Chapter-II

PREDICTION OF INDUSTRIAL SICKNESS

The growing incidence of industrial sickness has become a vexing problem in India. An increasing number of industrial undertakings - both in public and private, large and small sectors are falling prey to the malady of sickness. Due to its persistence, owners, financing agencies, employees, government and those who are directly and indirectly associated with the industrial development have been put under severe strain. The major setback is that sickness results in loss of production, capital and employment. Thus, the large scale incidence of sickness in the industry sector have resulted in locking up a colossal amount of money in the sick undertakings. Because of its disastrous impact on the economy, the problem has been uppermost in the minds of planners, entrepreneurs, financiers and the government.

Studies on prediction of corporate sickness in India have so far not made any significant headway. Of late, few studies on corporate sickness prediction have come up. Gupta\(^1\) conducted a study on corporate sickness prediction.

sickness to examine the financial ratios that can indicate the corporate health status. His study revealed that profitability ratios have relatively more potential in predicting the corporate health status. Further, he observed that companies having low or inadequate equity base i.e. reserved strength are more prone to sickness.

Kaveri\(^2\) developed a multiple discriminant model for predicting sickness in small scale industries. His model consists of five variables. They are stock to cost of goods sold, current assets to current liabilities, current assets to net sales, net profit to total capital employed and net worth to total outside liabilities. This study achieved 76 per cent classification accuracy at one year advance to sickness. Bhattacharya\(^3\) developed a model using multiple discriminant analysis in order to identify the different symptoms which can explain the sickness phenomenon and their relative contribution in determining the propensity of sickness. He selected 28 sick and 26 healthy companies for the study. The discriminant function was developed consisting of five variables similar to Altman's Z-score model with minor change in ratio


calculation. The discriminant model classified the sample companies into their respective groups by 80 per cent accuracy at one year prior to sickness. Thus, the studies on prediction of corporate sickness so far conducted in India are inadequate. Therefore, it is a cumbersome task to establish a quantitative standard which can demarcate a sick company from a healthy one. In view of this, a prediction model for identifying corporate health in the Indian context is of crucial importance. Further, a study of this kind would help in identifying potential sick industries so that appropriate measures can be taken for their rehabilitation.

The analysis in this chapter is aimed at the empirical testing of the predictive power of a wide variety of financial ratios. The analysis and interpretation of the empirical results provide many insights into the strengths and weaknesses of different financial ratios and lead to the selection of the best set of ratios to predict sugar industries sickness. The Sugar industries sickness predictive-capability of financial ratios has been judged by applying both the univariate and multivariate techniques.
SAMPLE SELECTION AND DATA COLLECTION:

An attempt was made to identify and organise the information and the sources of data in the following way:

(a) A set of sick sugar industries and matching non-sick sugar industries of U.P. was chosen.

(b) Information in respect of the above identified sugar industries was organised as under:
   i. Size
   ii. Type of unit.
   iii. Industry
   iv. Age

(c) Financial statements of such industries one to eight years prior to the event (i.e. sickness) was collected.

Selection of sick Sugar Industries in U.P.:

The selection of sick Sugar industries for which the financial data could be obtained was the most difficult task of data collection. After discussing the nature of problem with the representatives of several sugar industries, it was decided to take the primary list of sick industries from the Directory of Sugar industries in Uttar Pradesh.
To begin with, those sugar industries that had failed (i.e. reported to have gone into liquidation) during the period under study (2001 to 2009, both years included) were identified in the Directory of Sugar Industries in Uttar Pradesh. The compiled list of sick sugar industries was condensed into a list that satisfied the following four conditions:

1. The Sugar Industry is classified as manufacturing unit.

2. The Sugar Industry reported had gone into liquidation during the period under study (2001 to 2009).

3. The Sugar Industry is a Private unit; and

4. Finally, the availability of financial data of the sugar industry for at least one year prior to sickness.

Sick sugar industry was first tested by the above mentioned four criteria and then included in the final list of initial sample of sick sugar industries.

Collection of Data:

After defining the initial sample groups and selecting sugar industries to be included in the final list for study, the next task was to collect the required data from the annual financial statements of both the
sick and non-sick sugar industries. The financial statements collected were the annual reports of sugar industries in U.P. The data were collected primarily from two sources:

1. Annual Reports of Sugar industries (i.e. Balance Sheets and Profit and Loss Accounts); and

A large proportion of financial data of sick sugar industries for eight years prior to sickness were obtained from the Annual Reports of Sugar industries in U.P.. For some of the financial data of sick sugar industries, various issues of Hand book of Sugar Statistics were also consulted. A large proportion of annual reports of matching non-sick sugar industries were taken from the various issues of Hand book of Sugar Statistics.

The first year before sickness is defined as that year included in the most recent financial statement prior to the date of sickness of a sugar industry. The second year before sickness is the financial year proceeding the first year. The years from third to six prior to sickness are similarly defined.
DEVELOPMENT OF THE MODEL:

Selection of Variables (i.e. Financial Ratios): The emphasis upon financial ratios as predictor/variables does not imply that ratios are the only predictors of sickness. The concern is not with predictors of sickness, but rather with financial ratios as predictors of important event i.e. industrial sickness. Further, the primary concern is not with ratios as a form of presenting financial statement data but rather with the underlying predictive ability of financial statements themselves. The ultimate motivation is to develop a model which can verify empirically the predictability of financial ratios. Financial ratios as predictor variables for the prediction of sickness of a sugar industry are primarily selected on the basis of their exhypothetic capability to indicate the financial soundness or sickness of a sugar industry.

The construction of a model designed to predict the sugar industry's chances of survival or failure involves few specific problems which were classified into two categories:

1. Choosing the variables i.e. financial ratios to be included in the model;
2. (a) Deciding upon the mathematical relationships among the variables; and
(b) Assigning relative weights to the variables.

Three specific questions were raised to answer the above problems:

1. What weights must be attached to the ratio in a certain set of combinations or combinations?
2. What criteria are to be used to choose the variables i.e. financial ratios for the study?
3. Which ratios must be combined together in a specific case i.e. prediction of chances of survival or sickness of a sugar industry?

A list of 36 financial ratios was selected for the construction of a predictive model which were primarily conditioned by the objective of study and the availability of financial statement data which permitted the calculation of financial ratios.

The following guidelines were used to select the 36 ratios from the sets of all possible combinations and permutations of financial statement items:

1. The financial ratios performed well in studies.
   However, these are certain ratios which performed
well in predicting the changes of survival of failure of a sugar industry in recent empirical work, but were not included in this study on account of non-availability of relevant data e.g. Altman's Market Value of Shares/Book Value of Debt; Gupta's EBDIT/TA+Accumulated depreciation.

2. The potential relevancy of ratios for the study.

3. The popularity in the literature i.e. the frequency of appearance of financial ratios in the literature.

4. The ratios defined within the framework of cash flow concept in which the sugar industry has been treated as a reservoir of financial resources and the probability of sickness is described in terms of expected flows of these resources. Within the cash flow framework concept, other things being equal, the probability of sickness sugar industry is smaller:

(a) the larger the reservoir;

(b) the larger the net liquid flow from operations (i.e. cash in flow);

(c) the smaller the amount of debt held; and

(d) the smaller the fund expenditures for operations.
The presence of any one of the criteria was considered a sufficient condition for inclusion of a ratio in the study.

For every set of financial statement available, 36 financial ratios were computed for each of the years and classified under four groups depicting different aspect of sugar industry's operations. Financial ratios used for developing the sickness-prediction model are as under:

I. **Liquidity Ratios**
   
   (a) Liquid Assets to Total Tangible Assets Ratios
   
   \[ V_{19} \text{ Cash to Total Tangible Assets (C/TTA)} \]
   \[ V_{20} \text{ Quick Assets to Total Tangible Assets (QA/TTA)} \]
   \[ V_{21} \text{ Current Assets to Total Tangible Assets (CA/TTA)} \]
   \[ V_{22} \text{ Net Working Capital to Total Tangible Assets (NWC/TTA)} \]

   (b) Liquid Assets to Current Debt Ratios
   
   \[ V_{23} \text{ Cash to Current Liabilities (C/CL)} \]
   \[ V_{24} \text{ Quick Assets to Current Liabilities (QA/CL)} \]
   \[ V_{25} \text{ Current Assets to Current Liabilities (CA/CL)} \]

II. **Profitability Ratios**

   (a) **Cash Flow Ratios**
   
   \[ V_{1} \text{ Cash Flow to Net Sales (CF/NS)} \]
   \[ V_{2} \text{ Cash Flow to Total Tangible Assets (CF/TTA)} \]
   \[ V_{3} \text{ Cash Flow to Net Worth (CF/NW)} \]
   \[ V_{4} \text{ Cash Flow to Total Debt (CF/TD)} \]
(b) **Income Ratios**

- $V_{5}$ Net Income to Net Sales \( \frac{NI}{NS} \)
- $V_{6}$ Net Income to Total Tangible Assets \( \frac{NI}{TTA} \)
- $V_{7}$ Net Income to Net Worth \( \frac{NI}{NW} \)
- $V_{8}$ Net Income to Total Debt \( \frac{NI}{TD} \)
- $V_{9}$ Earning before Interest and Taxes to Total Tangible Assets \( \frac{EBIT}{TTA} \)
- $V_{10}$ Earning before Interest and Taxes to Net Sales \( \frac{EBIT}{NS} \)
- $V_{11}$ Net Operating Profit to Net Sales \( \frac{NOP}{NS} \)
- $V_{12}$ Earning before Interest and Taxes to Interest \( \frac{EBIT}{Int.} \)
- $V_{13}$ Net Income to Net Working Capital \( \frac{NI}{NWC} \)

### III. Turnover Ratios

- $V_{26}$ Net Sales to Debtors \( \frac{NS}{DEBTORS} \)
- $V_{27}$ Net Sales to Inventory \( \frac{NS}{Inv.} \)
- $V_{28}$ Net Sales to Quick Assets \( \frac{NS}{QA} \)
- $V_{29}$ Net Sales to Current Assets \( \frac{NS}{CA} \)
- $V_{30}$ Net Sales to Net Working Capital \( \frac{NS}{NWC} \)
- $V_{31}$ Net Sales to Total Tangible Assets \( \frac{NS}{TTA} \)
- $V_{32}$ Net Sales to Net Worth \( \frac{NS}{NW} \)
- $V_{33}$ Net Sales to Fixed Assets \( \frac{NS}{FA} \)
- $V_{34}$ Cash to Total Operating expenditures (Cash interval ratio)
- $V_{35}$ Defensive Assets to Total operating expenditures \( \frac{Defensive \text{ interval ratio}}{\text{Defensive operating expenditures}} \)
- $V_{36}$ Defensive Assets Minus Current Liabilities to Total Operating interval ratio expenditures
IV. Solvency Ratios

$V_{14}$ Total Tangible Assets to Current Debt (TTA/CD)

$V_{15}$ Total Tangible Assets to Long Term Debt (TTA/LTD)

$V_{16}$ Total Tangible Assets to Total Debt (TTA/TD)

$V_{17}$ Net Worth to Total Debt (NW/TD)

$V_{18}$ Net Worth to Long Term Debt (NW/LTD)

Note: The financial ratios from 1-36 are denoted by $V_1, V_2, V_3, \cdots, V_{36}$.

Analysis and Interpretation of Data

The empirical testing of predictive power of a wide variety of financial ratios have been made in order to get deep insights of their strengths and weaknesses in predicting corporate sickness. The ability of the financial ratios to predict corporate sickness has been judged by applying both the univariate and multivariate techniques.

The Method of Analysis:

The analysis of data is grouped under two heads in order to verify predictive power of financial ratios empirically:

(A) Univariate Analysis

(B) Multivariate Analysis
(A) **UNIVARIATE ANALYSIS**:

The basic object of univariate approach is to compare the financial ratios of sick sugar industries with those of non-sick sugar industries in order to detect systematic differences which might assist in predicting the chances of survival or sickness of a sugar industry or sugar industries. Under univariate approach, each ratio is considered individually for sick sugar industries and non-sick sugar industries. The analytical procedure applied for testing the predictive power of financial ratios on univariate basis is based on:

1. **Comparison of Mean Values of Financial Ratios of Sick Sugar Industries and Non-sick Industries**:

The mean values of financial ratios are computed for the sick sugar industries and non-sick sugar industries in each of the years prior to sickness. The comparison of mean values of ratios for the two groups -- sick group and non-sick group -- is undertaken in order to identify the discriminating power of ratios taken individually. It is not a predictive test. It is merely a convenient approach of sketching the general relationship between the sick and non-sick sugar
industries financial ratios. Student's t-value of each ratio is also computed in order to judge whether the difference between mean values of ratios of the two groups is statistically significant or insignificant.

II. Dichotomous Classification Test:

The dichotomous classification test predicts the sickness of a sugar industry based solely upon a knowledge of financial ratios. It is a simple predictive test measuring the relative differentiating power of various financial ratios. The classification test makes a dichotomous prediction i.e. a sugar industry is either classified into sick group or non-sick group. To make predictions of sickness, the ratios of mixed sample of sick and non-sick sugar industries are arrayed i.e. each ratio is arrayed in ascending order marking the sick sugar industry with (x). The array of each ratio is inspected to find a best cut off point i.e. a point that minimises the percentage of classification error rates. The best cut off point is determined by trial and error process for each array separately. If the ratio of a sugar industry is below the cut off point, sugar industry is classified as sick industry. If the sugar industry's ratio is above the cut off point, it
is classified as a non-sick sugar industry. If there are two cut off points in any array resulting in the same number of misclassification, anyone may be choosen, as our object is limited to the magnitude of classification error only. After classifying each sugar industry either in one of the two groups, the predictions are compared with the actual status of sugar industries in the sample and the percentage of predictive accuracy is computed. The percentage of sugar industries misclassified to the total number of sugar industries in the array is indicative of accuracy of the dichotomous classification test, and is called a misclassification error. The ratio which shows the least percentage of misclassification over a period of six years prior to sickness and the least misclassification at the earliest possible time (i.e. sixth year in our case) has the highest predictive power. This procedure is repeated for each of the 36 ratios.

It should, however, be noted that the univariate approach is a crude technique of predicting the chances of corporate survival or sickness, because each ratio is considered individually and thus, indicates only the individual information value of a ratio. The ratios analysed and presented univariately are susceptible to
faulty interpretations. The main shortcomings of univariate approach, as confirmed by few empirical studies are as under:

(i) The univariate approach ignores the interdependencies among the various ratios over time which may exist on account of (a) some items in financial statements tend to move in the same direction as others, e.g. net income and dividends, sales and market costs; and (b) many ratios have common components e.g. total sales in various activity ratios. If, as the sparse evidence indicates, ratio distributions are substantially correlated over time, then a smaller number of ratios taken together can convey the financial information contained in the financial statements.

(ii) It may result in ambiguous inferences on account of conflicting signals, for instance, sugar industry with poor profitability ratio may be classified as a potentially sick, but, however, the situation may not be considered serious because of its high (i.e. above average) liquidity ratio.

Criticism levelled against univariate approach clearly brings out that financial ratios taken individually cannot provide the sufficient information for understanding the various economic dimensions of a sugar industry. A set of financial ratios may contain more useful information than any particular representative ratio. Therefore, the long list of ratios usually provided to users is substantially redundant.

Keeping in view the shortcomings of univariate approach, an attempt has been made to overcome its shortcomings by the use of multivariate analysis in which several ratios are combined into a model in order to predict the chances of survival or sickness of a sugar industry.

(B) **MULTIVARIATE ANALYSIS**:

Univariate analysis, however, reveals only the differentiating and predictive power of individual ratios. It does not provide any index to classify a company into either sick or healthy group. Therefore, the multivariate analysis has been used to empirically test the predictive power of financial ratios in classifying the observations into a priori groupings. The appropriate statistics followed in this case is the multiple
discriminant analysis. It establishes a linear combination of discriminating variables and determines their respective co-efficients. This coefficients, when applied to actual ratios yield a financial score which gives base for group's classification.

In multivariate analysis, several ratios are considered simultaneously in order to develop an index or a meaningful predictive model. The construction of ratio index amounts to a formulation of a model designed to describe and predict industrial sickness. The formulation of sickness-prediction model involves specific problems which are to be considered:

(a) How should the weights be objectively established?
(b) Which ratios are most important and must be combined together in detecting the event i.e. industrial sickness? and
(c) What weights should be attached to the ratios in a certain combination?

After careful analysis of the nature and purpose of the investigation, statistical techniques known as Factor Analysis and Discriminant Analysis are applied to arrive at the final profile of ratios doing the best overall job together in the prediction of industrial
sickness. With the application of statistical techniques Factor Analysis and Discriminant Analysis - the multivariate problem is actually reduced to a simple univariate problem and assignment of sugar industries between two groups depends upon the value of a single variable. The following steps were taken to arrive at the final best discriminant function and to ascertain its predictive accuracy:

1. Thirty-six variables (i.e. financial ratios) are screened and reduced to a smaller number of important variables having independent direction and uncorrelated with each other by using a statistical technique known as Factor Analysis.

2. Observation of predictive accuracy of various discriminant functions one year prior to the date of sugar industry's sickness.

3. Determination of relative contributions of each independent variable to the total discriminating power of various ratio profiles with the use of scaled vector. The scaled vector is computed by multiplying corresponding variable coefficient by the square roots of the diagonal elements of the variance-covariance matrix.
4. Determination of relative weights to be attached to the variables determined under step 1 with the application of a statistical technique known as Discriminant Analysis.

5. Selecting the final best discriminant function and determining the best cut off point.

The final best discriminant function and the best cut off point is that which results in the least percentage of misclassifications. It is this figure of percentage of classification error which forms the basis of selection of final best discriminant function. The discriminant function which results in the least percentage classification error over a period of six years prior to the date of sickness and the least percentage of misclassification at the earliest possible time (i.e. sixth year) before sickness is selected as the final discriminant function performing the best job among the alternatives which include numerous computer runs analysing different ratio-profiles or discriminant functions.

6. The Discriminant Model is applied on additional samples of sugar industries taken irrespective of size in a homogeneous and non-homogeneous group in
order to test the effectiveness of the model, as the real efficiency of the Discriminant Model lies in classifying those sugar industries correctly which are not used to construct the best discrimination function.

7. Ascertaining the predictive accuracy of various discriminant functions one to six years prior to the date of sugar industry's sickness.

**Statistical techniques applied for model development:**

The statistical techniques which have been applied to analyse data and to build up a predictive model are outlined as under:

(i) **Factor analysis:**

Factor analysis is a statistical technique of analysing a prior set of observations from their inter-correlations to determine whether the variations represented can be accounted for adequately by a number of basic characteristics smaller than that with which the investigation was started. Thus data obtained with a large number of a priori measures may be explained in terms of a smaller number of variables. Factor analysis, for this study, is chosen to reduce the number of variables (i.e. 36 ratios) by describing each linearly
in terms of \( n \) new uncorrelated factors. The factor provides a parsimonious description of the observed data by retaining the most important information contained in the original data. The factor model extracts the maximum variance of the data explainable by the underlying factors that described the structure and pattern of the original variables.\(^5\) The number of factors are determined based on the criteria to extract and rotate factors with eigenvalues equal to or greater than 1. Since the eigenvalues measure the variance accounted for by a factor, this criterion assumes that the factor extracted defines a certain level of variance among the variances. Since the variance of a variable is unity, the cut off rule rejects factors that do not account for at least the variance of one variable. In addition, a minimum loading of 0.40 of a variable on a factor is used as an auxiliary criterion. Hofstede\(^6\) chose a minimum factor load of 0.35, however, Rummel\(^7\) chose a minimum factor load of 0.50. After careful analysis of the nature of problem the factor analysis is chosen as an appropriate statistical technique for this study because


there is evidence to believe that some of the ratios have a high degree of correlation with each other and the factor analysis technique has the advantage of reducing the large number of variables (i.e. 36) to a smaller number of uncorrelated variables which will have the potentiality of conveying a great deal of information. Factor analysis basic assumption, which is found in financial ratios, is that a battery of intercorrelated variables has common factors running through it and that the scores of individual variable can be represented more economically in terms of these reference factors. Secondly, the correlation between variables can be accounted for by the nature and extent of their factor loadings.

(ii) Discriminant Analysis:

The multiple discriminant analysis as an appropriate statistical technique has been chosen after careful consideration of the purpose and need for the present study. As the present analysis involves two groups, i.e. sick and non-sick (unidimensional), the concept multiple is used to refer multivariate nature of analysis.

Discriminant Analysis is a statistical technique that classifies an observation into one of several a priori groupings on the basis of observation's individual characteristics under appropriate assumptions. The basic assumptions of Discriminant Analysis are as under:

(i) The variables are normally distributed;
(ii) The groups are discrete and known; and
(iii) Each observation in each group is described by a set of characteristics or variables.

It is used primarily for classification and/or making prediction in problems where the dependent variable appears in qualitative form e.g. good or bad; sick or non-sick; male or female. Therefore, the first step is to establish the groups explicitly as in this study two groups, namely, sick and non-sick, are established. The number of original groups may be two or more. The purpose of discriminant function is to derive the linear combination of variables which best discriminate between the groups. It attempts to determine the weight to be given to each of the original variables in order that the resulting composite score

will have maximum potentiality for discriminating between the members of the two groups. In this manner, the multivariate problem is actually reduced to a simple univariate problem and the assignment of individuals between two groups depends upon the value of a single variable (i.e. combined score). To begin with, it is assumed that some unknown set of weighting coefficients exists which will define a composite score providing maximum discrimination between the two groups. The classification is done by means of linear discriminant function and the desired discriminant function is, thus, of the form:

\[ y = \lambda_1 v_1 + \lambda_2 v_2 + \lambda_3 v_3 \ldots \lambda_n v_n \]

where \( y \) = the discriminant score

\( \lambda_1, \lambda_2, \lambda_3, \ldots, \lambda_n \) are the discriminant coefficients

\( v_1, v_2, v_3, \ldots, v_n \) are discriminant variables.

The problem is to determine optimal values for the weighting coefficients such that the difference between mean scores for the two groups will be maximised relative to the variation within groups. The function to be maximised, as first defined by R.A. Fisher\(^\text{10}\), is the ratio (i.e. F-ratio) between groups variance to the

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within groups variance. A test to determine the overall discriminating power of the model is the F-value which is the ratio of the sums of squares between groups to the sums of squares within groups. When this ratio of the form is maximised, it has ...

\[ F = \frac{(\bar{y}_{g1} - \bar{y}_{g2})^2}{\frac{1}{n_{g1}} \sum (y_i - \bar{y}_{g1})^2 + \frac{1}{n_{g2}} \sum (y_i - \bar{y}_{g2})^2} \]

where

\[ (\bar{y}_{g1} - \bar{y}_{g2})^2 = \text{sums of the squares of the difference between means of the two groups} \]

\[ \frac{n_{g1}}{\sum (y_i - \bar{y}_{g1})^2} + \frac{n_{g2}}{\sum (y_i - \bar{y}_{g2})^2} = \text{the sums of squares within groups} \]

is maximised, it has the effect of the spreading the group means of Y-scores and simultaneously reducing the dispersion of individual scores around the group means. This test is appropriate because one of the objectives of discriminant analysis is to identify and to utilise these variables which best discriminate between groups and which are most similar within groups.

After careful analysis of the nature of problem and objective of the study, Discriminant Analysis is chosen as an appropriate statistical technique to
classify the sugar industries into one of the groups - sick group and non-sick group. Multiple Discriminant Analysis has been used in a variety of disciplines since its first application in the 1930's by Fisher. More recently this method has been applied in various empirical studies successfully in the area of finance specifically to the financial problems such as consumer credit evaluation and investment classification, classification of high and low price earnings ratio firms, classification of firms into standard investment categories, and prediction of rate of return. It has also been used with proven results for prediction of corporate failure in recent years by Altman, Deakin and Blum.

In the present study, financial ratios are used as discriminant variables and industrial sickness as the predicted or dependent variable. There are only two groups -- sick and non-sick, the analysis, therefore, takes the simplest form i.e. unidimensional. The discriminant analysis determines the discriminant coefficients of a set of variables (i.e. financial ratios) which do the best job of discriminating between sick sugar industries and non-sick sugar industries. When these coefficients are applied to actual ratios, a basis for classification into one of the mutually exclusive groupings exists. The discriminating power of the selected variables (i.e. ratios) profile is expressed by the classification error rates computed by the application of Y-scores and actual placement of the observations.

Discriminant analysis is chosen as an appropriate technique since it has the merit of considering an entire profile of ratios common to the relevant units, as well as the interaction of these properties. A univariate study, on the other hand, can only consider the ratios used for group assignments one at a time. Secondly, it has the merit of yielding a model with a relatively small number of selected variables
(i.e. ratios which have the potential of conveying a great deal of information).

It is assumed for the application of Discriminant Analysis that financial ratios used as discriminatory variables are having normal distribution. This assumption is, however, based upon some of the empirical studies which concluded that financial ratios have normal distribution. Bird and McHugh\textsuperscript{19} found in their study that the distribution of ratios within an unit can be approximated by a normal distribution in most of the cases, although quick asset structure ratios were often substantially non-normal at the significance level of 0.05. Horrigan\textsuperscript{20} has also suggested that financial ratios tend to be approximately normal. Deakin\textsuperscript{21} has also found that with the exception of TD/TA ratio, most of the ratios are normally distributed.

**ACCURACY AND VALIDITY OF THE MODEL**

The predictive accuracy of the discriminant model is ascertained by computing the percentage of

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classification error over a period of six years prior to the date of sickness in the initial sample. The misclassification rates are computed by comparing the predicted results of the discriminant model with the actual status of sugar industries in the initial sample. The predictive accuracy of the model is considered in two dimensions:

Type I - The accuracy of correctly classifying the sick sugar industries; and

Type II - The accuracy of correctly classifying non-sick sugar industries.

A type I error would be predicting a sick sugar industry not to fail and a type II error would be predicting a non-sick sugar industries to fail. Various statistical significance tests such as Student's t-test, the common F-ratio test are conducted in order to judge the reliability of accuracy of the discriminant model. Student's t-test is applied to test the statistical significance of individual discriminating power of ratios and the common F-ratio, which is a transformation of the Mahalanobis measure of distance '$D^2$' is applied to test the statistical significance of the overall discriminating power of the model. '$D^2$' is the Mahalanobis
squares distance between the centroids of the two groups. Statistical significance means that the results at a specified level, say .01 are not obtained by chance alone.

In order to test the validity and effectiveness of the model rigorously, additional samples of sick and non-sick sugar industries were introduced and classification error rates over a period of six years were ascertained by using the parameters of the discriminant model established in the initial sample. The additional samples contain industries from both homogeneous and non-homogeneous group of sugar industries. These samples were taken at random irrespective of size, fiscal year and age of the sugar industry. The importance of additional sample testing (i.e. validation tests) cannot be over-emphasized, since the real efficiency of the discriminant model lies in predicting the chances of survival or sickness of a sugar industry or sugar industries not contained in the initial sample used to develop the parameters of the model.

Probabilities of misclassification of the best cut off point and the probability of individual sugar industry belonging to each group is also computed in order to judge the predictive accuracy and validity of
the discriminant model more rigorously in taking the classification decision between sick and non-sick sugar industries with more confidence particularly in the cases of those individual sugar industries whose discriminant scores lie near the cut off point and are more likely to be placed in the wrong group than those having extremely large or small discriminant scores.

The above analysis leads to conclude that the financial ratios possess predictive power and can predict the potential sugar industries sickness used on univariate basis. But not all ratios predict equally well. There is a relative difference in the predictive power of financial ratios. The cash flow to total tangible assets ratio has the ability to correctly classify both the sick and non-sick sugar industries to a much greater extent throughout the six year period before sickness than would be possible through random prediction. However, the predictive power of liquidity ratios is much lower. Secondly, the net cash flow supplied to the reservoir is the most crucial factor, while the size of the reservoir is the least important factor in detecting the potential sugar industries sickness.

The present study as a whole is a fact finding research on the prediction of sickness in the sugar
Industries of Uttar Pradesh. In the course of the study as far as six years prior to the event (sickness) have been predicted through univariate analysis and multivariate analysis. Under univariate analysis the financial ratios have clearly demonstrated their power to differentiate the sick sugar industries from non-sick sugar industries. Further, their predictive power in providing early signals of sickness is also established. Amongst the selected financial ratios, net income to net working capital ratio is found to have high predictive power followed by net income to total liabilities ratio. Under univariate analysis, the study also established that profitability ratios have relatively better predicting ability than other ratio groups. Moreover, the study clearly indicates that not all financial ratios predict equally well. On the basis of the classification error of profitability and solvency ratios, the study establishes a high and positive association between the incidence of sickness and heavy reliance of debt. In the multivariate analysis, the ratios namely, cash flow to total liabilities, net income to total liabilities, total liabilities to total assets, net working capital to total assets, quick assets to current liabilities and net worth to net sales are found
aptly important for the development of discriminant model. Within these six financial ratios, cash flow to total liabilities ratio has got maximum contribution in discriminating the group observations.

The Indian Sugar Mills Association, while formulating their policies can use the model to predict the sickness at relatively high degree of accuracy and avert the incoming possible disaster. Moreover, the study has its own importance for the government, the financial institutions, the management, the Universities and the research Organisations. The Government can use findings of the study for major policy decisions like, mergers, takeover, etc. The financial institutions while formulating their investment policies and taking up cases for reorganisation can use the findings of this study and investment be made on the basis of the financial score of such industries. The management can use the findings of the study to remove the laxities in various functional areas. Further, the present study is streamlined under the basic idea of financial ratios as predictor variables and if used cautiously can predict the corporate health status quite ahead. Again, the range and the cut off point are the basic parameters which can suggest the Sugar industry's position, e.g.,
whether sick or tending towards sickness or healthy one. In this regard, the trend of financial scores can show the movement in which the sugar industry health status goes on.

Despite its importance to various users of financial informations, the study is not free from limitations. The size of the sample selected for the study is restricted. There are some Statistical Shortcomings do exist in the study. The statistical tools like t-test, F-test and measures of dispersion used for the analysis and interpretation have their own limitations.

The multivariate analysis applied to the study is based on the assumption that discriminating variables have multivariate normal distribution and they have equal variance-covariance within each group. But there is hardly any point that can fully support the normalcy of the multivariate distribution. Thus, the users of the findings of the study should be careful and use the same judiciously so that it can at lease check the malady and conserve the scarce resources of U.P.