The Determinants of Merger and Acquisition Activity in the United Kingdom: Parametric and Semi-Parametric Estimation.

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Abstract

In this article we attempt to identify the financial characteristics of takeover targets in UK using the period 1982-1990. The study analyses the relationship between bidders and targets, and targets and non-targets over two distinct sub-periods, 1982-1985 and 1986-1990 which are viewed as being homogenous. The first period followed a deep recession which followed a distinct shift in Macroeconomic Policy after 1979. The second period was associated with financial liberalisation in 1986 and the freeing up of Monetary policy that followed the Stock Market Crash in 1987. To facilitate this analysis, two bi-variate Logit models are estimated over each sub-period and over the period as a whole. The above models are used to test whether Merger and Acquisition behaviour has changed by undertaking a Likelihood Ratio based analogue of the Chow test. A General Modelling strategy is adopted to select variables as a mechanism for precluding inconsistency and reducing the impact of collinearity. Comparison is also made with a semi-parametric estimator.

Keywords: Bidders, General to Specific, Holdout Sample, Logit, Structural Change, Targets

1 Introduction

Following the seminal article of Singh (1971) we discriminate between bidders/targets and targets/non-targets. Singh and more recently Cosh et al (1989) have used the linear discriminant function to analyse Merger activity in the UK.

Unfortunately, the linear probability model has some well known limitations (Kmenta (1990)). Here, we follow the studies for the US by Harris et al(1982) and Palepu(1986) as we use the logistic function to explain the choice event. It should be noticed that this is not a tri-nomial problem as two distinct models of behaviour arise. Firstly, we are interested in the decision of the firms to pair off, the decision which makes a union between a particular targets and its bidder so appropriate. Secondly a pure choice decision is made by the bidder to select the target amongst the population of other firms. The use of a cross-sectional method is justified by the selection of what might be viewed as two fairly compact sub-periods, that is 1982-85 and 1986-1990.

In a recent study of Merger and Acquisition Behaviour, Dickerson (1997) has used a panel to pool behaviour over a number of periods. Here, the idea is to select sub-periods based on the economic environment rather than the arbitrary cut-off associated with a calender separation of time and secondly to test whether it is sensible to then pool the information associated with the two sub-periods.

As a further check on the appropriateness of logit and given the difficulty with knowing the true functional relationship describing the chance event, the results are compared with a semi-parametric estimator. Fairclough and Hunter (1998) found that on the basis of predictability, a non-parametric estimator generated by a neural net dominated the single layer net, which is a non-linear least squares analogue of logit. In this article, comparison is made with the semi-parametric, maximum score estimator. Firstly, the normalised logit parameters provided good starting values for the score estimator. Hence, the score associated with the initial estimates can be compared with those associated with the optimum for the score estimator. However, it is important to notice, that on this criterion the score estimator will always dominate logit, because logit can only hope to match the score estimator in the neighbourhood of a maximum.

The score estimator does not impose a functional form for the probability density, as a result inference is a problem as standard information criteria may not exist. Hence, the structure of any analogue likelihood function is not known, which means that there is no knowledge of how the score estimator behaves in a neighbourhood of the optimum. This has led to the bootstrap being used to construct approximate standard error, but with no knowledge of an equivalent likelihood such estimates may not be consistent. However, Lewbel (1998) has suggested that bootstrap standard errors are acceptable for a wide class of estimators when at least one regressor has massive support.

In this article, the maximum score estimator is used as a measure of the success of the parametric alternative. Some inferential procedures are suggested to check the specification of this estimator, based on a pseudo likelihood ratio test. It is also of interest to note, that the score estimator is more robust to the sample selected and it appears that the heterogeneity observed with the logit estimates, in the case of targets and non-targets does not occur in the case of the score estimator. The paper has three developments, the variable selection procedure, the tests for parameter constancy which discriminates between behaviour before and after 1986, and a new criterion for evaluating the maximum score estimator.

The article proceeds as follows. In section 2, we summarise the key empirical and theoretical literature. In section 3, we present the methodology adopted. In section 4 we address the question of sampling and the data collection. Section 5 present empirical findings based on logit and maximum score estimators for the sample periods 1982-85 and 1986-90. The results distinguish between bidder and target behaviour as compared with that of targets and non-targets.[1]. Section 6 offers conclusions.

2 Theoretical Developments

The role of merger and acquisition in economic and financial theory is much debated. Specifically, is it a sign of market efficiency or non-efficiency; is it a component of an optimal investment strategy or is it a sign of economic inefficiency both in the market for corporate control and in product markets via concentration. The following section argues, that in the light of the financial regime, mergers and acquisitions by their nature occur in an environment in which there are informational imperfections. It is suggested, that with the bargaining framework associated with the bidding process, an analysis of market based information is not appropriate. Finally, the literature provides a rich vein of financial theories from which such behaviour might be explained. It is argued, that by being able to define the motives for acquisition, then it is possible to extract from the results conclusions which are consistent with one view of how mergers are generated.

As with all economic and financial research, the determinants of merger and acquisition would appear to be an empirical question, in the sense that empirical research has defined many of the theoretical developments. Hughes(1993) has summarised much of the recent empirical research based on UK data.

In the finance and accounting literature, the topic of mergers and acquisitions relates to the market for corporate control, Associated with this are a number of hypotheses, which suggest that acquisition is linked with the avoidance of bankruptcy, under valuation, high relative profitability, unused debt capacity, unused tax endowment and risk reduction or sharing. In addition there are hypotheses directly related to increases in stock market ratios such as market value per share, payout and P/E ratio. Clearly changes in these ratios can be associated with many of the above theories.

Economic theory defines a number of motives for acquisition. Firstly acquisition is linked to concentration and monopolisation of an industry. The cost

[1] A non target firm is a firm which is neither a bidder nor a target firm for the period under examination.

of acquisition in economic terms relates to a loss in consumer surplus either via a reduction in quantity or a reduction in product diversity. However, concentration may also be related to dynamic benefits associated with increased scale economies, faster output growth and a more diversified product in the long-run. Specifically, Dixit and Stiglitz (1977) note that diversification defines a barrier to entry and that under monopolistic competition adverse market conditions are likely to drive out products for which demand is inelastic. Hence, concentration of an industry may have benefits in terms of greater diversity and this might be internal to the acquisition process. Often, the anticipated benefits of acquisition are much less tangible. The more traditional literature in economics talks of market structure and discusses the benefits in terms of acquiring distribution networks or scarce resources via vertical integration or less tangible gains via horizontal acquisition. This is suggestive of theories, which generate improved efficiency via synergetic benefits to acquisition either financial, operational or managerial. Unfortunately, such effects may not be determined on an ex-ante basis.

The market for corporate control is an important issue in the literature for mergers and acquisitions. There is sufficient empirical evidence (Manne (1965), Jensen and Ruback (1983) and Singh (1992)) to suggest that takeovers provide a control mechanism for disciplining managers, who run their firms in ways that does not maximise profits or who are inefficient. Before accepting such arguments at face value, one must also account for the possibility that: firstly managers may maximise different things to shareholders and secondly in a stochastic environment in which endowments differ, that the rigors of the market punish the weak.

Marris (1963) in his seminal work on Managerial Capitalism and Alchian and Demsetz (1972) discussed the implications of institutional and informational structure on managerial control. Alchian and Demsetz (1972) suggested that the existence of a " Monitor" is sufficient to determine an appropriate institutional structure to reward enterprise and penalise shirking. Monitoring justifies the role of the manager in economics, though this is complicated by joint production and the question of who monitors the manager. The issue of control of the monitor or managerial control was not a question addressed by Alchian and Demsetz. However, as Marris (1963) suggests the issue may have little to do with shirking as compared with the maximisation of different objectives. In this light, Jensen and Meckling (1976) suggested that managers optimise different objective function and they suggest that both bonding and monitoring would not of necessity result in the management optimising the objective function preferred by the shareholders. Hence, the non-existence of an internal mechanism for control is what gives rise to an external procedure, Merger and Acquisition.

If shareholders or the markets wish to maximise short-run profit while the agent or manager wishes to maximise the value of the company, then what is the appropriate criterion. Under Modigliani-Miller theorem (see Stiglitz and Weiss(1981)), the principal should be indifferent to income generated via capital gain or dividends. However, with market imperfections, then agents may not be indifferent between the two forms of income as capital gains have to be realisable at an appropriate point in time. Furtermore, the view that managers act for their own benefit and not in the interest of their shareholders has some support in the literature (e.g., Trautwein (1990) and Seyhum (1990)). Any suggestion that acquisition is affected by the financial composition of the company is indicative of market inefficiency and failure of the Modigliani-Miller Theorem.

Much is made of the short-termism that operates in financial markets. The theoretical implication of this view is that it permits a wedge to exist between the project evaluations of the market and those of the acquiring firm. If the acquiring firm is maximising net present value over a longer horizon, then financial markets evaluation of the acquisition are likely to be biased downwards, because of incomplete insurance and the heavy discounting of the future by the market. This suggests, the common finding of studies using market information that negative or zero excess returns are often observed when acquiring companies are analysed (Jarrel, Brickley and Netter(1988) and Scherer (1988)). The wedge, in terms of discounting is a function of project managers being risk neutral and highly optimistic about projected returns, while market analysts as employed skeptics are likely to be risk averse.

As Giammarino and Heinkel (1986), suggest, the price revelation process around an the time of an announcement is the result of a bargaining game, which depends on the structure of ownership of the two companies. The relative strengths of the two boards is likely to determine the extent to which the shareholders of the target company are able to bid away many of the potential gains associated with the new enterprise. This is especially likely when the management of the bidding company are inclined to sanction any purchase to the point at which they are indifferent to the acquisition. A criterion for such indifference might be the point at which the cost of acquisition equals the potential benefits less the potential loss of reputation should the bid fail. This is the down side of the hubris effect first discussed by Roll (1986). In conclusion, acquisition does provide a means for controlling inefficient management, though the success of any bid is then dependent on the strength of purpose of the management team doing the acquiring.

When one considers the studies based on company accounts, then measures of value such as profitability and price earnings ratios have often featured in the analysis. However, the evidence is inconclusive: Hogarty (1970) and Singh (1992) suggest that mergers have a neutral impact on profitability while Kuehn (1975) found that U.K. acquired firms had low profitability.

Leverage or increased debt capacity is another often cited financial reason for acquisition (Vance (1969), and Shrieves and Pashley (1984)). Potential targets may be characterised as having excess debt capacity, which means that the post-merger firm can issue more debt. This suggests financial synergy as neither the acquired nor the acquiring firm may be in a position to utilise the extra debt provision in a way which is optimal. Liquidity has been well documented in this literature, the above argument suggests that target firms are more liquid than non-acquired firms (e.g., Simkowitz and Monroe (1971)).

As was mentioned above, many of the benefits of acquisition relate to synergy which is the result of component parts of an enterprise being more productive in combination. According to Hunter and Wall(1989) synergy is self-evident in conglomerate and horizontal mergers as it provides automatic entry by one of the two enterprises into new product lines. As a result, there may very well be external benefits to acquisition which are likely to increase the level of the firm's profitability or indirectly improve efficiency in some way. Managerial synergies are realised when the bidding firm has better management team than the target firm. However, it is often the case that hostile and non-hostile acquisition leads to managerial wastage and often this has its own economies and dis-economies. Managerial teams are often dominated by managerial hard headedness rather than innate ability. Any synergies, that might arise are likely to come from the acquisition of a strong group of middle managers who can continue the activities of the acquired firm and strengthen the existing team. A more obvious benefit of acquisition, which may only be understood by the management team making the bid is one of financial synergy. Trautwein (1990) suggests that financial synergies are due either to the lowering of systematic risk, which is linked to the financial diversification associated with the newly defined investment portfolio or by increases in firm size, which should give an enterprise access to cheaper capital. Potentially these types of gains may be identified. For example, there is evidence that a merger increases the market value per share of the firm (Baker et al (1981)). And one financial strategy used by acquiring firms is to boost earnings per share (EPS) by acquiring firms with lower P/E ratios (Harris et al (1982) and Wansley and Lane (1983)). This is because a high P/E ratio in the acquired firm means that the acquiring firm is paying a high price for current earnings.

In line with this idea of increasing the net present value of the enterprise, it is possible that growth can be promoted by acquisition. Baker et. al.(1981) and Hunter and Fairclough (1998) provide evidence in favour of growth as a motive for Merger and Acquisition. Dietrich and Sorensen (1984) motivate their paper by noting that the acquisition process relates directly to present value enhancing activities. However, the theory is only addressed indirectly via the analysis of financial ratios.

Economies of scale are often viewed as a key motive for mergers along with a desire for increased market power. Economies of scale can perhaps best be realised with horizontal mergers. However, it is necessary to determine whether a merger is horizontal, to be able to evaluate the potential for scale economies and be able to determine the scale economies that might exist in an industry.

The construction of a model of the acquisition process is highly complex. Any of the empirical procedure discussed, thus far can only be viewed as reduced forms. Models based on market information have assumed efficient markets and are often limited by the data sample used. Given, these limitations a decision has been made to use the accounting information. Such information is consistent with the planning horizon required for an acquisition to be made and indirectly addresses many of the theories discussed above. Managerial efficiency can be addressed via turnover and asset holding behaviour, issues of liquidity, profitability and growth via measures of such variables, market efficiency via variables, which measure financial composition, while the present value computation is observed indirectly via the probability of acquisition relative to firms not acquired.

Next, the methodology is selected, and inferential procedures and the sampling methods discussed.

3 Methodology

The paper utilises logit to analyse the discrete choice problem. Logit provides an approximation to most well known distribution functions while the procedure is superior to the linear probability model on many counts. This includes the linear discriminant function whose parameters are a linear transform of the regression coefficients (Maddala (1983)).

Thus far, much of the recent work on the UK follows from the classic article by Singh (1971) who used the linear discriminant function and more recently this work has been updated by Cosh et al (1989). Otherwise, there are a number of articles looking at the US (e.g., Dietrich and Sorensen (1986) and Palepu (1986)) which have used Logit. To date there are only a small number of studies for the UK that have used either logit or probit (see Dickerson (1997)).

In this article, care is taken to select a fairly homogenous time period, prior to many of the big changes in UK financial markets (de-regulation in 1986 and the stock market crash in 1987). Given, the high degree of collinearity between financial ratios and the inconsistency associated with missing variables (Green (1999)), a general modelling strategy defined for time series by Davidson et al (1978) is used for variable selection. Whether the period before and after 1986 can be pooled is tested using a likelihood ratio test, which is the cross section analogue of the test used in Hendry (1981). To control for the choice of distribution function, comparison is made with results based on the maximum score estimator due to Manski (1986).

Wansley and Lane (1983) cite the use of the discriminant function as a reason for the insignificance of theoretically important variables such as liquidity and profitability. While, Simkowitz and Monroe (1971) emphasized that this was due to a high degree of collinearity between financial ratios. Bartley and Boardman (1990) suggested a stepwise regression procedure for the exclusion of variables, though here downward testing is preferred.

Logit moves us away from the linear probability model and unlike Probit it does not impose the cumulative normal as the distribution function describing the discrete event. However, all of the standard methods need to define a probability model and this implies that the choice problem is dependent on a vector of regressors or covariates. The regressors selected define measures of some of the hypotheses discussed above and the probability (π) that a firm is a takeover target can be described from the following function:

$$\pi = f\left(\rho_1 \rho_2 ... \rho_5\right) \tag{1}$$

where ρ_1=profitability, ρ_2=inefficient management (-), ρ_3=financial leverage (-), ρ_4 =corporate liquidity (+) and ρ_5 = capital expenditure (+).[2] The latent hypotheses behind the underlying theoretical model are described by ρ_1, ρ_2, ρ_3, ρ_4 and ρ_5. In practice, these latent hypotheses are captured by a k variable linear relationship $x\beta$ where x is k vector of financial ratios, selected to represent the latent hypotheses and β a k vector of parameters. For ease of comparison with the existing literature, the model which transforms the linear relationship into probabilities is defined by the logistic function:

$$f(x\beta) = \frac{e^{x\beta}}{1 + e^{x\beta}}$$

The logistic function defines a probability as $f(x\beta) \in [0, 1]$. The probability of acquiring a target is given by:

$$prob(\text{Of being Acquired}) = \frac{e^{x\beta}}{1 + e^{x\beta}}$$

The associated likelihood function is:

$$L = \prod_{i \in T} [\frac{e^{x_i\beta}}{1 + e^{x_i\beta}}] \prod_{j \in N} [\frac{1}{1 + e^{x_j\beta}}],$$

where T defines the number targets and N the number of non-active firms. The above likelihood when maximised yields the following non-linear moment condition:

$$\frac{\partial L(.|\beta)}{\partial \beta} = \sum_{i=1}^{N+T} x_i' \overset{\triangledown}{\varepsilon}_i = 0 \tag{2}$$

where $\overset{\triangledown}{\varepsilon}_i = y_i - \overset{\triangledown}{\pi}_i$, $\overset{\triangledown}{\pi}_i = e^{x_i \overset{\triangledown}{\beta}}/(1+e^{x_i \overset{\triangledown}{\beta}})$, $n = N+T$ is the number of observation and $\overset{\triangledown}{\beta}$ is the maximum likelihood estimate of the parameters.

The logit estimator is compared with a maximum score estimator (Manski(1986)), which does not involve the selection of a specific distribution function. This estimator maximises the scoring function which satisfies an optimal

[2] In the parenthesis we have put the expected sign associated with each hypothesis.

over-all prediction rule for a given cut-off quantile. The objective function to be maximised is:

$$Maximise_{(\beta)} S_{(N\alpha)}(\beta) = (\frac{1}{n}) \sum_{i=1}^{n} [y_i^* - (1 - 2\alpha)] z_i^* \tag{3}$$

where y_i^* takes the sign (-1or $+1$) depending on the whether y_i is either zero or one. Therefore z_i^* takes the sign (-1 or 1) given the proximity of $z_i = xb$ to zero or one. The cut-off implies $z_i < \alpha$ is associated with a zero and $z_i > \alpha$ is associated with a 1. If $\alpha = .5$, then (3) is considerably simplified as $y_i^* - (1 - 2\alpha) = y_i^*$.

Subject to the choice of starting values, maximising (3) will improve the predictive performance of the model relative to logit or probit as such estimators cannot dominate the score estimator. As non-linear estimators are sensitive to starting values, normalised logit parameters are used to initialise the scoring function. The score estimator (b) is maximised in a neighbourhood of the optimum when the smallest prediction error is disclosed. The procedure in Green (1997) is used here and is maximised subject to the normalisation constraint $\beta' \beta = 1$.

Unfortunately, the solution to the problem is not based on a likelihood criterion so the information matrix is not known, which implies that it is difficult to undertake inference. There is also some debate about the use of the bootstrap to generate approximate standard errors (e.g., Kim and Pollard (1990)), because such estimates may not be asymptotically consistent. In this article, the bootstrap standard errors, implemented in Green (1997) are used. They are based on the formula due to Efron (1979):

$$MSD = (\frac{1}{B})) \sum_{i=1}^{B} [(d_i - b)(d_i - b)'],$$

Where B is the number of bootstrap replications, d_i the i^{th} bootstrap estimate of β and b the Maximum Score estimator. Care needs to be taken in interpreting the standard errors as there is no asymptotic results to fall back on. However, Lewbel (1998) suggests that the bootstrap may be applied to a wide range of semi-parametric estimators, as long as, the conditional distribution of the error is independent of a co-variate with massive support.

A further question addressed, relates to the selection of the co-variates and the statistical design. As was mentioned above, the problem with financial accounting data is the preponderance of measures of the theoretical variables and the high degree of correlation between such measures. This also leads to a problem of comparability with other studies as the measures used are somewhat different. In an attempt to take account of this difficulty, the general to specific approach (Davidson et. al. (1978)) is used to test down to a specific model.

Some thirty eight financial ratios can be extracted from the literature, but of these only thirty three can be used in the general model, due to the existence of exact dependencies. The general to specific approach is particularly important as in these types of problems the ommission of variables causes inconsistency (Greene (1999)). Further, multicollinearity is a function of the latent structure given by (1) as the covariates define alternative measures of the same thing.

The standard test of specification is given by comparing the likelihood evaluated at the maximum against a model which only has a constant. Let:

$$y = X\beta + \varepsilon, \text{ where } X = [\iota : X_2] \text{ and } \beta = \begin{bmatrix} \beta_1 \\ \beta_2 \end{bmatrix},$$

where X is an $n \times k$ matrix of observations on the covariates, ι is a unit vector, X_2 is an $n \times k-1$ sub-matrix of X, β_1 the intercept and β_2 a $k-1$ vector of non-constant parameters. The test of model fit is associated with the following null:

$$H_o : \beta_2 = 0$$

Under the null the test is:

$$LR_i = -2(\log(L_B) - \log(L_{Mi})) \sim \chi^2(k-1) \tag{4}$$

where $\log(L_B)$ is the base likelihood associated with the model with a constant and $\log(L_{Mi})$ is the maximised likelihood for model i.

Now suppose a number of variables (g) are excluded, then $X = [X_1 : X_2]$, X_1 is an $n \times k-g$ sub-matrix of observations on the covariates included, X_2 is an $n \times g$ sub-matrix of variables to be excluded, β_1 is $k-g$ vector of included parameters and now β_2 is a g vector of excluded variables. The null is the same as above, except that it relates to a model under the null with $k-g$ variable. The test is:

$$LR_r = -2(\log(L_r) - \log(L_{GM})) \sim \chi^2(g).$$

Where $\log(L_r)$ is the maximised likelihood for the model that excludes X_2 and $\log(L_{GM})$ is the maximised likelihood for the general model, which has all the variables (X). The test can be written as the difference in Likelihood ratio tests for the two models. Therefore:

$$LR_{u-r} = LR_{GM} - LR_r \sim \chi^2(g) \tag{5}$$

The above test is used to determine whether the restrictions imposed on the general model are appropriate.

Given the fundamental changes that occurred in the UK economy in the 1980s and the change in the financial and regulatory environment, then it appears highly unlikely that the same model will explain acquisition behaviour over the two periods. To define a reasonably homogenous time frame we have differentiated between the period before the start of 1986 and a second sub-sample that ends in 1990, when the economy was thrust into a deep recession and merger and acquisition activity withered. To test the hypothesis, that the two periods are the same we follow Barnes (1989) who first suggested that it might be relevant to test parametric stability over two sub-periods. In this article, an analogue of the Chow test is defined, which is based on same type of likelihood ratio test used to test variable omission. The test compares a model estimated over the full sample (1982-1990) with a more general model which permits the parameters to change in the validation period (1986-1990). The test is made operational by stacking the data for the final model as follows:

$$X = [X_a : X_p] \text{ where } X_a = \begin{bmatrix} Xn_1 \\ Xn_2 \end{bmatrix} \text{ and } X_p = \begin{bmatrix} 0 \\ Xn_2 \end{bmatrix}.$$

where $\beta = \begin{bmatrix} \beta_1 \\ \beta_2 \end{bmatrix}$. The models for two sub-samples n_1 and n_2 can be pooled when:

$$H_o : \beta_2 = 0$$

The test is a likelihood ratio test of the form:

$$LR_{pf} = LR_u - LR_r \sim \chi^2(k) \tag{6}$$

where LR_u is the likelihood ratio test statistic for the model which combines the two sub-samples and LR_r is the likelihood ratio test statistic which pools the two sub-samples. If the restriction, $\beta_2 = 0$ holds, then the extra variables are not required and the two sub-samples can be pooled.

When the maximum score estimator is considered, then testing is more complicated as no likelihood function exists. In what follows a pseudo likelihood ratio test is developed from the score. Given that, the normalised logit estimates of β are used as starting values, then a direct comparison of models exists via the score function based on the normalised logit parameters and that for the maximum score estimator b. The Score function is binary in nature which suggests that the binomial approximation might hold for this statistic. To compare, the performance of the score estimator with that for logit, then the null hypothesis is:

$$H_{ro} : S^* = S^o$$

where $S^o$is the base score function associated with the initial values which maximise the logistic function.

The following test statistic is suggested:

$$\frac{S^* - S^o}{\sqrt{\frac{\sigma_1^2 + \sigma_o^2 - 2\sigma_{1o}}{n}}} \longrightarrow N(0,1)$$

where $\sigma_i^2 = (1 - S^i)S^i$ and σ_{1o} is the covariance. Consider the square of the above test statistic:

$$LR_s = \left[\frac{S^* - S^o}{\sqrt{\frac{\sigma_1^2 + \sigma_o^2 - 2\sigma_{1o}}{n}}} \right]^2 \underrightarrow{asy} \chi_1^2.$$

The above test might be viewed as a pseudo Likelihood Ratio test which compares in an equivalent way parameterised score estimators.

If the score is estimated in a consistent way, then comparison can be made for maximum score estimators over different periods and comparison of the predictive performance of the models. This procedure is suggested by Fairclough and Hunter (1998) in the context of their results based on a non- parametric estimator derived from a neural network. The measure of fit in this case is viewed as performance relative to random selection. The null and alternative hypotheses are given as:

$$H_{ro} : S^* = \alpha$$

$$H_{r1} : S^* > \alpha$$

where $S_i^*$is the score function associated with the maximum for model i and $\alpha =$ .5 is the cut off associated with randomness or the true population proportion. Now look at the test of sample proportions:

$$P_{ri} = \frac{S_i^* - \alpha}{\sqrt{\frac{(1 - S_i^*)S_i^*}{N}}}$$

Squaring the above test statistic yields the Pseudo Likelihood Ratio below:

$$LR_{ri} = \left[\frac{S_i^* - \alpha}{\sqrt{\frac{(1 - S_i^*)S_i^*}{N}}} \right]^2$$

It is well known, that the score statistic is not normal (Kim and Pollard,1990). However, the appeal given to the binomial approximation presented above and the observation in Fairclough and Hunter (1998), that score type estimators or their standard errors quite quickly collapse to their asymptotic values would suggest some form of normal approximation. It is conjectured, but not proven that the following asymptotic result holds:

$$LR_{ri} = \left[\frac{S_i^* - \alpha}{\sqrt{\frac{(1 - S_i^*)S_i^*}{N}}} \right]^2 \underrightarrow{asy} \chi_k^2$$

In the next sections, , the data are discussed and then are presented for models based on Bidders versus Targets and Non-Targets versus Targets. Likelihood ratio tests of specification are also undertaken.

4 Data and sample selection

In this section we briefly discuss the population, data definitions and the sample. The data are dealt with in more detail in the data appendix. The data was selected from a population which consists of a complete list of bidder and target firms extracted from various editions of Acquisitions Monthly[3] and the Financial Times Mergers and Acquisitions Journal[4]. A separate group of firms not involved in Merger and Acquisition activity are defined as the firms not recorded as bidders or targets during the period 1982-1990 in either of the above publications. The financial information and accounts for the selected firms have been taken from the Exstat database. The data employed in this study consists of firms selected from the chemical, construction, food, electrical and electronics engineering and mechanical engineering sectors. Initially a total number of 1,153 firms was selected of which there were 603 bidders, 314 target and 236 in the non-target group. From the initial sample which defines a population for the targets and bidders, the total number of firms falls to 427 companies. The final sample used for estimation is based on the following criteria: the existence of a comprehensive set of financial statements going back six years prior to the announcement and held within the Exstat database. As a result the final sample includes 96 bidders, 161 targets and 170 non targets. For targets and bidders the information set is defined for six years prior to the announcement date. For the non targets, we collect relevant financial statements for six years prior to the target announcement year. The rationale for this is the a priori judgement that given the size of the non-targets they are comparable with the targets rather than the bidders. Further, the choice is made by the bidder between targets and non-targets. Hence, one is not assumed to select to be a target as compared with being a bidder, it is not a choice.

5 Empirical Findings

The models developed in the present paper are based on thirty eight financial ratios denoted X1 - X38 (see Appendix I) of which thirty one are available to define a general model. As was explained above, the ratios are broken down into five fundamental characteristics: profitability, efficiency, liquidity, leverage and capital expenditure. The financial ratios selected are chosen to analyse the hypotheses discussed in section 2.

[3]The ‘ Acquisitions monthly ‘ gives information regarding the announcement date of the take-over, the names, and
industrial classification of both bidder and target firms as well as the price of the bid.

[4]‘ Financial Times -Mergers and Acquisitions Journal’ gives information regarding the announcement date of the take-over, the names, and industrial classification of both bidder and target firms as well as the price of the bid.

In this section, we examine the financial characteristics of target firms relative to bidder firms and target firms relative to non target firms. We present results based on the binomial logit for the time periods 1982-1985 (estimation period) and 1986-1990 (validation period). The estimates for the validation period are primarily used to examine parameter stability which we subsequently test using the method described in section 4. Variables are dropped using sequential likelihood ratio tests to test down from a model which includes thirty three variables to more specific models with considerably fewer variables. The procedure is in common use with time series econometric models (see Davidson et al(1978)). Furthermore, Hendry and Mizon (1978) consider the lack of consistency which might arise when a specific to general approach is used. The logit results are compared with those from the maximum score estimator.

The models presented here, encompasses those of Komis (1995) who used step wise regression and Varimax Factor analysis to select models. We also define a couple of new variables one of which provides a new measure of short-term assets. In undertaking any downward testing procedure one has to be aware of the critique of Leamer(1978) who suggests that this process by definition biases the t-statistic. However, with the severe risk of multi-collinearity with this type of data and our indirect emphasis on t-values when specifying models we believe that our implementation of the method is valid. Firstly, variables are deleted on the basis of a weak t criterion of 25% and as a result the excluded variables are highly insignificant. The final decision to drop is then based on a sequence of likelihood ratio test for which testing down in the Bidder Target model only required five steps. The final step involved the re-definition of three variables. It should also be noted, that the sequence of likelihood ratio tests are independent.

In Table 1 we present the parameter estimates for the final bidder-target model estimated over the period 1982-1985. We have decided to accept as our final results those from the second column. This specification depends on six variables of which Log(TA/S), (Q-WC)/S and (Q-WC)/TA are significant on the basis of the usual 5% criterion while the test for goodness of fit is highly significant and the other two variables are very close to the 5% critical value.

$$Table 1 \ goes \ here$$

It is of interest to notice, that while the parameters of the two models in table 1 are very similar, that the standard errors decline considerably with the exclusion Q/S. As a result, we can readily accept the restriction that the coefficients on Q/S and WC/S have equal and opposite sign. The variable Q-WC might be viewed as defining a new measure of short-run asset holding. It is not working capital, but it is the form of short-term finance which can be readily mobilised to fund the acquisition.

To summarise, when log(S/TA) is high then relative to the bidders you are at risk of being acquired. This is a measure of sales volume which was viewed by Dietrich and Sorensen (1984) and Hunter and Fairclough (1998) to have a positive coefficient. Relatively high sales volume reduces the cost of acquisition. The new measure of short-assets (Q-WC) is measured relative to sales and to total assets. On this basis it is hoped to distinguish two types of effect. Firstly, a liquidity effect as firms with substantial liquid asset holdings are likely to be attractive to bidders as this reduces the risk of acquisition and secondly a measure of financial weakness as potentially bankrupt or highly geared companies are likely to have low levels of liquid assets. If liquidity is viewed relative to sales, then this defines a real measure of the liquid asset position of the company or a real measure of the resources which might be mobilised to pay for the acquisition. From the perspective of the bidding company this purchase is attractive when the acquired company has high liquid assets relative to sales.

However, when one considers the same numerator relative to total assets, then the total asset holding of the bidder is likely to be a predominant feature of this ratio. A company with a relatively large easy to mobilise holding of liquid assets relative to total assets, will be able to use such assets to defend itself prior to any acquisition. Companies with liquidity low relative to total assets are not financially secure, because they need to renegotiate a substantial amount of short-term finance. There are two possible reasons for this, firstly they may be at risk of bankruptcy or secondly they may be highly geared with most of the funding coming from short-term finance. In either circumstance, the company is ill-prepared to defend itself from a takeover and is likely to benefit from some form of financial restructuring. This result implies that the sample of acquiring companies is financially more secure than the targets.

The log of sales is often used as a measure of company size. Companies which are targets have relatively lower sales than the sample of bidders. Hence, they are less likely to be able to fend off an acquisition. When discriminating between bidders and targets it appears that the targets are all relatively weak either in financial or in physical terms. Otherwise, the bidder finds it easy to mobilise short-term benefits associated with the acquisition. Suggesting that bidders select firms which are either easy to acquire, because they are weak or the cost of acquisition is low. This would suggest that UK acquisitions when the population of listed and unlisted firms are considered have been speculative or opportunist in nature.

When the performance of the logit estimator is considered, then jointly the parameters in the model are significant as $\chi^2(5)=$ 30.52 exceeds the critical value ($\chi^2_{.05}(5)$=11.1). When the test associated with the general is considered, then:

$$LR_{u-r} = LR_{GM} - LR_{M1} = 48.46 - 30.52 = 17.9362 \sim \chi^2(26)$$

When the test is compared with the critical values in the tables, then excluding twenty six variables is readily accepted at both the 5 and the 1% levels (($\chi^2_{.01}(26)$=45.6). If one takes the test as one of three model selection criterion, then an approximate joint confidence interval is based on the Bonferroni principle. That is selecting $\frac{\alpha}{i}$=1.67 as the level of each individual test when $i = 3$ and then the joint rejection region is approximately 5%. If the test of predictive failure is undertaken, then:

$$LR_{pf} = 15.012 \sim \chi^2(6)$$

This is not significant at the 1% level ($\chi^2_{.01}(6)$=16.8). If a once and for all adjustment is allowed for, via a shift in the constant, then the test is also accepted at 5% level as $\chi^2(5)$=10.225 is less than $\chi^2_{.05}(5)$=11.1. It would appear, that appart from a shift in the constant, the model accepts the notion that it is possible to pool the bidder-target behaviour across the 80s.

If the maximum score estimator is looked at, then the signs of coefficients are the same for all variables except $\frac{Q}{TA}$, which isn't significant which ever estimator is chosen. The score estimator dominates logit when the predictive performance is considered. If the fit is considered, then the Score estimator based on the pseudo Likelihood ratio when compared with the least favourable critical value is as significant as logit (the test statistics are very similar). When the score is compared with the logit measure for predictive performance, then the Score would not appear to be significantly better as the test, which is approximately $\chi^2(1)$=3.7846 is less than the critical value ($\chi^2_{.05}(1)$=3.84).

The maximum score estimator, for the period 1986-90 performs especially well with the best fit of all models. Its performance is significantly different from randomness when the test is compared with any of the conventional criterion. Again the explanation of all of the above models is conherent and in terms of specification the model estimated over the period 1982-85 cannot be rejected by the data.

Next we consider the decision to select a target against a family of non-acquired firms where the sample is paired by comparison with similar sized companies in the industry, but not involved in acquisition activity. The results of the model in Table 2 for the period (1982-1985) indicate that the key determinants for selecting the target are the log of equity plus capital reserves relative to total assets (log((E+K)/TA)) that is used in the literature as a measure of Turnover. As such, the sign is ambiguous (Dietrich and Sorensen, 1984), because it relates both to an efficiency and a growth argument. Loan capital plus preference capital relative to total assets ((LC+PC/TA) measures leverage. Variables significant at the 5% level are cash position no.3 (Cash) which is a measure of liquidity and number of debtor days (D-days), a

Table2 goes here

measure of risk of failure and cash to total assets (Cash/TA) another liquidity measure.

If we refer to previous studies, then we can see that the ratios in our specified model (See Table 2) have appeared in previous studies of both the UK and the

US. The natural log of total assets ratio was employed by Harris et. al.(1982) as a proxy for size. Here it combines with what might also be viewed as a measure of efficiency, which would suggest that target firms are relatively inefficient. This finding is also consistent with the results for bidders and targets.

Loan capital and preference capital to total assets was first used by Stevens (1973) as a proxy for leverage. He found that acquired firms have a lower Long-Term Liability/ Total Assets ratio, which is quite consistent with our finding of a negative coefficient. Similar results where also discovered by Harris et al.(1982), Wansley and Lane (1983) and Dietrich and Sorensen (1984). This implies that the targets have relatively low levels of leverage so they use less debt in their capital structure. If capital markets were perfect, then the proportion of debt to equity should not affect the ownership structure. Howerver, Firms with more debt appear more difficult to acquire.

Cash to total assets was first used by Belkaoui (1978) as a measure of liquidity. As was suggested in Table 1, targets are illiquid relative to all firm when cash holding relative to total assets is considered. This is a further indication, that these companies are financially weak when compared with other firms in the industry. A similar indication follows from the debtor days variable, which implies that the company is having difficulties receiving its debt repayments. Otherwise companies which grow too fast or become too highly geared sometime run into such difficulties. Again this is a sign of weakness which is likely to indicate a weak financial position and/or management which is inefficient.

Equity and capital reserves was employed by Simkowitz and Monroe (1971) who suggested that it was a proxy for growth. This variable according to Simkowitz and Monroe indicates that acquired firms were unable to build the equity base needed and this was a signal of low growth potential. However, Hasbrouk (1985) suggested that this ratio was better viewed as a measure of size. Both of these hypotheses are quite consistent with the target being relatively weak when compared with other firms in the industry. However, when this variable is in a model already employing total assets as a measure of size, then it appears more likely to measure turnover. According to Dietrich and Sorensen, when the sign is positive then the variable is linked to growth, which is consistent with the results in Fairclough and Hunter (1998).

Cash position (no.3) was used by Clayton and Fields (1991) as a proxy for liquidity, but did not appear in their final model. The present paper suggests that target firms have high cash reserves, this means that even should the company be highly inefficient or unprofitable their are assets, which can be used to cover a high proportion of the cost of the acquisition. This is consistent with the liquidity argument made above when the Target is viewed relative to Non-Targets. However this result changes when the maximum score estimator is considered.

In general the results for the model for the period 1986-1990 are remarkably consistent with the above results as most of the coefficients lie within two standard errors of each other. Certainly all of the signs are the same, though the coefficient on loan capital plus preference capital relative to total assets, a measure of Leverage is substantially smaller in the second period.

When the performance of the logit estimator is considered, then jointly the parametersin the model are significant as $\chi^2(6) = 34.05$ exceeds the critical value ($\chi^2_{.05}(6) = 12.6$). When the test associated with the general model is considered, then:

$$LR_{u-r} = LR_{GM} - LR_{M1} = 66.38 - 34.05 = 32.33 \sim \chi^2(25)$$

If the test is compared with the critical values in the tables, then excluding twenty six variables is readily accepted at both the 5 and the 1% levels (($\chi^2_{.05}(25) = 37.7$). If the test of predictive failure is undertaken, then:

$$LR_{pf} = 18.9 \sim \chi^2(7)$$

This is marginally rejected at the 1% level ($\chi^2_{.01}(7) = 18.5$). A once and for all adjustment in the intercept seems less relevant here as it appears to be the coefficient on the gearing variable which is different ($\frac{LC+PC}{TA}$). Hence, it would appear that it is not possible to pool bidder compared with non–active behaviour across the 80s.

If the maximum score estimator is looked at, then the signs of coefficients are the same in the case of the significant variables except for the cash position which is the most important variable. The improvement in this model seems to follow from the behaviour of cash position, which appears to operate as a defence against acquisition or rather a reason not to be selected. If the fit is considered, then the pseudo Likelihood ratio for the score estimator when compared with the least favourable critical value is more significant, than in the logit case. As might be anticipated this model fits the best over the two regimes. It is also highly consistent in terms of parameters. If a comparison is made of the fit over the two period, then the test is not significant. The maximum score estimator, for the period 1982-85 performs especially well with the best fit of all models. Its performance is significantly different from randomness when the test compared with whatever chi-squared criterion might be viewed as acceptable. Furthermore, this estimator would appear to generate models, which are indistinguishable across the two periods.

5.1 Conclusion

This article has analysed the behaviour of bidders and targets over the estimation period 1982-1985. This model was a special case of a more general specification and subject to the acceptance of a test at the 1% level or that the two periods are only different by a fixed factor then the results do not sugest substantially different behaviour over the two sub-periods.

When the best estimator for the second sample is considered, then the stability of the relationship for the behaviour of targets relative to non-targets is even more impressive as the two relationships estimated over different periods are very similar. Usually the key determinant of a well specified model is the ability to predict in a substantially different period. This is clearly accepted when the maximum score explanation of targets relative to non-targets is considered.

When bidders and targets are compared, then the key factors which appear to discriminate between the two categories of firm is that targets are financially weaker and smaller than their bidders. Relatively high sales volume and high liquidity to sales also discriminates targets from bidders. Relatively high sales and liquidity make the firm attractive as they suggest that the firm has the cash through put to cover some of the costs of acquisition. These results are also reflected, though with slightly different ratios in the results for the targets relative to non-targets.

Non-targets are also viewed as being financially weak when debtor days and liquidity as measured by cash flow is considered. They are also have growth potential when turnover is looked at and spare debt capacity on the basis of the leverage position. Hence, the acquired firm relative to the non-acquired has less debt, more cash and growth potential, but is financially weak in terms of cash to assets and debt position in terms of debtor days. The above results would also appear to be consistent with financial theory and provide an acceptable theoretical explanation.

It also appears to be the case that the diagnostic tests have helped in the selection of the best models. Specifically, logit and maximum score appear to be indistinguishable for the bidders and targets data, but the maximum score estimator appears to be preferred in the case of targets versus non-targets. This leads to models that are consistent across the two sub-periods.

6 Data Appendix

The bidder is defined as a firm that has announced an attempt to takeover another firm. We have defined the year this offer is announced as the " announcement year" .A target is defined as a firm that has received a bid by another firm. We have defined the year this offer is received as the " announcement year" .A non target is defined as a firm that has neither received a bid by another firm nor has attempted to takeover another firm but the year of announcement for that group is the year a target firm received the bid. The following key variables entered the final specifications are defined as variables:

Profitability Group:

X_1 = Return on Capital Employed = (Profit before tax/ Total Assets) $\times$100

X_2 = Profit to Sales = (Profit after tax/Sales) $\times$100

X_3 = Profit to Total Assets = (Profit after tax/ Total Assets) $\times$100

X_4 = EBIT to Sales = (Profit before tax/ Sales) X 100

Efficiency Group:

X_5 = Sales to Shareholders' Funds = (Sales/ Shareholders' Funds)

X_6 = Sales to Total Assets = (Sales/ Total Assets)
X_7 = Annual Sales = Natural Log of Sales
X_8 = Sales to Fixed Assets = (Sales/ Total Net Tangible Assets)
(Net Tangible Assets exclude leased assets and those under construction).
X_9 = Sales to Current Assets = (Sales/ Total Current Assets)
X_{10} = Annual Equity and Capital Reserves = Natural Log of Equity and Capital
Reserves.
X_{11} = Annual amount of Total Assets = Natural Log of Total Assets
X_{12} = Average Debtor Collection Period = (Debtors/ Sales) $\times 365$
X_{13} = Debtors Turnover = (Sales/ Debtors)
X_{14} = Current Ratio or Working Capital Ratio = (Total Current Assets/ Total
Current
Liabilities)
X_{15} = Acid Test or Liquid Asset or Quick Asset Ratio
= (Total Current Assets-Stock of Finished Goods)/ Total Current Liabilities
X_{16} = Asset Cover = (Total Assets/ (Total Liabilities-Total Current Liabilities)
X_{17} = Cash Position No1 = [(Cash & Equivalent + Interest Received)/ Total Current
Liabilities] $\times 100$
X_{18} = Cash Position No2 = [(Cash & Equivalent + Interest Received)/ Sales] $\times 100$
X_{19} = Cash Position No3 = [(Cash & Equivalent + Interest Received)/ Total Assets]
$\times 100$
X_{20} = Working Capital to Sales = (Total Current Assets - Total Current Liabilities)/
Sales
X_{21} = Working Capital to Total Assets = (Total Current Assets - Total Current
Liabilities)/ Total Assets
X_{22} = Cash to Total Assets = (Cash & Equivalent/ Total Assets)
X_{23} = Cash to Current Liabilities = (Cash & Equivalent / Total Current Liabilities)
X_{24} = Quick Assets to Total Assets = (Total Current Assets-Stock of Finished
Goods/
Total Assets)
X_{25} = Quick Assets to Sales = (Total Current Assets-Stock of Finished Goods/
Sales)
X_{28} = Current Assets to Total Assets = (Total Current Assets/ Total Assets)

X_{29} = Current Assets to Sales = (Total Current Assets/ Sales)

Leverage Group:

X_{26} = Long Term Liabilities to Shareholders' Equity = (Total Liabilities-Total Current

Liabilities)/ Shareholders' Funds

X_{27} = Total Liabilities to Shareholders' Equity = (Total Liabilities/ Shareholders'

Funds)

X_{30} = Preference and Loan Capital to Equity and Reserves=

= [Preference Capital + (Total Liabilities-Total Current Liabilities)/ Shareholders'

Funds]

X_{31} = Loan Capital and Preference Capital to Total Assets=

= [(Total Liabilities-Total Current Liabilities)+Preference Capital / Total Assets]

X_{32} = Interest Paid to Loan Capital

= [(Total Interest/ (Total Liabilities-Total Current Liabilities)]

X_{33}= Total Profit to Interest Paid = (Profit after tax/ Total Interest)

X_{34} = Gearing Ratio

= [(Total Liabilities+Preference Capital)/(Shareholders' Funds+Minority Interest+Total Liabilities)]

X_{35} = Debt to Equity Ratio= [(Total Liabilities+Preference Capital)/(Shareholders' Funds+Minority Interest]

X_{36} = Interest Cover = (Profit before Interest & Tax/ Total Interest)

Capital Expenditure Group:

X_{37} = Capital Expenditure to Total Assets = Capital Expenditure Contracted/ Total

Assets

X_{38} = Capital Expenditure to Sales = Capital Expenditure Contracted/ Total Sales

New Ratios:

X_{40} = X_{11}-X_7= log (TA/S)

X_{41} = X_{20}-X_{25}= (WC-Q)/ S

X_{42} = X_{21}-X_{24}= (WC-Q)/ TA.

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Table 1 Bidder vs Target firms, 1982-85 and 1986-90

Variable	1982-85	1982-85(semi-par)	1986-90	1986-90(semi-par)
Constant	0.72072 (2.608)	.15516(.24008)	3.7306(2.029)	.2909 (.14281)
$\log(\frac{S}{TA})$	9.4214 (4.289)*	.51531(.25134)	2.4784(1.448)	.14859 (.15072)
$\frac{(Q-WC)}{S}$	20.915(8.102)**	.79906(.29999)	7.8739 (2.285) **	.82304(.0841)
$\frac{(Q-WC)}{TA}$	-11.462(5.518)**	-.26167(.29813)	-2.5343(2.029)	.43086 (.19188)
log(S)	-0.58038(0.3164)	-.44663 (.03188)	-0.48293(0.2517)	-.02582 (.02619)
$\frac{Q}{TA}$	-3.0038 (3.948)	.03246 (.21769)	-0.55539(1.223)	-.16628 (.1459)
$\frac{Q}{S}$	-0.011203 (4.828)	-.01893 (.23283)	1.9396(0.6759)**	.04396 (.15623)
Score	.50515	.74227	.75714	.80714
Log-L	-51.96824		-75.1168	
Base Log-L	-67.23012	.5	-89.34125	.5
$\chi^2(5)$	30.52376**		28.449 **	
$\chi^2(31)$G-M[5]	48.46**		75.4077	
$\chi^2(26)$[6]	17.9362		46.99**	
$\chi^2(6)$	15.012*			
	10.225			
Count R^2	68.7643	74.23%	76.60%	80%

Where Q=Quik Assets, S=sales TA=Total assets and WC = Working Capital. (* significant at the 5% level and ** significant at the 1% level)

[5] The Chi-squared goodness of fit statistic for the General Model which includes 31 ratios.
[6] Likelihood ratio test for the restricted model for which P2(25) = P2(31) - P2(6).

Table 2 Non-Active vs Target firms, 1982-85 and 1986-90

Variable	1982-85	1982-85(semi-p)	1986-90	1986-90(semi-p)
Constant	0.63922 (2.490)	.01154 (.00779)	-2.7225(1.790)	.0121 (.01478)
$\text{Log}(\frac{E+CR}{TA})$	7.5526*(2.822)	.13707* (.0059)	3.0137** (1.137)	.13516 (.01304)
Log(TA)	.78714* (0.3448)	.01436* (.00364)	.34451* (.2188)	.00918(.01293)
D-days	0.011791** (0.008089)	.00018 (.00033)	0.023128****(0.006052)	.00032(.00098)
LC+PC/TA	-7.3222**** (2.508)	.00794 (.00523)	-0.90835**** (0.3835)	.01657(.00957)
Cash	0.47118*** (0.2658)	-.9816* (.00054)	0.42626***(0.1198)*	-.98262(.05737)
Cash/TA	-54.732*** (29.53)	-.13146*(.00419)	-41.630***(12.70)*	-.12527(.01345)
Score	.71963	.76636	.55556	.74242
Log-L	-56.7623		-113.6270	
$\chi^2(6)$	34.05		108 44.78276	
$\chi^2(30)$G-M[7]	66.38		56.99(15)	
$\chi^2(25)$[8]	32.33		12.12(9	
$\chi^2(7)$[9]	18.9		(NA)	
Count R^2	71.96%	76.636%	68.69%	74.242%

Significant at the 95%(**) and 99% (*) level and (standard error). LC defines Loan Capital, PC is Preference Capital, E annual equity, D-days debtor collection period, CR, Capital Reserves.

[7]The Chi-squared goodness of fit statistic for the General Model which includes 31 ratios.
[8]Likelihood ratio test for the restricted model for which P2(25) = P2(31) - P2(6).
[9]Likelihood ratio test for parameter constancy relative to the holdout is P2(7) = P2(14) - P2(7)..