CHAPTER 3

THE THEORETICAL FRAMEWORK FOR MODEL DEVELOPMENT

3.1 INTRODUCTION

This chapter discusses the purpose of developing prediction models, the various statistical models that can be used for the purpose and the rationale behind the choice of logistic regression model for our study.

3.2 PURPOSE OF DEVELOPING PREDICTING TAKEOVER MODELS

Most studies that incorporate a range of firm characteristics are conducted on targets, mainly with the aim of predicting potential targets for acquisition. These studies have used mainly the categorical classification methods of multiple discriminant analysis, the logit model or the probit model. The prediction of markets in advance of the market is done for the purpose of developing investment strategies to earn abnormal returns. Studies of price movements around the takeover announcements have found that targets capture most of the gains of the takeover. Dodd and Ruback (1977) and Asquith (1983) have found that price movements signalling acquisition occur 30 to 40 days before the announcement and so, the predictive accuracy in advance of the market would allow abnormal
returns to be earned. Wansley and Lane (1983) demonstrated that using predictions from an MDA model based on historical data, abnormal returns can be made. However, Palepu (1986) found evidence to the contrary. He concluded that it is difficult to predict takeover targets and prediction accuracies reported by the earlier studies were overstated. He attributes this to methodological flaws such as the use of non-random equal share samples and use of arbitrary cut of probabilities.

Barnes (1990) says that three factors affect the predictive ability: (i) the strict statistical assumptions on which the estimating procedures are used, (ii) further statistical implications arising from the way in which sample is chosen and the predictive ability of the model which includes, the stability over time. One key assumption is multi-variate normality. Industry relative ratios obtained by dividing a firm’s ratio by industry average ratio may solve this problem. If this problem is addressed, the MDA model will be an optimum classification model. One way to address the problem of stability is to estimate industry specific models. This suggestion provides the rationale for industry specific prediction models.
3.3 TYPES OF MODELS USED FOR CONSTRUCTING TAKEOVER PREDICTION MODELS

Four types models have been used for predicting the likelihood of a company being taken over. They are:

- Multiple discriminant analysis
- Probit models
- Logistic models
- Artificial neural networks

3.3.1 Multiple Discriminant Analysis

Usually, the statistical technique of multiple discriminant analysis (MDA) has been used in order to estimate a linear model that best discriminates between two groups of population in terms of their distinguishing financial characteristics.

Multiple discriminant analysis involves finding the values of the coefficients of a linear function of the form

\[ Z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n \]

Where \( X_j \) is the jth independent variable, \( \beta_j \) is the jth independent variable, and \( Z \) is the discriminant score that maximizes the distinction between the two groups. A given firm will be classified as a takeover target if \( Z > Z_c \) (the critical \( Z \)), and it will be classified as non-target if \( Z \leq Z_c \). Alternatively, a given firm may be classified as
target or non-target based on its posterior (conditional) probability of takeover, i.e., the. This approach is consistent with the logit and probit models, as discussed below.

The study by Singh (1975) looked at then characteristics and efficiency differences (as measured by the economic and financial variables) between bidder and target firms to explain the UK takeover process of the late 1960s. The study used discriminant analysis to discriminate between the buyer and target firms using the financial variables of profitability, change in profitability, growth, liquidity, gearing, retention ratio and size. The discriminant function developed in the study was able to correctly classify 83% of the firms. The most important discriminator between the bidder firm and the target firm was size, followed by change in profitability and profit level. The study provides support to the managerial discipline theory that managers concentrate more on size than profitability.

Wansley (1984) used twelve discriminant models to test the sensitivity of MDA to variable selection. Twenty variables were used to represent ten dimensions. These variables and dimensions were chosen from past studies. Some variables which had not been previously studies were also included. Forty-four firms that merged in 1975 and 1976 were selected. Twelve different samples of 44
firms that remained unmerged in 1982 were selected and matched on financial year end in the same reporting period. The study examined different linear discriminant models used in merger studies to determine whether the classification accuracy and selection of variable differ depending on the model used. Wnasley concluded that discriminant analysis results should be viewed cautiously when the sample is small and a sound theoretical basis for including variables is not present. His results provide a sound basis for using a large sample and logit and probit analysis when the dependent variable is binary.

The study by Simkowitz and Monroe (1984) uses operational and financial information to identify firms with a high probability of being taken over. They used stepwise multiple discriminant analysis to discriminate target firms from non-target firms. They found that firms that have low price-earnings ratio, low dividend-pay out ratio, low growth rate, low sales, loss carry forward and high market activity have a high probability of being acquired. Of the sample firms, 82.6 % of the targets and 72% of the non-targets were correctly classified. For the hold-out sample, the model correctly predicted 64% of targets and 61% of the non-targets. The t-tests showed high predictive power for both the analysis group and the holdout sample. However, the researchers cautioned that future
research should utilize holdout samples from time periods other than the one used to build the model and should normalize the data by industry.

Kaur (2002) used multivariate discriminant analysis to test a model to classify firms into targets and non-targets in the Indian context. The discriminating variables in the classification test were modified net profit margin or operating margin, in other words, earnings before interest and taxes (EBIT) divided by sales, return on capital employed (ROCE), debt equity ratio, assets turnover ratio, current ratio, cash flow to sales, enterprise value (EV) divided by earnings before interest, taxes, depreciation and amortization (EBITDA) and market price to book value. The model was able to discriminate correctly to the tune of 62.2 per cent.

### 3.3.2 Logit Models

Logit model is another popular prediction model. A logit model predicts the posterior probability of takeover. The model is based on the cumulative logistic probability function. Specifically,

$$Z_i = \log \left( \frac{P_i}{1 - P_i} \right) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_n X_{ni}$$

and

$$P_i = F(Z_i) = \frac{1}{1 + e^{-Z_i}}$$

where $\log$ is the natural logarithm, $P_i$ is the probability that firm $i$ will be taken over, $X_j$ is the $j$th independent variable, and $\beta_j$ is
the coefficient of the jth independent variable. The coefficients measure the effect on the odds of takeover of a unit change in the corresponding independent variables.

Target prediction studies using the logit model include Detrich and Sorenson (1984) and Palepu (1986). Detrich and Sorenson used a sample of 30 targets and matched pair of 60 non-target firms in a five year period of 1969 to 1973 from four industries. They found the following variables to be significant: pay-out ratio, asset turnover, market value of equity and trading volume. 93% of the target firms were correctly identified. The predictive power of the model was confirmed using a holdout sample. 93% of the targets were correctly identified. However, the study was confined to four industries. Generalising the results to industries other than the ones represented in the study would be difficult.

Palepu (1986) used the logit model to predict target firms. He used an optimal cut off probability instead of the arbitrary cut-off probability of 0.5 as in other studies. He developed four models using different combinations of the nine variables, namely, CAR, return on equity, growth, liquidity, leverage, industry dummy, size, market to book value ratio and price-earnings ratio. These variables represented each of the six hypotheses which finance literature suggests as reasons
for firms becoming merger targets. These six dimensions are inefficient management, growth-resources imbalance, industry disturbance, firm size, asset undervaluation and price earnings ratio. The estimated model was found to be statistically significant but the explanatory power was small. 80% of the targets and only 44.7% of the non-target firms were correctly classified.

Mat-Nor and S.Hussin (1997) employed the logit model using variables similar to the ones used by Palepu to predict Malaysian target firms. They used seven exploratory variables, namely, size, return on equity, average sales growth, price-earnings ratio, dividend payout, leverage and liquidity. They studied a sample of 34 target firms and randomly selected non-target firms. The results indicated that a firm is likely to be target when growth, leverage, liquidity, size and return on equity are low and dividend pay-out and P/E are high. However, only the size variable that was negative was found to be significant indicating that the smaller the size, the more is the likelihood of being acquired. The likelihood ratio index, which measures the model’s explanatory power, stood at 75.89 and the model was able to correctly predict target firms with about 94% accuracy. The holdout sample consisting of 3 targets and 15 non-targets was correctly predicted at 83.3%.
Meador, Church and Rayburn (1996) used binary logit model to determine the factors which predict merger and acquisition target companies for the total sample of 160 US firms and the horizontal and vertical sub-samples of merged companies. The model for horizontal acquisitions showed the strongest predictive ability with the variables long-term debt/total assets, long-term debt/market value, market value/book value, asset growth and sales growth showing significance.

Zanakis and Zopoundis (1997) used samples from Greece and developed linear and quadratic discriminant analysis as well as logit models with factor analysis input. Prediction results were mixed. Most models correctly classified a significant proportion of acquired or non-acquired firms, but not both. The only model that provided significantly correct predictions for both acquired and non-acquired firms in either the calibration or holdout sample was a linear discriminant function with six financial ratios, namely, long-term debt and current liabilities/working capital one-year prior to takeover, long-term debt and current liabilities/cash flow one-year prior to takeover, long-term debt and current liabilities/working capital two years prior to takeover, inventory/working capital two years prior to takeover, earnings/total assets three years prior to takeover and current assets/current liabilities three years prior to takeover. Its classification accuracy was 70%, 65% and 67.5% for the acquired, non-acquired firms and
overall respectively in the calibration sample, all significant at the 95% confidence level. Its corresponding predictive abilities in the holdout sample were 66.5%, 62% and 64.3% respectively—all significantly better than by chance.

The study by Cudd and Duggal (2000) replicates the study by Palepu and explores the importance of capturing industry-specific distributional characteristics in analyses that are based on financial ratios. Their study made adjustments for industry-specific distributional characteristics and the results were consistent with four acquisition hypotheses, namely size, inefficient management, growth resources mismatch and industry disturbance hypotheses.

Espabhodi and Espabhodi (2003) compared the ability of four different classification models (logit, probit, discriminant and recursive positioning models) in predicting corporate takeovers. The original classification accuracy and the validation test results indicate that the recursive partitioning model outperforms the other models (although its accuracy drops significantly in the validation test). The results also indicate the difficulty in predicting corporate takeovers.

Alcalde and Espitia (2003) analysed the characteristics presented by Spanish firms that have been the subject of takeover bids that allow them to be
differentiated from other firms. They used a sample made-up of 69 non-financial firms that were the subject of takeover bids in Spain during the period 1991–1997, together with a further 69, selected randomly on an industrial and time basis, that were not. The results showed that the firms that were subject to a takeover bid were not, in general, characterised by having lower profitability or a worse market valuation than other firms operating in the same sector. By contrast, certain variables that exerted an influence over the cost of the transaction, such as the size and the ownership structure of the firm, did appear to play a relevant role in the selection of the target on the part of the bidding firm.

Dhayanithy and Vasudevan (2004) applied the logit model to predict corporate takeovers. This model was used by them to categorize the sample firms into takeover targets and non-takeover targets with an accuracy of 92.4 per cent.

Iliopoulos, Georgopoulos and Tsagkanos (2006), using a logit model, have conducted a study in a small open economy like Greece. They find age, size and productivity emerging as significant determinant variables of target firms in a merger, as compared to financial and performance variables. Their results indicate that bidders prefer mature targets with large size and high productivity. Other financial variables were of limited importance in explaining takeover activity. These findings concerning firm size are in broad agreement with the findings of
Chatterjee (2000) who found that companies in the UK acquire large targets. In the Greek economy, large firm size becomes a crucial parameter in acquiring large market share and sales networks. This contrasts with the results of Singh (1971, 1975) and Kuehn (1975) in UK and that of Alcade and Espitia (2003) in Spain and Palepu (1986) in the USA who all suggest that the likelihood of takeover decreases with the size of the target firm.

3.2.3 Probit Models

The probit model is similar in form to logit, but it based on the cumulative normal probability function specifically, and

\[ P_i = F(Z_i) = \]

Where \( P_i \) is the probability that firm \( i \) will be taken over, which is equivalent to the probability that a standard normal random variable will be less that or equal to \( Z_i \), and

Harris, Stewart, Gulkey and Carleton (1982) used probit models on financial and product market variables to study the likelihood of a firm being a target. Their results show that size and size have strong negative effects on the probability of acquisition.
Pastena and Ruland (1986) studied the decision to merge as an alternative to bankruptcy. Probit analysis was used to test the importance of three variables in explaining the merger /bankruptcy decision. These variables were revenues, financial leverage and the magnitude of tax carry forwards. Results showed size and leverage as important variables because the larger firms with lower financial leverage tended to merge to avoid bankruptcy. Firms with higher owner control also tended to merge to avoid bankruptcy. Pastena and Ruland suggest that the self-interest of managers motivates the choice between merger and bankruptcy.

3.2.4 Artificial Neural Networks


3.3 SELECTION OF THE MODEL

Discriminant analysis is a statistical technique which allows the researcher to study the differences between two or more groups of objects with respect to
several variables simultaneously. Logistics regression analysis has been used to investigate the relationship between binary or ordinal response probability and explanatory variables. The Logistics regression model, a nonlinear model, is one of the prediction techniques with few assumptions and the dependent variable is a binary variable.

However several authors modelled the mergers and acquisitions through models like MDA, Logit and Probit analysis. Simkowitz and Monroe (1971), Stevens (1973), Rege (1984) and Barnes (1990) used Multiple Discriminant Analysis in their studies; Probit Models were used by Harris (1982) and Pastena and Ruland (1986). Discriminant analysis requires data to have multivariate normal distribution and the dispersion matrices of the groups to be equal. Neter and Wasserman (1974) state “both theoretical and empirical considerations suggest that when the dependent variable is binary, the underlying relationship is frequently curvilinear.” In logit analysis, no assumptions need be made about the prior probability that the firm belongs to a specific group, and the assumptions of normal distribution and the equality of variances and co variances across groups are less critical.

Thus, many researchers used Logistic Regression analysis at later years in modelling the mergers and acquisitions scenarios. Dietrich and Sorenson (1984),
Megginson (1992), Cudd and Duggal (2000), Sorenson (2000) and Panigrahi (2004) are few research works, that predominantly used logit models. Thus, in the present study, it is proposed to fit a Logistic Regression Model rather than a Discriminant Model.

The proposed model is given below;

\[ \text{Logit} (Y) = f (\text{SIZE, RD, BV, MBCE, PE, FCOTA, MEFV, DIVIDENDYIELD, GROWTH, LIQUIDITY, LEVERGAE, AGE, EXRETURN, ROWNW}) \] …………………………………….. (M1)

Then, the probability that a company becoming a takeover target is computed by

\[ P (Y = 1) = \frac{e^{(\text{Logit} Y)}}{1 + e^{(\text{Logit} Y)}} \]

Stepwise backward selection technique is employed to develop the logit models. Specifically variables would be dropped from each model one at a time based on their contribution to the overall fit of the model (increase in the Chi-square goodness of fit value). Thus, only a subset of the original variables that best separate target and non-target firms is represented in the final model.