Enhancing Procedural Efficiency in Multiple-Industry Ratio-Based Modeling of Corporate Collapse

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This paper utilizes a methodological approach called Multi-Level Modeling (MLM) that addresses two major shortcomings in the two-step analytic process that is traditionally adopted in the pertinent literature for modeling corporate collapse; thereby, enhancing procedural efficiency. The robustness of MLM vis-à-vis the traditional two-step procedure is ascertained using a data sample of Australian publicly listed companies, equally split between collapsed and non-collapsed, during the period 1989 to 2006. The results indicate that not only does MLM improve procedural efficiency, it does so while enhancing the robustness of signaling corporate collapse; in particular, MLM signals collapse with an overall 6.6% increase in accuracy.

Field of research: Accounting and Finance

1. Introduction

Some of the literature for signaling corporate collapse uses financial ratios as variables in the prediction models. Sometimes, when raw financial ratios are used, the models might be inappropriate for signaling collapse across different industry sectors. This has prompted researchers to develop procedures for adjusting the financial ratios so that the same prediction models can be used effectively across a range of industries. However, the traditional analytic process that underlies such procedures suffers from inherent deficiencies. First, it cannot determine which ratios in which industry sectors require alteration. Second, when modification of the ratios is required, the traditional approach does not allow for variations in the adjustment schemes between the observed sectors. This paper utilizes a methodological approach called Multi-Level Modeling (MLM) that addresses these shortcomings. Using MLM both deficiencies are dealt with concurrently, thereby enhancing procedural efficiency. The remainder of this paper is structured as follows: section 2 provides a brief literature review; section 3 describes the methodology; section 4 discusses the findings; finally, section 5 draws this paper to a conclusion.

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2. Literature Review

A strand of literature for signaling corporate collapse relies on financial ratios as endogenous variables in the prediction models. Quite often, these ratios are calculated for a data sample of companies that are sourced from more than one industry sector. Regardless of the statistical procedure used in generating the prediction models, there are instances when certain adjustments need to be made to the raw financial ratios so that the robustness of the models for signaling collapse is consistent across the spectrum of industry sectors from which the companies in the data sample are sourced. In this regard, the traditional pertinent literature can be assigned to two broad streams concerning the treatment of financial ratios in the context of multiple-industry data samples.

The first stream tries to circumvent having to make adjustments to the financial ratios; instead, each collapsed company in the data sample is paired with a financially healthy one (this process is referred to as a paired sample design) that belongs to the same industry sector based on some criterion such as the Global Industry Classification Standard (GICS) (for example, Altman, 1973; Casey and Bartczak, 1985; Clark et al., 1997; Darayseh et al., 2003; Hossari, 2006). While the empirical findings generated by this group of studies are useful, they are nevertheless lacking in that they cannot be extended to data constructs that are not based on a paired sample design.

The second stream does not consider the paired sample process adopted by the first stream to be crucial; instead, the emphasis is on adjusting the raw financial ratios for a random sample of companies that are drawn from multiple-industry sectors (for example, Coats and Fant, 1993; Jones and Hensher, 2004; Ohlson, 1980; Sheppard and Fraser, 1994; Zmijewski, 1984). As such, the empirical findings generated by this stream are superior to those generated by the other one, because they attempt to ascertain the integrity of the prediction models across a wide spectrum of industry sectors without imposing a paired sample restriction.

Analysis of studies that belong to the second stream reveals a two-step procedure with respect to derivation of the prediction models. The first step involves altering the financial ratios for each company in the data sample using some mathematical algorithm. The second step involves using some statistical procedure for deriving the prediction models based on the adjusted ratios; whereby, a myriad of statistical techniques are available.

Regardless of the mathematical algorithms used for altering the ratios, and regardless of the statistical techniques adopted in deriving the prediction models, the traditional two-step procedure retains inherent deficiencies.

One deficiency relates to the inability of the traditional procedure to determine which financial ratios in which industry sector(s) require adjustment. That is, the traditional approach assumes implicitly that the same adjustment scheme is to be applied to all financial ratios in all industry sectors. However, this is not necessarily the case.

For instance, when comparing the means of financial ratios Bird and McHugh (1977), one of the earlier pertinent studies, found that they were statistically different across *some* (not all) industry sectors. Such a finding indicates implicitly that

adjustments need only be made to the financial ratios of companies that belong to the industry sectors that exhibit significant differences between the means of their corresponding ratios. Another deficiency in the traditional procedure is that when modification of the ratios is required, it does not allow for variations in the adjustment scheme between one industry sector and another; rather, a 'one-size-fits-all' process is applied across the board.

For example, Sheppard and Fraser (1994) apply the same adjustment scheme to each financial ratio, across all industry sectors in their data sample: namely, subtracting the industry average from the raw value of each corresponding ratio. A reasonable criticism here is what if the financial ratios of companies that belong to a particular industry sector require to be altered using an algorithm that is distinct to the one applied to the ratios of companies that belong to a different industry sector? If this is the case, then the integrity of the prediction model could be compromised for at least one industry sector.

Recently, (Hossari, 2009) put forward an alternative analytic framework to test for the presence – or lack thereof – of an industry effect when modeling corporate collapse in Australia. The methodological approach referred to therein is based on Multi-Level Modelling (MLM). Accordingly, MLM is adopted in this paper, but with a different emphasis: whereas (Hossari, 2009) utilized MLM to test for an industry effect; this paper adopts MLM as a more parsimonious methodological approach for modeling corporate collapse, in that it addresses the two major shortcomings (discussed above) in the traditional pertinent literature, thereby enhancing procedural efficiency. In order to ascertain the robustness of MLM, the traditional two-step procedure adopted in Sheppard and Fraser (1994) is utilized as the benchmark for comparison. Accordingly, the next section considers the methodology applicable in this paper.

3. Methodology

Although corporate collapse is an identifiable event, signaling it requires developing a model that is based on a number of observable variables, such as financial ratios. Traditionally, the pertinent literature has assumed implicitly that the modeling process occurs at a *single level*; namely, the *company level*. Accordingly, the traditional modeling process associates each measurable financial ratio with a corresponding company in the data sample. For this reason it was necessary to adopt the inefficient two-step procedure discussed earlier in this paper in order to adjust the financial ratios for data samples of companies that are sourced from multiple industries.

The MLM approach utilised herein circumvents the methodological inefficiency inherent in the traditional two-step procedure by allowing the modeling process to occur at *multiple levels*, such as the *company level* and the *industry sector level*. Although any number of levels could be represented using MLM, all the essential statistical features are found in the fundamental two-level model (Raudenbush and Bryk, 2002). (Hossari, 2009) provides a detailed discussion of the technicalities of MLM in the context of modeling corporate collapse; therefore, only the essentials are presented in what follows. To start with, it is necessary to define the following variables:

y_{ij}: identifies whether or not a particular company 'i' in a particular industry sector 'j' belongs to the collapsed group.

x_{ij}: represents a particular financial ratio 'x' for a particular company 'i' in a particular industry sector 'j'.

a: is the intercept.

b_j: is the slope for the linear relationship for industry sector 'j'.

'u_j' and 'e_{ij}': are random quantities.

'π_{ij}': represents the probability that collapse, defined by '$y_{ij} = 1$', would occur based on a specific value for a financial ratio 'x_{ij}' (or a set of financial ratios); such that, $\pi_{ij} = \dfrac{1}{1 + \exp(-a - b_j x_{ij} - u_j)}$ where, 'exp' represents 'exponential'.

The assumption is that the observed binary responses 'y_{ij}' follow a binomial distribution, which is what is needed in the context of modeling corporate collapse due to the binary nature of the response variable 'y_{ij}'. Therefore, the ensuing binary response multi-level model can be expressed as follows (Goldstein, 1991):

$$y_{ij} = \pi_{ij} + e_{ij} z_{ij} \qquad (1)$$

Such that, $z_{ij} = \sqrt{\pi_{ij}(1 - \pi_{ij})}$, where the level-1 variance, 'σ_e^2' should be constrained to unity; that is '$\sigma_e^2 = 1$'.

A salient characteristic of a multi-level model like Equation 1 is its ability to apply industry-specific adjustment schemes – if necessary – for the corresponding financial ratios used in signaling corporate collapse. This process takes place during derivation of the corporate collapse prediction model, thereby enhancing procedural efficiency compared to the traditional two-step method that was described earlier in this paper. As mentioned earlier in this paper, the two-step procedure adopted in Sheppard and Fraser (1994) is replicated, and serves as a benchmark against which MLM can be compared.

Accordingly, the initial step prior to model derivation involves subtracting the industry average from the raw values of each of the useful financial ratios for each company in the data sample. For consistency, the same industry classifications adopted in generating the MLM-based model, are also applied for the purposes of adjusting the financial ratios using the traditional two-step procedure. The next step involves generating the corporate collapse prediction model based on the adjusted financial ratios and using logistic regression. Thus, although it seems that - at least *conceptually* - MLM is more efficient than the traditional two-step procedure that has so far been adopted in the literature; in order to ascertain the robustness of MLM, it is necessary to carry out some empirical tests. The next section presents the findings.

4. Findings

The data consists of a sample of Australian publicly listed companies equally split between those that collapsed and those that were still a going concern during the period 1989 to 2006. In the interest of the integrity of the modeling process, industry sectors with fewer than six companies are excluded (for example, Huberty, 1994).

In addition, and in keeping with normal practice in the literature, financial institutions are also excluded.

Financial statements are collected for each company in the data sample, from which financial ratios are calculated. Selection of financial ratios is based primarily on their technical merit as evidenced from a formal ranking of their popularity according to their usefulness as portrayed in (Hossari and Rahman, 2005). Accordingly, a total of 44 financial ratios are identified as potential predictors of collapse. These ratios are then screened in order to ascertain their computational integrity; doing so led to the removal of 22 ratios that could not be successfully computed due to missing items in the financial statements, or that required division by zero. The remaining 22 ratios are utilized in model derivation in this paper.

The process for ratio selection is repeated for each company and for the year in which the last financial statements are available preceding observed collapse; whereby, observed collapse is defined from a legal perspective, when the courts declare a financially fragile company to have ceased being a going concern (Hossari, 2007). The choice of such a time horizon is based upon close examination of the literature, which reveals that prediction models usually produce the highest accuracy during the final year prior to observed collapse. Not all 22 ratios would make it into the final prediction model. Analysis of the mainstream literature indicates that a prediction model usually relies on less than a handful of financial ratios as predictor variables, with a mean of two ratios per model.

Using MLM, all 22 financial ratios are entered one at a time into the model expressed in Equation 1 and their coefficients, represented by 'b_j', checked for statistical significance. To that effect, a second order Marginal Quasi-Likelihood (MQL) procedure is used (McCullagh and Nelder, 1995). Of the 22 ratios, only two are statistically significant at the 95% level of confidence; these are: 'Quick Assets divided by Current Liabilities' (QACL) and 'Total Equity divided by Total Liabilities' (TETL). The corresponding statistical output indicates that the constant term 'a' is statistically significant, however the random quantity 'u_j' is insignificant. The implication is that the raw financial ratios must be adjusted; however, the same adjustment scheme can be applied to the financial ratios of all companies across all industry sectors.

As mentioned earlier in this paper, although the procedural efficiency of model derivation using MLM is indisputable when compared to the traditional two-step process, the robustness of the model cannot be ascertained until its predictive accuracy is compared to the outcomes of a model that is derived using the traditional approach. To this end, the two-step procedure adopted in Sheppard and Fraser (1994) is replicated using the data sample described earlier in this paper. Moreover, in order to maintain consistency, the two financial ratios, QACL and TETL, are retained in deriving the prediction model using the traditional two-step procedure.

With this in mind, the initial step prior to model derivation involves subtracting the industry average from the raw values of each of the two financial ratios, QACL and TETL, for each company in the data sample. For consistency, the same industry classifications adopted in generating the MLM-based model, are also applied for the purposes of adjusting the financial ratios using the traditional two-step procedure.

The next step involves generating the corporate collapse prediction model based on the adjusted financial ratios and using logistic regression, as per Sheppard and Fraser (1994). The corresponding statistical output indicates that the coefficients for the constant and the ratio TETL are statistically significant at the 95% level of confidence, and the coefficient for the ratio QACL is statistically significant at the 90% level of confidence.

The decision to classify a company as either collapsed or financially healthy is made based on comparing its probability, as generated by each model, to some cut-off value; whereby, the general logic is to maximize the differences between the two groups of collapsed and financially healthy companies while minimizing variation within them (Klecka, 1982). Accordingly, a classification matrix based on the analysis carried out in this paper is presented in Table 1 below.

Table 1 - Predictive accuracies of the MLM-based model and its traditional counterpart

	Actual company status	Predicted company status		Total
		Non-collapsed	*Collapsed*	
Using MLM	*Non-collapsed*	64%	36%	100%
	Collapsed	17%	83%	100%
	Actual company status	Predicted company status		Total
		Non-collapsed	*Collapsed*	
Using the traditional two-step procedure	*Non-collapsed*	65%	35%	100%
	Collapsed	27%	73%	100%

Thus, the results presented in Table 1 indicate that the MLM-based model correctly predicted 64% of non-collapsed companies and 83% of collapsed ones, thereby generating an overall prediction accuracy of 74%. Similarly, the model derived using the traditional two-step procedure correctly predicted 65% of non-collapsed companies and 73% of collapsed ones, which when combined translate to an overall prediction accuracy of 69%.

Therefore, not only does the alternative MLM approach enhance procedural efficiency; it does so without compromising the accuracy of signaling corporate collapse vis-à-vis the traditional two-step procedure. As a matter of fact, the empirical results in Table 1 indicate that the alternative MLM approach signals collapse with an overall 6.6% (i.e., 74% less 69%, divided by 69%.) increase in accuracy compared to the model derived using the two-step traditional approach.

5. Conclusion

Considering the key role that financial ratios play in signaling corporate collapse (they are the variables used in the prediction models), the deficiencies in the traditional pertinent literature have to do with the general procedure for adjusting their raw values, particularly in situations where the data samples consist of companies that belong to different industry sectors. More specifically, one of the inherent deficiencies of the traditional analytic framework is that it cannot determine which ratios in which industry sectors require alteration. Another deficiency is that when modification of the ratios is required, the traditional approach does not allow for variations in the adjustment schemes between one industry sector and another.

Accordingly, this paper utilised an alternative methodological approach – called MLM - that addressed the shortcomings of the traditional approach. Using MLM, both shortcomings were dealt with concurrently during model derivation, thereby enhancing procedural efficiency. In order to ascertain its robustness, MLM was empirically tested against the traditional two-step procedure adopted in Sheppard and Fraser (1994); using a data sample of Australian publicly listed companies equally split between those that collapsed and those that remained a going concern during the period 1989 to 2006. The empirical findings indicated that not only did the alternative MLM approach improve procedural efficiency; it did so while enhancing the robustness of signaling corporate collapse with an overall 6.6% increase in accuracy.

6. References

Altman, E.I. 1973. "Predicting Railroad Bankruptcies in America", *Bell Journal of Economics and Management Science*, vol. 4 no. 1, pp. 184-212.

Bird, R.G. & McHugh, A.J. 1977. "Financial Ratios - An Empirical Study", *Journal of Business Finance and Accounting*, vol. 4 no. 1, pp. 29-46.

Casey, C. & Bartczak, N. 1985. "Using Operating Cash Flow Data to Predict Financial Distress: Some Extensions", *Journal of Accounting Research*, vol. 23, pp. 384-402.

Clark, C.E., Foster, P.L., Hogan, K.M. & Webster, G.H. 1997. "Judgemental Approach to Forecasting Bankruptcy", *Journal of Business Forecasting Methods and Systems*, vol. 16 no. 2, pp. 14-19.

Coats, P.K. & Fant, L.F. 1993. "Recognizing Financial Distress Patterns Using a Neural Network Tool", *Financial Management*, vol. 22 no. 3, pp. 142-156.

Darayseh, M., Waples, E. & Tsoukalas, D. 2003. "Corporate Failure for Manufacturing Industries using Firms Specific and Economic Environment with Logit Analysis", *Managerial Finance*, vol. 29 no. 8, pp. 23-36.

Goldstein, H. 1991. "Nonlinear Multilevel Models, with an Application to Discrete Response Data", *Biometrika*, vol. 78 no. 1, pp. 45-52.

Hossari, G. 2006. "A Dynamic Ratio-Based Model for Signalling Corporate Collapse", *Journal of Applied Management Accounting Research*, vol. 4 no. 1, pp. 11-32.

Hossari, G. 2007. "Modelling Corporate Collapse: Definitional Issues of the Collapse Event", *Journal of Applied Management Accounting Research*, vol. 5 no. 2, pp. 75-83.

Hossari, G. 2009. "Absence of Industry Effect in Modelling Corporate Collapse in Australia", *Global Economy and Finance Journal*, vol. forthcoming.

Hossari, G. & Rahman, S. 2005. "A Comprehensive Formal Ranking of the Popularity of Financial Ratios in Multivariate Modeling of Corporate Collapse", *Journal of American Academy of Business, Cambridge*, vol. 6 no. 1, pp. 321-327.

Huberty, C.J. 1994. *Applied Discriminant Analysis*, John Wiley, New York.

Jones, S. & Hensher, D.A. 2004. "Predicting Firm Financial Distress: A Mixed Logit Model", *Accounting Review*, vol. 79 no. 4, pp. 1011-1038.

Klecka, W.R. 1982. *Discriminant Analysis*, 5TH edn, Sage Publications, London.

McCullagh, P. & Nelder, J. 1995. *Generalized Linear Models*, 2ND edn, Chapman and Hall, London.

Ohlson, J.A. 1980. "Financial Ratios and the Probabilistic Prediction of Bankruptcy", *Journal of Accounting Research*, vol. 18 no. 1, pp. 109-138.

Raudenbush, S.W. & Bryk, A.S. 2002. *Hierarchical Linear Models Applications and Data Analysis Methods*, 2ND edn, Sage Publications, Inc., Thousand Oaks.

Sheppard, J.P. & Fraser, S. 1994. "The Dilemma of Matched Pairs and Diversified Firms in Bankruptcy Prediction Models", *Mid-Atlantic Journal of Business*, vol. 30 no. 1, pp. 9-26.

Zmijewski, M.E. 1984. "Methodological Issues Related to the Estimation of Financial Distress Prediction Models", *Journal of Accounting Research*, vol. 22, pp. 59-82.