualifications of the employees needed in your business firm?</td>
</tr>
<tr>
<td>SELA5</td>
<td>237</td>
<td>109</td>
<td></td>
<td>Will you please give me an interpretation of the status of this business as represented on these financial sheets?</td>
</tr>
<tr>
<td>SELA6</td>
<td>239</td>
<td>111</td>
<td></td>
<td>What do you feel the main purposes of financial statements?</td>
</tr>
<tr>
<td>SELB1</td>
<td>407</td>
<td>140</td>
<td></td>
<td>How many years of formal education have you completed? <em>(ENCIRCLE APPROPRIATE NUMBER.)</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8 or less 9 10 11 12 13 14 15 16 17 18 19 20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Elementary High School College Beyond BA or BS</td>
</tr>
</tbody>
</table>
### 3. Continued

<table>
<thead>
<tr>
<th>Item/quest.</th>
<th>Anal. file var. #</th>
<th>Sched. var. #</th>
<th>Item or question and code</th>
</tr>
</thead>
<tbody>
<tr>
<td>SELB2</td>
<td>186</td>
<td></td>
<td>I.Q. Parts Raw Score.</td>
</tr>
<tr>
<td>SELB3</td>
<td>249</td>
<td>89</td>
<td>How do you feel about your self-confidence?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>a. ___ I am quite confident of myself in any phase of activity.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. ___ I am quite confident of myself in most phases of activity.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c. ___ I have quite a bit of self-confidence about my intellectual ability, but I am not as self-confident about my social abilities.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>d. ___ I have quite a bit of self-confidence about my social ability, but I am not as self-confident about my intellectual ability.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>e. ___ I lack some self-confidence in both intellectual and social activities.</td>
</tr>
<tr>
<td>SELB4</td>
<td>236</td>
<td>108</td>
<td>When pricing products and services several factors must be taken into account. Under certain conditions it may be wise to maintain a wide margin even at the sacrifice of sales volume while in other instances it would be better to maintain a smaller margin to get increased sales volume.</td>
</tr>
<tr>
<td>SELB5</td>
<td>238</td>
<td>110</td>
<td>What additional information do you need to take full advantage of these statements? For each situation, please state whether you would maintain a large margin with the possibility of decreasing the volume, or maintain in a small margin with the possibility of increasing the volume. (ENCIRCLE ONE.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>L S 1. Brand handled is recognized by customers as superior to that of competitors.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>L S 2. Extra services wanted by customers cannot be (or are not) provided by this coop.</td>
</tr>
</tbody>
</table>
|             |                   |               | L S 3. Many other dealers in the trade area have full competitive lines.
3. Continued

<table>
<thead>
<tr>
<th>Item/quest. file var. #</th>
<th>Schedule #</th>
<th>Item or question and code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L S 4. An aggressive sales and merchandising program is maintained.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L S 5. Many expenses are fixed so that total per unit handling costs decrease sharply as volume increases.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L S 6. Increased sales of this line have little value for increasing sales of other lines handled.</td>
</tr>
</tbody>
</table>

SELB5 238 110 What additional information do you need to take full advantage of these statements?

SELB6 240 112 Persons conducting management training sessions often list certain functions of management. What do you consider to be the major functions of management?

4. Scope

SCOA1 245 85 Assuming you have free choice, to whom would you go for advice on an exceptionally difficult business problem?

a. ______ my board
b. ______ associates within my community
c. ______ my assistant manager or other key employees
d. ______ other managers of businesses of this type

SCOA2 119 50 What is the extent to which your employees can influence the goals, methods, and activities of their jobs? How much influence do they have?

a. no influence ...................................................... = 1
b. little influence .................................................. = 2
<table>
<thead>
<tr>
<th>Item/quest.</th>
<th>Anal/ana var.</th>
<th>Schedule</th>
<th>Item or question and code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>c. moderate influence ........................................... = 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>d. a great deal of influence ....................................... = 4</td>
</tr>
<tr>
<td>SCOA3</td>
<td>304</td>
<td>63a</td>
<td>Who <strong>actually</strong> makes the decision on the firing of employees other than the manager?</td>
</tr>
<tr>
<td>SCOA4</td>
<td>307</td>
<td>66a</td>
<td>Who <strong>actually</strong> makes the decision on organizing and coordinating the day's work?</td>
</tr>
<tr>
<td>SCOA5</td>
<td>309</td>
<td>68a</td>
<td>Who <strong>actually</strong> makes the decision on determination of the amount and type of advertising commodities?</td>
</tr>
<tr>
<td>SCOB1</td>
<td>246</td>
<td>B6</td>
<td>Which of the following best describes your action when you have a tough business problem to solve?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>a. _____ sit down and figure it out myself</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. _____ talk it over with my wife or friends</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c. _____ talk it over with some of the key employees</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>d. _____ talk it over with my board of directors</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>e. _____ let it ride for awhile then tackle it fresh later on</td>
</tr>
<tr>
<td>SCOB2</td>
<td>303</td>
<td>62a</td>
<td>Who <strong>actually</strong> makes the decision on whether or not to add or drop a product line?</td>
</tr>
<tr>
<td>SCOB3</td>
<td>306</td>
<td>65a</td>
<td>Who <strong>actually</strong> makes the decision on hiring of a new employee for an existing position other than a manager?</td>
</tr>
<tr>
<td>SCOB4</td>
<td>308</td>
<td>67a</td>
<td>Who <strong>actually</strong> makes the decision on assignment of daily work tasks to employees?</td>
</tr>
</tbody>
</table>
### 4. Continued

<table>
<thead>
<tr>
<th>Item/quest.</th>
<th>Anal file</th>
<th>Sched var.</th>
<th>Item or question and code</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCOB5 310</td>
<td>69a</td>
<td></td>
<td>Who actually makes the decision on when to make repairs or order parts on worn but serviceable equipment?</td>
</tr>
<tr>
<td>SCOB6 520</td>
<td>129e</td>
<td></td>
<td>During the last 18 months, have you attended any of the following with one or more of your directors?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>a. Short courses (and clinics)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Meetings (and clinics)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c. (ISU) Extension Specialists — Personal Visit</td>
</tr>
</tbody>
</table>

### 5. Pervasiveness

| PERVA1 138 | 86       | Do you have an organizational chart? Yes = 1 (GO TO Q.88) No = 0 (GO TO Q.87) |
| PERVA2 169 | 98       | Please indicate whether there is a written policy regarding (total number listed) |
|            | a) vacation time (annual leave) | Yes ______ = 1 No ______ = 0 |
|            | b) sick leave | Yes ______ = 1 No ______ = 0 |
|            | c) evaluation of job performance | Yes ______ = 1 No ______ = 0 |
|            | d) job contracts | Yes ______ = 1 No ______ = 0 |
|            | e) credit policy (for customers) | Yes ______ = 1 No ______ = 0 |
|            | f) objectives (goals) | Yes ______ = 1 No ______ = 0 |
|            | g) plans (short or long run) | Yes ______ = 1 No ______ = 0 |
|            | h) dismissals | Yes ______ = 1 No ______ = 0 |
|            | i) employee-patron relation | Yes ______ = 1 No ______ = 0 |
|            | j) budget | Yes ______ = 1 No ______ = 0 |
|            | k) sales plan | Yes ______ = 1 No ______ = 0 |
### 5. Continued

<table>
<thead>
<tr>
<th>Item/quest. #</th>
<th>Analas file var. #</th>
<th>Schedule #</th>
<th>Item or question and code</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERVA3</td>
<td>179</td>
<td>118</td>
<td>How many departments do you have _____ (No.)? What are they?</td>
</tr>
<tr>
<td>PERVB1</td>
<td>178</td>
<td>117</td>
<td>What are your major product lines?</td>
</tr>
<tr>
<td>PERVB2</td>
<td>191</td>
<td>128</td>
<td>&quot;Very informal&quot; to &quot;Very formal.&quot;</td>
</tr>
<tr>
<td>PERVB3</td>
<td>193</td>
<td>144</td>
<td>To how many local community organizations do you belong?</td>
</tr>
<tr>
<td>PERVB4</td>
<td>228</td>
<td>45</td>
<td>How do you determine the responsibilities and workloads of each of your employees?</td>
</tr>
</tbody>
</table>

### 6. Salience

<table>
<thead>
<tr>
<th>SALA1</th>
<th>121</th>
<th>52</th>
<th>Are you satisfied with your present position when you compare it to similar managerial positions in the state?</th>
</tr>
</thead>
<tbody>
<tr>
<td>SALA2</td>
<td>124</td>
<td>55</td>
<td>Are you satisfied with your present salary?</td>
</tr>
<tr>
<td>SALA3</td>
<td>125</td>
<td>56</td>
<td>Are you satisfied with the amount of time you must devote to your job?</td>
</tr>
<tr>
<td>SALA4</td>
<td>126</td>
<td>57</td>
<td>Are you satisfied with the amount of interest shown by the community in its cooperative?</td>
</tr>
<tr>
<td>Item/quest. #</td>
<td>Anal file var. #</td>
<td>Sched-ule #</td>
<td>Item or question and code</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------</td>
<td>-------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>SALA5</td>
<td>129</td>
<td>60</td>
<td>Are you satisfied with the level of challenge and responsibility you are faced with in your present position? Yes - S No - D 1 2 3 4 5</td>
</tr>
<tr>
<td>SALA6</td>
<td>135</td>
<td>75</td>
<td>The board of this coop does not take the initiative in the areas where they have the responsibility.</td>
</tr>
<tr>
<td>SALA7</td>
<td>158</td>
<td>125</td>
<td>While on the job, to what extent do you feel the employees &quot;think of themselves first&quot; versus &quot;working/thinking of the good of the coop?&quot;</td>
</tr>
<tr>
<td>SALB1</td>
<td>122</td>
<td>53</td>
<td>Are you satisfied with the progress that you are making toward the goals which you set yourself in your present position? Yes - S No - D 1 2 3 4 5</td>
</tr>
<tr>
<td>SALB2</td>
<td>123</td>
<td>54</td>
<td>Are you satisfied that the people of your community give proper recognition to your work as a manager of a cooperative? Yes - S No - D 1 2 3 4 5</td>
</tr>
<tr>
<td>SALB3</td>
<td>127</td>
<td>58</td>
<td>Are you satisfied with your present job when you consider the expectations you had when you took the job? Yes - S No - D 1 2 3 4 5</td>
</tr>
<tr>
<td>SALB4</td>
<td>128</td>
<td>59</td>
<td>Are you satisfied with the work that you do as the manager of a cooperative? Yes - S No - D 1 2 3 4 5</td>
</tr>
<tr>
<td>SALB5</td>
<td>133</td>
<td>73</td>
<td>I wish my board would move more quickly in making decisions so this business could keep up-to-date. Yes - S No - D 1 2 3 4 5</td>
</tr>
</tbody>
</table>
### 6. Continued

<table>
<thead>
<tr>
<th>Item/quest.</th>
<th>Anal file</th>
<th>Sched-var.</th>
<th>#</th>
<th>Item or question and code</th>
</tr>
</thead>
<tbody>
<tr>
<td>SALB6</td>
<td>157</td>
<td>124</td>
<td></td>
<td>To what extent do you feel the employees work here because they like the work and other employees versus working here because the pay is better?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>much more</td>
<td>more</td>
<td>difficult</td>
<td>more because</td>
<td>much more</td>
</tr>
<tr>
<td></td>
<td>because</td>
<td>because</td>
<td>to decide</td>
<td>because they</td>
<td>because they</td>
</tr>
<tr>
<td></td>
<td>the pay</td>
<td>the pay</td>
<td></td>
<td>like other employees</td>
<td>like the work</td>
</tr>
<tr>
<td></td>
<td>better</td>
<td>is better</td>
<td></td>
<td>and other employees</td>
<td>and other employees</td>
</tr>
</tbody>
</table>

### 7. Tension

<table>
<thead>
<tr>
<th>Item</th>
<th>Code</th>
<th>Code</th>
<th>Item or question and code</th>
</tr>
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<tbody>
<tr>
<td>TENA1</td>
<td>505</td>
<td>136b</td>
<td>Degree of difficulty — satisfaction</td>
</tr>
<tr>
<td>TENA2</td>
<td>506</td>
<td>136b</td>
<td>Degree of difficulty — efficiency</td>
</tr>
<tr>
<td>TENA3</td>
<td>509</td>
<td>136c</td>
<td>Amount of pressure — satisfaction</td>
</tr>
<tr>
<td>TENB1</td>
<td>507</td>
<td>136b</td>
<td>Degree of difficulty — productivity</td>
</tr>
<tr>
<td>TENB2</td>
<td>510</td>
<td>136c</td>
<td>Amount of pressure — efficiency</td>
</tr>
<tr>
<td>TENB3</td>
<td>511</td>
<td>136c</td>
<td>Amount of pressure — productivity</td>
</tr>
</tbody>
</table>
8. Adaptive Performance

<table>
<thead>
<tr>
<th>Item/quest.</th>
<th>Anal. file var.</th>
<th>Schedule</th>
<th>Item or question and code</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADPA1</td>
<td>224</td>
<td>11</td>
<td>In making a major decision what steps or processes do you go through?</td>
</tr>
<tr>
<td>ADPA2</td>
<td>223</td>
<td>9</td>
<td>Do you seek any specialized outside help in the operation of this business to help you and the board make decisions and carry them out?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No ........... 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes ........... 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>(IF YES TO QUESTION 9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>What type of specialized help do you use?</td>
</tr>
<tr>
<td>ADPA3</td>
<td>226</td>
<td>16</td>
<td>What factors do you take into consideration in making decisions concerning how your business or organized into departments and functions? (Include decisions such as those concerning functions to be performed and departments to have.)</td>
</tr>
<tr>
<td>ADPA4</td>
<td>227</td>
<td>23</td>
<td>What do you take into consideration in selecting your wholesale sources and outlets?</td>
</tr>
<tr>
<td>ADPA5</td>
<td>095</td>
<td>15</td>
<td>(IF YES TO QUESTION 14): Have you given any consideration to probable future sales trends in your trade area?</td>
</tr>
</tbody>
</table>

Which of the statements on CARD 5 best describes the methods you used?

a. made projections on the basis of personal judgment based on day-to-day knowledge of business potential ............................................. 1
b. worked out potential sales on paper or mentally by using some of the available sales records in my business ............................................. 2
8. Continued

<table>
<thead>
<tr>
<th>Item/ Anal quest.</th>
<th>Anala file</th>
<th>Sched-var. #</th>
<th>Item or question and code</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>c. worked out mentally the potential sales using business records and other available data .......................................................... 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>d. worked out on paper the potential sales using business records and other available data .......................................................... 4</td>
</tr>
<tr>
<td>ADPB1 225</td>
<td></td>
<td>13</td>
<td>Once a major decision to make a change has been made, what are some of the things you would do to insure that the implementation of this decision will be successful? Include planning for change, and planning for the period after the change has been made.</td>
</tr>
<tr>
<td>ADPB2 222</td>
<td></td>
<td>6</td>
<td>Have you ever used the field representatives of wholesale companies to assist you in this business? Include such things as: financial assistance, technical information, rental equipment, resale help, pamphlets and bulletin letin, financing on credit for customers, pricing policy, etc.</td>
</tr>
</tbody>
</table>

No ............ 1
Yes ............ 2

7 (IF YES TO QUESTION 6):

In what way(s) were they of assistance to you?

8 How valuable do you feel this assistance has been?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
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<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
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<tr>
<td>No</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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8. Continued

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<th>Analarchive file var. # Schedule #</th>
<th>Item or question and code</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADPB3 231</td>
<td>24</td>
<td>How do you protect yourself against market price changes on products and supplies in inventory?</td>
</tr>
<tr>
<td>ADPB4 093</td>
<td>12</td>
<td>In making a major decision, which of the statements on CARD 4 best describes the methods you use in evaluating alternatives?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a. rely solely on managerial judgment in making most decisions .......... 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. work out potential profits (expected sales and expenses) but do not have detailed records which can be used as a base .................. 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. work out potential profits (expected sales and expenses) from records mentally ............................................. 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. work out potential profits (expected sales and expenses) from records on paper ................................. 4</td>
</tr>
</tbody>
</table>

9. Salary, Revenue, Saving, and Size

<table>
<thead>
<tr>
<th>Item code</th>
<th>Analarchive code Schedule #</th>
<th>Item or question and code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLRY 073</td>
<td>Arch 93</td>
<td>Manager salary</td>
</tr>
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</table>
9. Continued

<table>
<thead>
<tr>
<th>Item code</th>
<th>Anal/a/</th>
<th>Schedule #</th>
<th>Item or question and code</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>archive #</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Revenue**

- NORA1 074Ana, Total commodity savings 1969
- NORA2 075Ana, Total other income 1969
- NORA3 078Ana, Income-patronage refunds 1969
- NORA 200Ana, Net operating revenue 1969 = (NORA1 + NORA2 - NORA3)/10,000
- NORB1 082Ana, Total commodity savings 1970
- NORB2 083Ana, Total other income 1970
- NORB3 086Ana, Income-patronage refunds 1970
- NORB 201Ana, Net operating revenue 1970 = (NORB1 + NORB2 - NORB3)/10,000
- NORT 202Ana, Average net operating revenue = (NORA + NORB)/2.0

**Saving**

- SVGAl 076Ana, Total expense 1969
- SVG Al 203Ana, Adjusted net savings 1969 = (NORA - SVGAl)/10,000
- SVGB1 084Ana, Total expense 1970
### 9. Continued

<table>
<thead>
<tr>
<th>Item code</th>
<th>Analal/archival #</th>
<th>Schedule #</th>
<th>Item or question and code</th>
</tr>
</thead>
<tbody>
<tr>
<td>SVGB</td>
<td>204Ana</td>
<td></td>
<td>Adjusted net savings 1970 = (NORB - SVGB1)/10,000</td>
</tr>
<tr>
<td>SVGT</td>
<td>205Ana</td>
<td></td>
<td>Adjusted average net savings = (SVGA + SVGB)/2.0</td>
</tr>
<tr>
<td>Size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIZEA1</td>
<td>071Ana</td>
<td></td>
<td>Fixed assets 1969</td>
</tr>
<tr>
<td>SIZEA2</td>
<td>079Ana</td>
<td></td>
<td>Fixed assets 1970</td>
</tr>
<tr>
<td>SIZEA</td>
<td>196Ana</td>
<td></td>
<td>Average fixed assets = (SIZEA1 + SIZEA2)/2,000 and standardized</td>
</tr>
<tr>
<td>SIZEB</td>
<td>069Arch</td>
<td>90</td>
<td>Total number employees (standardized)</td>
</tr>
<tr>
<td>SIZET</td>
<td></td>
<td></td>
<td>(SIZEA + SIZEB)/2.0</td>
</tr>
</tbody>
</table>
APPENDIX B

Variance of Error of Measurement

Consistent to our measurement procedure, \( X_i = \frac{(X_{iA} - X_{iB})}{2.0} \)
where \( i \) refers to all variables except Salary, A and B are the split halves of the variable. It is assumed that

\[
X_{iA} = x_{iA} + u_{iA}
\]

\[
X_{iB} = x_{iB} + u_{iB}
\]

\[
= x_{iA} + c + u_{iB}
\]

\[
X_i = x_i + u_i
\]

\[
u_{iA} + u_{iB} = 2u_i
\]

where: \( X \) is the observed value,
\( x \) is the true value,
\( u \) is the measurement error.

It follows then

\[
\text{Var} \left( \frac{(X_{iA} - X_{iB})}{2.0} \right) = \frac{1}{4} \text{Var}(x_{iA} + u_{iA} - x_{iB} - u_{iB})
\]

\[
= \frac{1}{4} \text{Var}(x_{iA} - x_{iA} - c + u_{iA} - u_{iB})
\]

\[
= \frac{1}{4} \text{Var}(u_{iA} - u_{iB} - c)
\]

\[
= \frac{1}{4} \text{Var}(u_{iA} + u_{iB})
\]
\[ = \frac{1}{4} \text{Var}(2u_i) \]

\[ = 4 \times \frac{1}{4} \text{Var}(u_i) \]

\[ = \text{Var} u_i, \text{ that is the variance of the error of measurement.} \]
APPENDIX C

Path Analysis, or Costner, and Blalock Approach to Measurement Error

Suppose the model is

\[ y_{5t} = \beta_{53} x_{5t} + q_5, \quad t = 1, 2, \ldots, 153 \]

where
- \( y_5 \): Adaptive performance, true value
- \( x_3 \): Selectivity, true value
- \( q_5 \): disturbances,
- \( \beta_{53} \): coefficient, and it is assumed that \( E(x_3e_5) = 0 \).

It is also assumed that

\[
\begin{align*}
X_{3A} &= p_1 x_3 + p u_{3A} u_{3A} \\
X_{3B} &= p_2 x_3 + p u_{3B} u_{3B} \\
Y_{5A} &= p_3 y_5 + p u_{5A} u_{5A} \\
Y_{5B} &= p_4 y_5 + p u_{5B} u_{5B}
\end{align*}
\]

where:
- \( X_{3A} \): Observed value of split half A of Selectivity,
- \( X_{3B} \): Observed value of split half B of Selectivity,
- \( Y_{5A} \): Observed value of split half A of Adaptive Performance,
- \( Y_{5B} \): Observed value of split half B of Adaptive Performance,
- \( p_m (m = 1, 2, 3, 4) \) are path coefficients,
- \( u_{ij} \): error of measurement. (\( i = 3, 5; j = A, B \))

It is assumed that \( E(x_3u_{31}) = E(x_3u_{32}) = E(y_5u_{51}) = E(y_5u_{52}) = 0 \).
The model is diagrammed as the following:

The estimation is proceeded in the following:

\[ r_{X_{3A}X_{3B}} = 0.63995 = p_1p_2, \text{ labelled here as } A, \]
\[ r_{X_{3A}X_{5A}} = 0.44251 = p_1p_3, \text{ labelled as } B, \]
\[ r_{X_{3B}X_{5A}} = 0.35245 = p_1p_4, \text{ labelled as } C, \]
\[ r_{X_{3B}X_{5B}} = 0.47924 = p_2p_3, \text{ labelled as } D, \]
\[ r_{X_{5A}X_{5B}} = 0.42423 = p_2p_4, \text{ labelled as } E, \text{ and} \]
\[ r_{X_{5A}X_{5B}} = 0.50319 = p_3p_4, \text{ labelled as } F. \]

It can be seen that,

\[ p_3/p_4 = D/E = 0.47924/0.42423 = 1.1294838 \]
\[ FD/E = p_3^2 = 1.1294838 \times 0.50319 = 0.568349, \text{ and} \]
\[ p_3(1) = 0.7533865. \text{ But,} \]
\[ p_3/p_4 \text{ is also } B/C = 0.44251/0.35245 = 1.2555256, \]
\[ FB/C = p_3^2 = 1.2555256 \times 0.50319 = 0.6317679, \text{ or} \]
\[ p_3(2) = 0.7948 \]

\[ p_4 \text{ is } F/p_3. \]

Since there are two values of \( p_3 \), there are also two values of \( p_4 \), i.e. 0.6675, and 0.6331, respectively.

By the same procedure \( p_1 \) may be calculated as the square root of \( AC/E = 0.7292 \) and the square root of \( AB/D = 0.7687 \). \( p_2 \) can also be calculated as \( A/p_1 \), found as 0.8777 and 0.8325 for both \( p_1 \) values, respectively.

The two sets of estimator values can be summarized as follows:

<table>
<thead>
<tr>
<th></th>
<th>set 1</th>
<th>set 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>( p_1 )</td>
<td>0.72916</td>
<td>0.76870</td>
</tr>
<tr>
<td>( p_2 )</td>
<td>0.87766</td>
<td>0.83251</td>
</tr>
<tr>
<td>( p_3 )</td>
<td>0.75389</td>
<td>0.79484</td>
</tr>
<tr>
<td>( p_4 )</td>
<td>0.66746</td>
<td>0.63307</td>
</tr>
</tbody>
</table>

Observing the structure of parameters from \( A \) to \( F \), \( c \) can then be calculated in various procedures. Because there are two sets of estimators, then the estimate of \( c \) can be found as:

\[ c = B/p_1p_3 = 0.44251/p_1p_3 = 0.80499 \text{ or } 0.72425, \]

\[ = C/p_1p_4 = 0.35245/p_1p_4 = 0.72418 \text{ or } 0.72425, \]

\[ = D/p_2p_3 = 0.47924/p_2p_3 = 0.72430 \text{ or } 0.72424, \]

\[ = E/p_2p_4 = 0.42423/p_2p_4 = 0.72419 \text{ or } 0.80493. \]

Because there are different values of \( c \), one must be chosen for the estimate. If \( c = 0.7243 \) is chosen, for example, the estimate of \( \beta_{53} \), i.e. \( b_{53path} \) can be found as the following:
The estimate regression equation is

\[ y_5 = 0.7530x_3 + v_5 \]

where \( v_5 \) is vector of residuals.

By utilizing set 2 of the estimators, \( p_{uij} \) can be estimated as

\[ (1 - p_k^2)^{1/2}, \ k = 1, 2, 3, 4, \ i.e. \]

\[ P_{u3A} = (1 - 0.7678^2)^{1/2} = 0.64 \]
\[ P_{u3B} = (1 - 0.8325^2)^{1/2} = 0.55 \]
\[ P_{u5A} = (1 - 0.7948^2)^{1/2} = 0.61 \]
\[ P_{u5B} = (1 - 0.6331^2)^{1/2} = 0.77 \]
Appendix Table 1A. Regression coefficients, standard errors of the coefficients, t-values, and $R^2$ of the Ordinary Least Squares and Errors-in-Variables solution to the postulated theoretical model and the Errors-in-Variables significant relationships.

**Dependent variable:** Scope

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Ordinary Least-Squares</th>
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<tr>
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<tr>
<td>$R^2$</td>
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<td>$F_{n-k}$ for set of coeff. of $x_1, x_2$ is zero</td>
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<td>$F_{151}$; 0.05 table</td>
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<td>$F_{152}$ that $s^2_q$ is zero</td>
<td>1.81</td>
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</table>

$F_{149}$, tabular 0.05 = 1.32, $F_{152}$, tabular 0.05 = 1.32.
Appendix Table 1B. Regression coefficients, standard errors of coefficients, t-values, and $R^2$ of the ordinary Least Squares and Errors-in-Variables solution to the postulated theoretical model and the Errors-in-Variables significant relationships.

**Dependent variable: Scope**

<table>
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<th>Errors-in-Variables</th>
<th>Significant relationships</th>
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</table>

$F_{n-k}^3$ for set of coeff. of $x_1$, $x_2$, $x_3$ is zero = 0.5800

$F_{152}^1$ that $s^2_{qi}$ is zero = 1.80

Two-tailed $t_{0.05; 148} = 1.96$  
$t_{0.10; 148} = 1.65$
Appendix Table 2A. Regression coefficients, standard errors of coefficients, $t$-values, and $R^2$ of the Ordinary Least Squares and Errors-in-Variables solutions to the postulated theoretical model and the Errors-in-Variables significant relationships.

**Dependent variable:** Pervasiveness

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<th>Errors-in-Variables Significant relationships</th>
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<td>$Y_1$ Scope</td>
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<td>Constant</td>
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$R^2$ = 0.2384

$F_{148}^{152}$ that $s^2_{q1}$ is zero: 0.4306

$F_{152}$ that $s^2_{q1}$ is zero: 1.70
### Appendix Table 2b

Regression coefficients, standard errors of coefficients, t-values, and $R^2$ of the Ordinary Least Squares and Errors-in-Variables solutions to the postulated theoretical model and the Errors-in-Variables significant relationships.

**Dependent variable:** Pervasiveness

| Independent variables | Ordinary Least-Squares | Errors-in-Variables
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$R^2 = 0.3181$ for set coeff. of $X_1$, $Y_1$ is zero

$F_{n-k}$ for set coeff. of $X_2$, $Y_1$ is zero: 0.6095

$F_{152}$ that $s_q^2$ is zero: 1.80
Appendix Table 3A. Regression coefficients, standard errors of the coefficients, t-values, and $R^2$ of the Ordinary Least Squares and Errors-in-Variables solution to the postulated theoretical model and the Errors-in-Variables significant relationships. 

Dependent variable: Salience

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<td>Constant</td>
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$R^2$ for set coeff. of $x_3$, $y_1$, $y_2$ is zero

$F_{n-k}$ for set of $y_1$, $y_2$ is zero

$F_{149}$ that $s^2_{q1}$ is zero

$F_{152}$ for set coeff. of $x_3$, $y_1$, $y_2$ is zero

$F_{2n-k}$ for set of $y_1$, $y_2$ is zero
Appendix Table 3B. Regression coefficients, standard errors of the coefficients, t-values, and $R^2$ of the Ordinary Least Squares and Errors-in-Variables solution to the postulated theoretical model and the Errors-in-Variables significant relationships.

**Dependent variable:** Salience

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Appendix Table 4A. Regression coefficients, standard errors of the coefficients, t-values, and $R^2$ of the Ordinary Least Squares and Errors-in-Variables solutions to the postulated theoretical model and the Errors-in-Variables significant relationships.

Dependent variable: Tension

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$R^2$ for set of coeff. of $x_3$, $y_1$, $y_2$ is zero: 0.1009
$R^2$ for set of coeff. of $x_3$, $y_1$, $y_2$ is zero: 0.0624

$F_{n-k}$ for set of coeff. of $x_3$, $y_1$, $y_2$ is zero: 1.8865
$F_{148}$ that $s^2$ is zero: 1.89
Table 4B. Regression coefficients, standard errors of the coefficients, t-values, and \( R^2 \) of the Ordinary Least Squares and Errors-in-Variables solution to the postulated theoretical model and the Errors-in-Variables significant relationships. 

<table>
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<th>Errors-in-Variables</th>
<th>Significant relationships</th>
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\( R^2 \) for set of coeff. of \( x_3, x_4, y_1, y_2 \) is zero: 0.0661

\( F_{4 \text{dof}} \) for set of coeff. of \( x_3, x_4, y_1, y_2 \) is zero: 1.4499

\( F_{147 \text{dof}} \) that \( \sigma_1^2 \) is zero: 1.81
Appendix Table 5A. Regression coefficients, standard errors of the coefficients, t-values, and $R^2$ of the Ordinary Least Squares and Errors-in-Variables solutions to the postulated theoretical model and the Errors-in-Variables significant relationships.  
Dependent variable: Adaptive Performance

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<td>$X_2$ Communication</td>
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$F_{n-k}^4$ for set of coeff. of $x_1$, $x_2$, $y_1$, $y_4$ is zero 3.8477

$F_{n-k}^2$ for set of coeff. of $y_1$, $y_4$ is zero 0.0001
Appendix Table 5A. Continued

<table>
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<tr>
<th>Independent variables</th>
<th>Ordinary Least-Squares</th>
<th>Errors-in-Variables</th>
<th>Theoretical model</th>
<th>Significant relationships</th>
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\[ F_{152}^{145} \text{ that } s^2_{qi} \text{ is zero} \]

\[ F_{152}^{145}, \text{ tabular 0.05 } = 1.32 \]
Appendix Table 5B. Regression coefficients, standard errors of the coefficients, t-values, and R² of the Ordinary Least Squares and Errors-in-Variables solutions to the postulated theoretical model and the Errors-in-Variables significant relationships. Dependendent variable: Adaptive Performance

<table>
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<th>Errors-in-Variables</th>
<th>Errors-in-Variables Significant relationships</th>
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### Appendix Table 5B. Continued

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</table>

F\(_{n-k}^2\) for set of coeff. of \(y_1, y_4\) is zero  
F\(_{144}^1\) that \(s^2_{q1}\) is zero  

\[
\begin{align*}
F_{n-k}^2 & \approx 0.0437 \\
F_{152}^1 & \approx 1.25
\end{align*}
\]
Appendix Table 6A. Regression coefficients, standard errors of the coefficients, t-values, and $R^2$ of the Ordinary Least Squares and Errors-in-Variables solutions to the postulated theoretical model and the Errors-in-Variables significant relationships.

**Dependent variable:** Manager's Salary

<table>
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<td>1.0399</td>
<td>0.5443</td>
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<tr>
<td>$Y_1$ Scope</td>
<td>1.4111</td>
<td>0.5588</td>
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<tr>
<td>$Y_2$ Pervasiveness</td>
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<td>0.4779</td>
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<tr>
<td>$Y_3$ Salience</td>
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<tr>
<td>$Y_4$ Tension</td>
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<tr>
<td>Constant</td>
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$R^2$ for set of coeff. of $X_1$, $X_2$, $X_3$, $Y_4$ is zero: 0.5897

$F_{n-k}^{4}$ for set of coeff. of $X_1$, $X_2$, $X_3$, $Y_4$ is zero: 0.3980

$F_{152}^{145}$ that $s^2_{q1}$ is zero: 1.70
Appendix Table 6B. Regression coefficients, standard errors of the coefficients, t-values, and $R^2$ of the Ordinary Least Squares and Errors-in-Variables solutions to the postulated theoretical model and the Errors-in-Variables significant relationships. Dependent variable: Manager's Salary

<table>
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<tr>
<th>Independent variables</th>
<th>Ordinary Least-Squares</th>
<th>Errors-in-Variables</th>
<th>Theoretical model</th>
<th>Significant relationships</th>
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<tr>
<td>$X_2$ Communication</td>
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<td>0.54</td>
<td>0.1554</td>
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<td>$X_3$ Selectivity</td>
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<td>0.4672</td>
<td>1.77</td>
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<td>$X_4$ Size</td>
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<td>7.32</td>
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<td>$Y_3$ Salience</td>
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<td>$Y_4$ Tension</td>
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<td>$R^2$</td>
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$F^6_{n-k}$ for set of coeff. of $x_1, x_2, x_3, y_1, y_2, y_4$ is zero

$F^4_{144}$ that $s^2$ is zero

$F^{144}_{152}$ that $q_1$ is zero
Appendix Table 7A. Regression coefficients, standard errors of the coefficients, t-values, and $R^2$ of the Ordinary Least Squares and Errors-in-Variables solution to the postulated theoretical model and the Errors-in-Variables significant relationships. Dependent variable: Net Operating Revenue

<table>
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<td>$X_1$ Socialization</td>
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<td>$X_2$ Communication</td>
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<td>$X_3$ Selectivity</td>
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<td>$Y_1$ Scope</td>
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<td>$Y_3$ Salience</td>
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<tr>
<td>$Y_4$ Tension</td>
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<tr>
<td>Constant</td>
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$R^2$ for set of coeff. of $x_1, x_2, x_3, y_4$ is zero $0.7870$

$F_{n-k}^{145}$ that $s^2_q1$ is zero $1.70$
Appendix Table 7B. Regression coefficients, standard errors of the coefficients, t-values, and $R^2$ of the Ordinary Least Squares and Errors-in-Variables solution to the postulated theoretical model and the Errors-in-Variables significant relationships.

Dependent variable: Net Operating Revenue

<table>
<thead>
<tr>
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<th>Errors-in-Variables</th>
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<tr>
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<tr>
<td>Y2 Pervasiveness</td>
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<td>1.0553</td>
</tr>
<tr>
<td>Y3 Salience</td>
<td>0.9611</td>
<td>0.2884</td>
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<tr>
<td>Y4 Tension</td>
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<td>Constant</td>
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<td>$R^2$</td>
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<tr>
<td>$F_{n-k}^{\text{5}}$</td>
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<td>$F_{146}$</td>
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Note: Set of coeff. of $x_1, x_2, x_3, y_1, y_4$ is zero.

Note: That $s^2$ is zero.

Theoretical model

Significant relationships
Appendix Table 7C. Regression coefficients, standard errors of the coefficients, t-values, and $R^2$ of the Ordinary Least Squares and Errors-in-Variables solution to the repostulated statistical model and Errors-in-Variables significant relationships.

**Dependent variable: (Net Operating Revenue/Size)**

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<th>Repostulated model</th>
<th>Significant relationships</th>
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<td>t</td>
<td>b</td>
<td>s.e.</td>
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<tr>
<td>$X_3$ Selectivity</td>
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</tbody>
</table>

- $P_{n-k}$ set of coeff. of $x_1, x_2, x_3, y_1, y_2, y_4$ is zero: 0.0086
- $P_{n-k}$ set of coeff. of $x_1, x_2, y_2, y_4$ is zero: 0.4009
- $P_{145}$ that $s_q^2$ is zero: 1.61
Appendix Table 8A. Regression coefficients, standard errors of the coefficients, t-values, and $R^2$ of the Ordinary Least Squares and Errors-in-Variables solution to the postulated theoretical model and the Errors-in-Variables significant relationships.

Dependent variable: Savings

<table>
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<tr>
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<th></th>
<th>Errors-in-Variables</th>
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<td>t</td>
<td>b</td>
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<td>t</td>
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<td>2.1172</td>
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<td>2.0452</td>
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$R^2 = 0.1627$  
$F^*_{n-k}$ for set of coeff. of $x_1, x_3, y_2, y_4$ is zero  
$0.7931$  
$F^*_{145}$ that $s^2_{q1}$ is zero  
$1.64$
Appendix Table 8B. Regression coefficients, standard errors of the coefficients, t-values, \( R^2 \) of the Ordinary Least Squares and Errors-in-Variables solutions to the postulated theoretical model and the Errors-in-Variables significant relationships.

**Dependent variable: Savings**

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Ordinal Least-Squares</th>
<th>Errors-in-Variables</th>
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\( R^2 \) set of coeff. of \( x_2, x_3, y_1, y_4 \) is zero

\( F_{n-k}^{4} \) that \( s^2 \) is zero

\( F_{152}^{144} \) that \( s^2 \) is zero

\( F_{152}^{144} \) that \( s^2 \) is zero

R² 0.4097 0.6347 0.6388

F₄ₙ₋ₖ set of coeff. of \( x_2, x_3, y_1, y_4 \) is zero

0.7472
APPENDIX E

The distribution of variables on the classification that their EIV regression coefficients are significant or nonsignificant at 10% level, and that the EIV coefficients are greater or less than the Ordinary Least Squares coefficients in absolute values.
<table>
<thead>
<tr>
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<th>( Y_i )</th>
<th>Significant ( b_{eiv} &gt; b_{ols} )</th>
<th>Significant ( b_{eiv} &lt; b_{ols} )</th>
<th>Nonsignificant ( b_{eiv} &gt; b_{ols} )</th>
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<td>-</td>
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<tr>
<td>3A</td>
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<td>( y_1, y_2 )</td>
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<td>( x_2 )</td>
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<td>( x_3, y_4 )</td>
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Recapitulation; number of variables

| 38 | 0 | 40 | 21 |
APPENDIX F

Computation of Errors in Equation and Explained Variance
### Appendix table

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<td>A. Sample total variance</td>
<td>0.1925</td>
<td>0.1925</td>
<td>0.3011</td>
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<tr>
<td>B. Measurement error var.</td>
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<td>0.0627</td>
<td>0.1146</td>
<td>0.1146</td>
<td>0.6581</td>
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<tr>
<td>C. True variance in y</td>
<td>0.1298</td>
<td>0.1298</td>
<td>0.1865</td>
<td>0.1865</td>
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<tr>
<td>D. $s^2_v$ (MSR)</td>
<td>0.1826</td>
<td>0.1584</td>
<td>0.2399</td>
<td>0.2141</td>
<td>3.0353</td>
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<td>E. Summation of $b^2_{isu}$</td>
<td>0.0044</td>
<td>0.0068</td>
<td>0.0191</td>
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<td>F. $s^2_{qi}$</td>
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<td>0.0889</td>
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<td>0.0858</td>
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<td>G. Explained variance in y</td>
<td>0.0143</td>
<td>0.0409</td>
<td>0.0803</td>
<td>0.1007</td>
<td>0.0901</td>
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<td>H. $R^2$</td>
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<td>0.3152</td>
<td>0.4306</td>
<td>0.5402</td>
<td>0.0370</td>
<td>0.0505</td>
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Note: C = A - B; F = D - B - E; G = C - F; H = G/C

### Ordinary Least-Squares

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<thead>
<tr>
<th></th>
<th>1A</th>
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<td>5A</td>
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<td>Y₅</td>
<td>Y₅</td>
<td>Y₆</td>
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<td>0.2825</td>
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<td>B. Measurement error var.</td>
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<td>C. True variance in y</td>
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<td>1.7701</td>
<td>0.1608</td>
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<td>0.0307</td>
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<td>F. $s^2_{qi}$</td>
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<td>0.9824</td>
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<td>0.0341</td>
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<td>0.1524</td>
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<td>H. $R^2$</td>
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<td>0.8095</td>
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<td>0.3931</td>
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Note: C = A - B; F = D - B - E; G = C - F; H = G/C

**Ordinary Least-Squares**

<p>| I. $s^2_{y}$             | 1.7426 | 1.7520 | 0.1541 | 0.1545 | 7.9322 | 5.8219 |
| J. Explained variance    | 0.1199 | 0.0907 | 0.1355 | 0.0907 | 3.5228 | 5.5744 |
| K. $R^2$                 | 0.0648 | 0.0661 | 0.4798 | 0.4821 | 0.3177 | 0.5027 |</p>
<table>
<thead>
<tr>
<th>Appendix table</th>
<th>7A</th>
<th>7B</th>
<th>7C</th>
<th>8A</th>
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<td>6.9117</td>
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Note: $C = A - B$; $F = D - B - E$; $G = C - F$; $H = G/C$.

Ordinary Least-Squares

<table>
<thead>
<tr>
<th></th>
<th>7A</th>
<th>7B</th>
<th>7C</th>
<th>8A</th>
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<tbody>
<tr>
<td>I. $s_v^2$</td>
<td>236.0662</td>
<td>34.7025</td>
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<td>0.8939</td>
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