

THE PREDICTION OF CORPORATE FINANCIAL DISTRESS AND BANK CREDIT DECISIONS: HONG KONG EMPIRICAL EVIDENCE*

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1. Introduction

In the course of financial intermediation when commercial banks gather deposits and extend credit, loans become a major component of their asset portfolios. Management of credit risk represents then an important bank function. Credit risk management encompasses three broad phases, namely, the pre-decision credit risk assessment, the credit decision, and the post-decision credit risk pricing and control.

In Hong Kong, the 1980s witnessed waves of bank failures stemmed not only from inadequate bank supervision from the local monetary authority but also and more fundamentally from mismanagement on the part of the banks themselves, particularly the mismanagement of their credit risk. The financial crisis began in early 1980s when a number of small finance companies went bankrupt, leaving their depositors' money unpaid. This was then followed by a series of bank failures, notable examples of which are the failure of Hang Lung Bank in 1983 and Overseas Trust Bank in 1985 and their ultimate takeovers by the Hong Kong Government. Ka Wah Bank became insolvent and was acquired by China International Trust & Investment Corp in 1986. Other banks which experienced financial problems and were subsequently bailed out by the government or by the larger banks in the 1980s include Hong Kong Industrial & Commercial Bank, Wing On Bank, Union Bank of Hong Kong, and Hon Nin Bank. More recently, Bank of Credit and Commerce similarly liquidated its business in 1991. A major common characteristic observed of these problem banks was the poor quality of their loan portfolios. This points vividly to the significance of effectively managing a bank's credit risk.

Credit decisions carry the usual financial objective of maximizing the market value of the bank and are hence critical decisions to make. However, to arrive at a sound credit decision, it is necessary that the credit risk of the potential borrower be properly assessed prior to the decision.

Bankers have been using various methods, both technical and judgmental, to evaluate credit risk. Classification model is one of the techniques that has been gaining increasing application in bank management. These models assist basically in predicting future corporate financial distress, which will in turn contribute to assessing the credit risk involved.

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2. Distress Prediction Models

Predicting corporate financial distress requires information input. While the primary source of information has been the firms' financial statements, capital market variables can also form an input to the prediction process.

The vast majority of the studies to date on distress classification involved analyses of the firms' financial statements, which can be either univariate or multivariate. Univariate analysis is found in many of the earlier work to predict distress, e.g., Beaver (1966), Altman (1973), and Zmijewski (1983). Univariate studies are obviously deficient in that different variables can imply different predictions for the same firm.

Given the serious weakness of the univariate models, much efforts have been devoted to the development of multivariate prediction models which prescribe typically a dependent variable as either a prediction as to group membership or a probability estimate of group membership. Though Hamer(1983) contends that classification performance of multivariate models is not highly sensitive to the choice of statistical techniques, there have evolved over the past years a number of techniques in multivariate analysis, namely, multiple discriminant analysis, multi-logit or probit analysis, recursive partitioning analysis, and neural networks.

Multiple discriminant analysis (MDA) aims to classify observations into one of two groups, based on a set of predesignated variables. The classic study by Altman (1968) suggested the usefulness of MDA as a basis for distress prediction. Altman's linear formula was made up of differently weighted financial ratios that best discriminate between solvent and insolvent firms. Prediction accuracy of his model was evident for 2 years prior to bankruptcy when tested on a range of U.S. companies of similar asset sizes in the manufacturing sector. Altman contends that his model could be used to complement, *inter alia*, business loan evaluation, by rating a borrower's overall performance (via Z-score) and by pinpointing problem areas (via individual ratios). Altman's model was later extended by Altman, Haldeman and Narayanan (1977) who coined the term ZETA Analysis. In fact, the Z-score and the ZETA model are predictive in the sense that the coefficients of the discriminant function possess expectational content because they are estimated prior to the actual past bankruptcies.

Prompted by the Altman (1968) study, numerous researchers attempted to apply MDA in distress classification in the past two decades or so. Some examples of studies in this area include Edmister (1972), Altman (1973), Blum (1974), Altman et al. (1977), Altman et al. (1981), Scott (1981), Ball and Foster (1981), Zavgren (1983), Sinkey et al. (1987), Gilbert et al. (1990), Platt and Platt (1990, 1991), Hsieh (1993), and Altman, Eom and Kim (1994).

While MDA is successful in analyzing a whole profile of firm variables simultaneously rather than sequentially examining its individual characteristics, it suffers from some difficulties:

- (i) The basic assumption of MDA which compares the characteristics of a solvent set with those of an insolvent set may be open to question. The varying discriminant coefficients in the MDA models tend to pull the characteristics of a solvent set as far as possible from those of an insolvent set of firms. The net effect is a generic comparison which ignores the idiosyncrasies of firms;
- (ii) A more serious weakness of MDA lies perhaps in its sectoral limitation which requires separate models for different industry sectors and firms of different asset sizes. Given the computational routines needed to determine the discriminant coefficients, MDA does not seem practical.

In order to improve upon the robust but restrictive discriminant structure, ohlson's (1980) logit-regression framework and Zmijewski's (1983, 1984) probit analysis model were put forward to quantify the likelihood of bankruptcy and assess more directly the impact of specific variables on the distress probability. Zavgren (1985) and Koh (1992) represent, among others, the more recent efforts to apply probit and logit analyses in distress prediction.

Another method in distress classification is Recursive Partitioning Analysis (RPA), a technique based on pattern recognition. Marias, Patell and Wolfson (1984) and Frydman, Altman and Kao (1985) applied Classification and Regression Trees, a variant of the RPA, to the problems of classifying commercial bank loans according to default risk and predicting financial distress respectively. RPA, as opposed to the more widely used classification models, such as MDA, is nonparametric in nature and enjoys the advantages of use under very general conditions, and ease of understanding and computation. The combination of multivariate analysis and simple splits based on a single variable makes RPA attractive. RPA helps eliminate many of the problems associated with MDA. Indeed, when Srinivasan and Kim (1987) analyzed the relative performance of classification procedures, they concluded that RPA was slightly superior as a classification model.

More recently, an artificial intelligence methodology known as Neural Networks (NN) has been offered as a solution to the statistical problems of many other classification techniques, such as MDA. In the NN method, input information, e.g., ratios, and their associated outputs, e.g., firm failure, can be analyzed to reflect satisfactorily all of the input-output associations. Like RPA, NN do not rely on the variables being linearly separable or independent of each other. Subtle interrelationships among variables can be discerned,

and qualitative assessment as well as inconsistent and incomplete data can be dealt with. Karels and Prakash (1987), Raghupathi et al. (1992), Rahimian et al. (1992), Chung and Tam (1993), Coats and Fant (1993), and Altman, Marco and Varetto (1994) assessed NN for distress prediction and concluded the promising and superior performance of the NN approach. Altman, Marco and Varetto (1994) pointed out, however, that the NN systems suffer from the problems of illogical weightings of the indicators and overfitting in the training stage, and suggested to integrate NN with MDA for predictive reinforcement.

Among the many research studies in multivariate distress prediction, an interesting attempt to depart from the use of MDA is the work of Bathory (1984) in Britain. He developed a prediction model which prescribes a linear relationship between the firm's synoptic financial condition and 5 financial ratios as independent causal variables with equal coefficients or weights. Accordingly, this model is also free from the problems with MDA discussed above, and was found to be of high predictive power. In fact, the present study, details of which will be described in later sections of the paper, seeks to test empirically the performance of this Bathory model based on Hong Kong company data.

The above paragraphs review briefly the methodologies of distress prediction based primarily on the analyses of the firms' financial statements. But, as capital market variables, such as security returns and bond ratings, contain current information about corporate conditions over and above that in models based on financial statement data, some researchers turned their attention to examining the reaction of the capital markets to corporate distress, e.g., Aharony et al. (1980), Pettway and Sinkey (1980), Altman and Brenner (1981) and Clark and Weinstein (1983), Zavgren et al. (1988), and Altman (1989).

While distress prediction models have many applications in business, its potential in credit risk assessment should be tremendous. Myers and Forgry (1963), Apilado et al. (1974), Orgler (1975), Wiginton (1980), and Clarke and McDonald (1992) individually developed scoring models for consumer loans. On the other hand, Edmister (1972), Chesser (1974), Altman (1980), Cowen and Page (1982), Fulmer et al. (1984), Whitted and Zimmer (1985), Wood and Piesse (1988), and Altman (1993) attempted to apply classification models in commercial lending decisions.

To date, the majority of the studies in distress prediction were performed on U.S. data, but similar work in other countries have also been reported and many of these were documented in the *Journal of Banking & Finance* (JBF), Vol. 8, No. 2, 1984, and JBF's "Special Studies in Finance", Vol. 7, 1988. Further, Altman (1993) presented a more updated international bibliography on non-U.S. models.

In the Asia-Pacific region, Castagna and Matolcsy (1981), Izan (1984), and Lincoln

(1984) studied corporate distress in Australia; and Takahashi, Kurokawa and Watase (1984), Bidin (1988), Ta and Seah (1988), Bhatia (1988), and Altman, Eom and Kim (1994) developed distress classification models for firms in respectively Japan, Malaysia, Singapore, India, and Korea. Nonetheless, it appears that, in Hong Kong, no work of similar kind has ever been done and, accordingly, a study is directed to develop and to test empirically a model for predicting business insolvency in Hong Kong.

3. The Model

The present study employs the Bathory's (1984) Corporate Insolvency Prediction Model which takes the following form:

$$Y = 0.2 (X_1 + X_2 + X_3 + X_4 + X_5)$$

where

X_1 = Gross cash flow/current debt (debt service ability)

X_2 = Pre-tax profit/capital employed (annual profitability)

X_3 = Equity/current liabilities (reserves adequacy)

X_4 = Tangible net worth/total liabilities (cumulative profitability)

X_5 = Working capital/total assets (liquidity)

Y = Synoptic financial condition, or degree of solvency or insolvency

(if $Y > 20$, the firm is predicted to be solvent, and if $Y < 20$, the firm is predicted to be insolvent)

Insolvency refers to the inability of a firm to meet its financial obligations as they fall due. For the purposes of this model, however, it specifically means outright firm failures or situations of trading only with the continued support of the firm's creditors.

The cutoff point of 20 for the model was estimated on an initial estimation sample of firms in the U.K., and the predictive ability of the model was further examined on a holdout sample of U.K. firms.

For the present study, the Bathory model is viewed as a more appropriate model to use on a number of grounds:

- (i) The model is multivariate in nature.
- (ii) The Bathory model departs significantly from the traditional MDA models given their limitations as described in the previous section. It is a simple and naive model with equal weights for each independent variables; and hence does not require the estimation of the discriminant coefficients, which might be too complicated and time-

consuming for the decision-makers in industries. The model can thus be used to test firms, public or private, of any asset sizes and in any industry sector. Given its simplicity and generality of use, the model should prove to be of practical value to the decision-making of the practitioners in industries. Indeed, Myers and Forgy (1963) demonstrated that equal weights yielded superior discriminating power.

- (iii) The independent variables of the model were selected after numerous test runs from 25 short-listed ratios as having a high degree of predictive ability.
- (iv) The model itself is not proprietary, and requires the minimum statutory accounting data disclosed by private companies. More importantly, Hong Kong accounting practices resemble those of the U.K., thus making the financial ratios from the two countries more comparable with each other so that the Y scores will not be distorted. According to Argenti (1976) and Richmond (1977), U.S. ratios used in Altman's model are not directly comparable with ratios for British firms, and tests on U.K. firms showed anomalies.

4. Data

The sample contains 34 small- to medium-sized private companies operating in Hong Kong of widely varying asset sizes and engaged in different business activities. It is divided into 2 sub-samples:

- (i) Insolvent Set (HK), containing 17 insolvent firms; and
- (ii) Solvent Set (HK), containing 17 solvent firms.

The data of these 34 firms were collected in 1990 from their financial statements for different years from 1982 to 1988 retrieved from the loan files of one of the branch offices of a commercial bank in Hong Kong.

In an attempt to demonstrate the generality of use of the model, as opposed to the MDA, the 34 firms were selected so as to cover as wide a range of firm sizes and industries as possible. Total asset value of the firms in the sample varies from HK\$1 million to HK\$300 million, and the firms are operating in different industries, including manufacturing (e.g., handbags, jewellery), service (e.g., import/export, marketing) and investment (e.g., properties, land investment). Tables 1 and 2 give more information about the data sample.

Table 1: Data Sample by Asset Size

Asset Size (HK\$ million)	No. of firms	%
<\$10	19	56
\$10 - \$100	10	29
>\$100	5	15
	34	100

Table 2: Data Sample by Industry Sector

Industry	No. of firms	%
Jewellery manufacturing	5	15
Garment manufacturing	4	12
Handbag manufacturing	2	6
Property development & investment	4	12
Trading, and import/export	11	31
Retailing	4	12
Fashion design	1	3
Service, e.g., marketing agency	3	9
	34	100

5. Methodology and Results

5.1. The Bathory (1984) Study

The approach to this study is similar to that of Bathory who, based on his own corporate insolvency prediction model, tested in 1984 a sample of 40 U.K. firms of varying asset sizes and business activities using 1980/81 financial data. The sample contains 2 sub-samples, namely, a set of 20 insolvent firms, and a set of 20 solvent firms. His results are summarized in Table 3 and imply a good predictive performance of the model, which should be no worse than the more traditional MDA in insolvency classification. The predictive time horizon is about 2-3 years.

Table 3: The Bathory (1984) Results

	no. of firms		total	prediction accuracy
	$Y < 20$	$Y > 20$		
Insolvent Set	19	1	20*	95%
Solvent Set	1	19	20**	95%

* all 20 firms became insolvent in 1982-84.

** all 20 firms remained solvent in 1981-84.

5.2. Computation of Y Scores

This study commenced in 1990 and continued till 1994. The Y scores were computed in 1990. Detailed statistics are presented in the Appendix, and a summary of the results appears in Table 4.

While the firms in the Insolvent Set (HK) were known in 1990 to have been insolvent, observations subsequent to Y score computation in 1990 were made about the performance of the firms in the Solvent Set (HK) during the years 1990-1994. Evidence reveals vividly the high predictive power of the model, which compares favourably with Bathory's (1984) results. However, in order to confirm the capability of the model when applied in the Hong Kong context, Chi-square tests are performed to prove that the local results do not differ significantly from their U.K. counterparts.

Table 4: Summary of Y Scores Computed in 1990

	Y < 20	no. of firms Y > 20	total	prediction accuracy
Insolvent Set (HK)	13	4	17*	77%
Solvent Set (HK)	1	16	17**	94%

* all 17 firms became insolvent since 1982-1988.

** all 17 firms remain solvent till 1994.

Chi-square Test on Insolvent Set

Let $H_0: \pi_1 = \pi_2$

$H_1: \pi_1 \neq \pi_2$

where

π_1 = proportion of firms with Y < 20 in Insolvent Set (UK) (Bathory's sub-sample of insolvent firms in the U.K.)

π_2 = proportion of firms with Y < 20 in Insolvent Set (HK)

Significance level = 0.01

Degree of freedom = 1

Critical X^2 = 6.635

	Observed Frequencies		total
	Y < 20	Y > 20	
Insolvent Set (UK)	19	1	20
Insolvent Set (HK)	13	4	17
	32	5	37

	Expected Frequencies		total
	Y < 20	Y > 20	
Insolvent Set (UK)	17.3	2.7	20
Insolvent Set (HK)	14.7	2.3	17
	32.0	5.0	37

Computed $X^2 = 2.691 < 6.635$

Therefore, accept H_0 , and reject H_1

Chi-square Test on Solvent Sets

Let $H_0: \pi_3 = \pi_4$

$H_1: \pi_3 \neq \pi_4$

where

π_3 = proportion of firms with Y > 20 in Solvent Set (UK) (Bathory's sub-sample of solvent firms in the U.K.)

π_4 = proportion of firms with Y > 20 in Solvent Set (HK)

Significance level = 0.01

Degree of freedom = 1

Critical $X^2 = 6.635$

	Observed Frequencies		total
	Y < 20	Y > 20	
Solvent Set (UK)	1	19	20
Solvent Set (HK)	1	16	17
	2	35	37

	Expected Frequencies		total
	Y < 20	Y > 20	
Solvent Set (UK)	1.1	18.9	20
Solvent Set (HK)	0.9	16.1	17
	2.0	35.0	37

Computed $X^2 = 0.022 < 6.635$

Therefore, accept H_0 , and reject H_1

6. Conclusion

Both Bathory (1984) and this study demonstrated the high degree of predictive ability of the model in the U.K. and the Hong Kong settings respectively. The results of the present study using Hong Kong data are further found to be consistent with those of Bathory, i.e.,

the two sets of results do not differ significantly. It can therefore be concluded that Bathory's insolvency prediction model is useful in the Hong Kong environment and possibly also in other countries, and should be an aid to credit decision making of the commercial bankers, with a prediction horizon of around 2-4 years. This should in turn facilitate the financial intermediation process in the economy.

More specifically, several significant findings emerged from this study. First, the model tested is not as restrictive as the more traditional MDA models and can be applied to firms of all sizes and in any industries, and further, it avoids the time-consuming computations necessary to estimate the discriminant coefficients. Its simplicity and generality of use makes the model a practical one, which should be of interest to the practitioners in industries and should add value to their decision-making process, e.g., the credit decisions of the bankers. Secondly, the study overcomes a major weakness of prior work in this area, namely, the retrospective or ex post nature of the analysis; samples invariably included firms that were known to have failed or not failed on a set date. On the contrary, this study has attempted to make predictions about the future solvent or insolvent status of the firms in the Solvent Set (though not the firms in the Insolvent Set) by observing their operation through the years 1990 (year of Y score calculation) to 1994. The true test of the model's predictability is therefore more properly addressed. In addition, the model used in the present study yields a Type I misclassification error which is lower than the Type II error. This is a virtue given the fact that Type I error is normally much more costly than Type II error. In fact, Altman et al. (1977) reported that, in bank loan decisions, the cost of a Type I error was 35 times that of a Type II error.

Appendix: The Y Score

Firm	X ₁	X ₂	X ₃	X ₄	X ₅	Y*	Data**	Insolvent***
1	2.1	4.9	37.5	13.0	9.2	13	1982	1983
2	-69.0	-0.1	-94.4	-95.2	-1704	-393	1984	1985
3	70.0	255.1	26.1	26.1	15.6	79	1983	1985
4	0.4	6.2	19.1	-56.2	3.7	-5	1983	1985
5	62.2	43.3	26.2	26.1	9.0	33	1986	1988
6	3.4	3.9	54.8	-76.3	25.1	2	1984	1985
7	3.5	5.3	29.0	-28.0	18.9	6	1984	1985
8	14.3	21.7	55.9	55.9	12.1	32	1983	1984
9	5.8	2.4	90.9	83.1	28.1	42	1985	1986
10	0.1	-0.3	12.8	-20.3	11.5	1	1985	1986
11	0.4	-1.3	24.1	24.1	18.1	13	1980	1984
12	-12.8	-28.2	35.4	-55.4	-117.6	-36	1984	1984
13	-8.5	169.3	-6.4	-28.4	-52.8	15	1982	1984
14	-0.1	-0.2	59.5	59.5	-62.6	11	1983	1984
15	-85.3	8.6	-38.2	-62.8	-158.7	-67	1981	1982
16	-88.7	102.8	-32.0	-32.0	-89.3	-28	1985	1985
17	-8.3	-11.5	-19.5	-10.2	0.0	-10	1983	1983
18	51.5	10.2	446.9	446.9	58.4	203	1986	-
19	50.5	19.5	168.7	168.7	56.4	93	1986	-
20	154.0	30.4	79.5	66.2	36.0	73	1987	-
21	698.4	33.0	203.2	203.2	66.5	241	1987	-
22	31.7	48.5	33.2	23.6	-1.4	27	1986	-
23	5.8	38.5	23.8	17.8	20.3	21	1987	-
24	9300	21.9	254.3	254.3	57.0	1977	1987	-
25	50.4	61.6	47.5	12.8	22.3	39	1987	-
26	6550	27.4	90.9	90.9	46.0	1361	1987	-
27	23.0	11.2	178.7	174.2	17.4	81	1987	-
28	341.0	7.5	1345	1330	85.0	622	1986	-
29	79.0	65.8	116.0	116.0	13.7	78	1987	-
30	12.3	4.1	62.2	37.4	-43.1	15	1988	-
31	110.5	72.1	114.6	114.6	25.0	87	1987	-
32	28.3	2.1	1049	1049	-8.6	424	1987	-
33	21.5	37.0	27.2	11.1	16.4	23	1988	-
34	957.9	14.7	7105	7105	16.1	3040	1987	-

* All Y scores were calculated in 1990.

** Year of data on which computation of the Y scores was based.

*** The Year since which the firm became insolvent.

Note:

1. The Insolvent Set (HK) contains firms 1-17; all 17 firms in this Set became insolvent since the years shown.

2. The Solvent Set (HK) contains firms 18-34; all 17 firms in this Set remain solvent from the years of their respective Y scores to the year 1994.

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Abstract

This is the first study in Hong Kong to investigate the usefulness of financial distress prediction models in bank credit decisions. Using data from a sample of solvent and insolvent firms in Hong Kong, the predictive ability of a distress classification model is examined. This model, as distinct from the models based on multiple discriminant analysis, is simple and easy to use and can be applied to firms of all sizes and in different industries. Evidence indicates a high predictive power of the model which should therefore be an aid to the credit decision-making process of the bankers in Hong Kong and possibly also in other countries. This should in turn facilitate the financial intermediation process in the economy.