

CHAPTER V

SUMMARY AND CONCLUSIONS

Industrialisation in the modern age is held as a synonym for economic development. Though a strong case has been built in favour of industrialisation, it is not a smooth task in India. The process of industrialisation gets confronted with a number of barriers.

During the last three decades, the mounting industrial sickness in India has assumed unmanageable proportions. India has been witnessing a spurt in the number of sick units as well as in the total outstanding bank credit locked up due to their sickness. The annual growth rate of the number of sick units and the outstanding bank credit locked in these units was much higher than the overall industrial growth rate. However, the intensity of the industrial sickness was more grim in the large and medium industrial sector with nearly 83 percent of the outstanding bank credit locked up in the sick units of this sector.

The common adverse effects of such sickness have been, locking up of financial resources, wastage of capital, loss of production and fall in employment. Thus more than being a problem, industrial sickness has been an obstacle for the economic development of the country.

Industrial sickness in India thus requires a comprehensive redressal, since it does not occur overnight but develops gradually

overtime. Therefore it calls for an efficient framework for an early forewarning sickness prediction system, for which an objective analysis of the units' financial condition over a period is required.

In the last three decades considerable research has been done to suggest that financial ratios can be used to predict industrial sickness with greater reliability, as they are considered to be the diagnostic indicators of the health of a business. Prediction of industrial sickness has gained wider acceptance in many studies, although the financial ratios used in the models were varied.

However, most of the earlier models on the prediction of industrial sickness were beset with certain defects, which adversely affected the accuracy of prediction results. The previous studies concentrated on only a few ratios selected according to an appropriate choice based criteria.

Further, the selection of the sick and the non-sick companies was based on a paired design sample. Most of the earlier studies, applied only an isolated data pertaining to the different financial years prior to the year of sickness and they were treated independently in the models.

The current study tried to remove the defects of the earlier studies, by applying Principal Component Analysis as a significant technique in the prediction of Industrial sickness and by analyzing and comparing the performance of a statistical and a soft computing prediction models with principal components of the financial ratios as their inputs. The statistical

model employed the Multiple Discriminant Analysis as its classifier and the Soft Computing Model employed an Evolutionary Neural Network as its classifier.

The basic *objectives* of the study are:

- (i) To estimate the principal components of the financial ratios and choose the appropriate principal components as inputs for the prediction models;
- (ii) To examine the validity of the statistical prediction model (PCA-MDA model) in predicting the industrial sickness;
- (iii) To analyse the validity of the soft-computing prediction model (PCA-ENN model) in the prediction of industrial sickness;
- (iv) To test the predictive power of the statistical and the soft computing prediction models on an out of sample period dataset and
- (v) To recommend a reliable and an authentic industrial sickness prediction model

The study is confined only to large and medium scale industries. Ten industrial categories of steel, automobiles, chemicals, textiles, cement, fertilizer, sugar, tea, rubber tyres, food and consumer products were chosen. The study focused on the financial year 2000-01, when there was a severe setback in the industrial growth rate. Large and medium companies which had reported to have gone into sickness as

per the Reserve Bank of India declaration and whose financial data for at least three years prior to sickness was available were alone selected for the sample of sick companies. Thereby 34 sick companies were identified in the ten industrial categories. Non-sick companies were selected independent of the industry category and size but of the same financial year and whose three-year financial data prior to the year of sickness were available. Based on the above criteria 38 non-sick companies were chosen.

The required data for the study were obtained from the various issues of the Reports on Currency and Finance by the Reserve Bank of India, New Delhi and websites on Indian investments and industrial performance data (www.indiainfoline.com and www.indiastat.com). Twenty one financial ratios comprising of eleven turnover ratios, three liquidity ratios, four solvency ratios and three profitability ratios were estimated. The study applied the technique of Principal Component Analysis as an initial step to derive the principal components of the original financial ratios and then choose the appropriate principal components to be retained for the model, as per the Kaiser's criterion, where only those principal components whose eigen values greater than one were retained. The software IDL Version 5.0 was used to estimate and choose the appropriate principal components. These

chosen principal components were used as inputs in both the statistical PCA-MDA and the soft computing PCA-ENN models.

Both the models had two phases-*the learning phase* where the predictive capabilities of the models were determined and *the testing phase* where the predictive capabilities of the models were tested.

The *learning phase* of the two models was trained over the isolated database which comprised of the financial data (twenty one ratios) of the 72 companies (34 sick and 38 non-sick) considered independently as one, two and three years prior to the year of sickness and the non-isolated database constituting the financial data of the 72 companies over a period. With the observation period chosen as three years, the study employed datasets pertaining to year1, year1 and 2 taken together and year1, 2 and 3 considered together.

The *testing phase* involved two test sets, out of which one included the within the sample datasets pertaining to 72 companies of the financial year 1999-2000 only, termed as ex post sample for validation test and the other test set which included the out of sample period dataset pertaining to 13 companies (7 sick and 6 non-sick) for the financial year 2000-01 only, termed as the ex ante sample for forecast test.

The study formulated the following *hypotheses*

- (i) There is no significant difference in the predictive accuracy of the PCA-MDA isolated and non-isolated models in the prediction of industrial sickness.
- (ii) There is no significant difference in the predictive accuracy of the PCA-ENN isolated and non-isolated models in predicting industrial sickness.
- (iii) There is no significant difference in the predictive accuracy of the PCA-MDA and the PCA-ENN models in accurately predicting industrial sickness.

The PCA-MDA model developed with respect to the first hypothesis in its learning phase applied the chosen principal components as inputs, to estimate the coefficients of the MDA component of the model, pertaining to both the isolated and non-isolated database, in predicting sick and non-sick companies. The software IDL Ver 5.0 was used to acquire the results.

The PCA-ENN model developed with respect to the second hypothesis in its learning phase applied the same principal components chosen for the PCA-MDA model, as inputs. With the configuration of the network comprising of the input layer (chosen principal components), the hidden layer (15) and the output layer (i.e. sick or non-sick) the results were estimated, pertaining to both the isolated and non-isolated database

in predicting the sick and non-sick companies. The software Salford C was applied to calculate the results.

In the succeeding testing phase, both the models PCA-MDA and the PCA-ENN, were tested using the *expost* and *exante* sample datasets for their predictive accuracy in classifying the sick and the non-sick companies. A classifier accuracy test (Z test) was applied to test the significance of the prediction results. Both the hypothesis were then tested at 95 percent level of confidence applying the test of significance of differences in the means of two samples. While the test of significance of large samples was applied to the *expost* sample data, the test of significance of small samples was used for the *exante* sample dataset.

Ultimately, in relation to the third hypothesis the PCA-MDA model was compared with the PCA-ENN model, pertaining to both the isolated and the non isolated data base of the two models and with respect to the *expost* and *exante* samples datasets, to find out which model was more reliable and authentic in accurately identifying sick and non-sick companies upto three years prior to sickness. The hypothesis was also tested at 95 percent level of confidence applying the tests of significance of differences in means of two samples.

The *major findings* of the study are as follows

- (i) The PCA-MDA *isolated model* applied to the *expost sample* showed a predictive accuracy of 85.29 percent, 91.17 percent

and 88.23 percent pertaining to sick companies and 86.84 percent, 78.94 percent and 71.05 percent for non-sick companies respectively in year 1, year 2 and year 3 prior to the year of sickness. Even in the *ex ante sample* dataset, the predictive ability was 100 percent, 85.71 percent and 100 percent in the case of sick companies and 83.30 percent, 100 percent and 100 percent in the case of non-sick companies respectively in the three consecutive years prior to sickness.

(ii) The PCA-MDA *non-isolated model* tested on the *expost sample* dataset revealed the predictive accuracy of 85.29 percent, 88.23 percent and 91.17 percent for sick companies respectively in the three observation periods prior to the year of sickness namely year 1, year 1 and 2 taken together and year1, 2 and 3 considered together, it was correspondently 86.84 percent, 86.84 percent and 84.21 percent in the case of non-sick companies. Similarly the *ex ante sample* exhibited a predictive accuracy of 100 percent in the all the three periods of observation, with respect to sick companies while it was correspondingly 83.30 percent, 100 percent and 100 percent pertaining to the non-sick companies.

(iii) The PCA-ENN *isolated model* applied to the *expost sample* dataset, depicted that the predictive ability of the model to

classify sick companies accurately was 82.35 percent, 91.17 percent and 76.47 percent respectively in year 1, year 2 and year 3 prior to the year of sickness, while it was only 78.94 percent, 76.31 percent and 86.84 percent respectively in the corresponding three years, pertaining to non-sick companies. The *ex ante sample* also exhibited similar results. While the classification accuracy of the model was 100 percent, 100 percent and 85.71 percent in the case of sick companies, it was only 66.66 percent, 83.33 percent and 83.33 percent for the non sick companies respectively in year 1, year 2 and year 3 prior to the year of sickness.

- (iv) The PCA-ENN *non-isolated* model applied to the *ex post sample* test data, exhibited a predictive accuracy of 82.35 percent, 88.23 percent and 88.23 percent respectively in the three observation periods of year 1, year1 and 2 taken together and year 1,2 and 3 considered together pertaining to the sick companies, it was only 78.94 percent, 68.42 percent and 84.21 percent respectively in the corresponding observation periods, with respect to non-sick companies. Similarly in the case of *ex ante sample* dataset, the model depicted a predictive accuracy of 100 percent in the all the three consecutive periods, with respect to sick companies while it was correspondingly only

66.66 percent, 83.33 percent and 83.33 percent, pertaining to the non-sick companies.

(v) The PCA-MDA *isolated and non-isolated* dataset models classified the sick and non-sick companies with equal level of confidence. This was found both in the case of the expost and exante sample datasets.

(vi) The PCA-ENN *isolated and non-isolated* dataset models also identified the sick and non-sick companies with the same level of confidence, both in the expost and exante sample datasets.

The above findings proved that inclusion of the PCA in the predictive models has resulted in *predictions which are not influenced by the nature of the database, be it isolated or non-isolated.*

(vii) The PCA-MDA model exhibited a better predictive ability to classify sick and non-sick companies compared to the PCA-ENN model both in the expost and exante sample datasets, for the *isolated database.*

(viii) Similarly the PCA-MDA model exhibited a better performance than the PCA-ENN model in accurately identifying the sick and non-sick companies both in the expost and exante sample datasets for the *non-isolated database.*

Conclusion:

The Principal Component Analysis is a robust technique for inclusion in the prediction models of industrial sickness. The application of principal components of financial ratios as inputs to the models, rather than the ratios themselves, has resulted in consistent prediction results irrespective of the nature of the learning datasets, viz isolated and non-isolated.

A comparison of the two models PCA-MDA and the PCA-ENN revealed that the PCA-MDA model was more accurate in predicting sick and non-sick companies even three years prior to sickness.

Recommendations:

(i) Industrial sickness in large industrial units is an industry-specific problem. Official yardsticks for identifying them are based on cash loss and on network erosion. These have undesirable effect of delaying the identification of sick units making them turn non-viable and so non eligible for any rehabilitation package. So industries should adhere to early detection of sickness and prevent them.

(ii) Once an industrial unit is identified as sick, a viability study should be conducted to assess whether the unit can be revived or rehabilitated within a reasonable period.

(iii) Greater exposure to competition forces companies drastically to restructure their ways of business. All precautions should be taken to avoid sickness by carefully evaluating their financial parameters.

(iv) A firm identified as sick should exercise a strict control over its cost particularly over its discretionary expenses. A zero- base review of all the discretionary expenses may be undertaken to eliminate programmes and activities, which are a drain on the finances of the firm and

(v) The industrial units, which are predicted, to go into sickness over a period should meticulously examine and streamline their operations, namely the manufacturing, purchasing and selling operations. Value engineering, standardization, simplification, cost-benefit analysis and other approaches should be exploited fully to improve the efficiency of the operations.

Scope for future research:

(i) A study on prediction models applying hybrid neural network models and modern statistical techniques like logit and probit analysis can be designed.

(ii) A comparative study of the prediction models of industrial sickness in India with other countries of the World can be formulated.

(iii) The extent of sickness in the different industrial groups or in the different industrial regions can be compared.
