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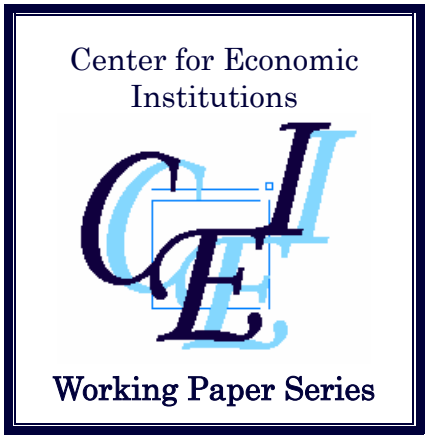

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Can Corporate Governance Variables Enhance the Prediction Power of Accounting-Based Financial Distress Prediction Models?

Tsun-Siou Lee*, Yin-Hua Yeh** and Rong-Tze Liu**

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Abstract

We integrated accounting, corporate governance, and macroeconomic variables to build up a binary logistic regression model for the prediction of financially distressed firms. Debt ratio and ROA are found to be the most explanatory accounting variables while the percentage of directors controlled by the largest shareholder (which measures negative entrenchment effect), management participation, and the percentage of shares pledged for loans by large shareholders are shown to have positive contribution to the probability of financial distress. For macroeconomic sensitivities, firms with higher sensitivities to the annualized growth rates of manufacturing production index and money supply (M2) are more vulnerable to financial distress.

As to the issue of sampling technique, we find that oversampling of distressed firms is subject to the problem of choice-based sample bias pointed out by Zmijewski (1984). The classification accuracy is overstated consequently. We try to include as many healthy firms as possible in our sample instead of following the traditional 1: 1 or 1: 2 matching principle. The results show that the classification accuracy is mostly significantly improved in our integrated prediction model when the sample is closest to the actual population.

For the trade-off between type I and type II errors in the predicted probability classification, we maximize the sum of classification accuracy for both groups of firms (the healthy and the distressed). It is found that an estimated probability of financial distress of 0.2000 represents the optimal cutoff point for predicting financial distress. Under such a cutoff scheme, our integrated model produces an in-sample classification accuracy of 80.7% for distressed firms and 93.2% for healthy firms. For out-sample prediction, 90% of the distressed firms and 85.4% healthy firms in 2001 are correctly identified using an integrated model built upon samples from 1998 to 2000.

Keyword：Corporate governance, Financial distress prediction model, Choice-based sample bias

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Introduction

Financial accounting information has long been widely used in explaining the possibility of corporate financial failures. Beaver (1966), Altman (1968) and Ohlson (1980), among others, are the mostly cited examples. However, financial data are ex post in nature, in the sense that audited annual statements are not released until next year. Furthermore, earnings management may create misleading information which, in most cases, exaggerates profitability to a certain degree[1]. It is therefore logical to search for more information other than accounting data when building early warning systems for financial distress.

Several researches point to the weakness in corporate governance as one of the major causes for Asian Financial Crisis that occurred in 1997[2]. For example, Rajan and Zingales (1998) and Prowse (1998) conclude that poor corporate governance on top of concentrated ownership structure paved the way to the Crisis. Johnson, Boone, Breach and Friedman (2000) find that in a poor corporate governance environment, agency problem tends to be more serious especially facing economic downturns. Thus both stock and currency markets are more vulnerable to unfavorable economic situation.

These literatures are mostly macro-empirical in nature, which investigate sample countries as a whole. Yet even in a country that runs into financial turmoil, there are still profitable firms that survive the crisis. Further micro-research based on individual firms, therefore, would help to generate more insights.

Under concentrated ownership structure, the hypothesis of convergence of

[1] Schipper (1989), Healy and Wahlen (1999) as well as Dechow and Skinner (2000) provide excellent review on earnings management.
[2] World Bank (1998) urged East Asian countries to strengthen corporate governance mechanism, such as investors protection, information transparency and stricter regulation on insiders trading.

interests (Jensen and Meckling, 1976) predicts that positive incentive effects are driven by high ownership of the controlling shareholder (Claessens, et al, 2002). On the other hand, Shleifer and Vishny (1997), La Porta et al. (1999) argue that conflicts of interests may exist between the controlling shareholder and small investors, which results in wealth expropriation. This leads to the hypothesis of negative entrenchment effects.

Pyramid ownership structure[3] and cross-shareholding are often employed to widen the gap between cash flow rights and voting rights. Claessens et al. (2002), La Porta et al. (2002), Lemman and Lins (2001) further provide evidence for the positive relationship between corporate value and investor protection are well as cash flow rights of the controlling shareholder, and for the negative relationship between corporate value and the discrepancy between cash flow rights and control rights.

Several types of behavior are characterized by La Porta, Lopez-de-Silanes, Shleifer and Vishny (2000) and Johnson et al. (2000)[4] to have adverse effects on corporate values and financial performances. However, to prolong the wealth expropriation, the controlling shareholders may not like to see their firms fall into bankruptcy as pointed out by Claessens, Djankov and Klapper (1999). This extra defense against financial distress is again carried out at the expense of the small shareholders. Thus even though we have strong evidence to support the negative association between corporate value and corporate governance, whether more likelihood of financial distress will follow remains an open question.

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[3] Pyramid structure refers to an ownership structure where multilayer control chains are created to enhance the controlling power. Cross-shareholding refers to a situation where firms hold shares of one another to entrench the control.

[4] Aside from direct embezzlement, other possible expropriation include the sale of assets, products or securities to another entity that the controlling shareholder owns at below-market price, the transfer or technologies to a third party without royalty payment, etc. Although these arrangements usually appear perfectly legal, their net effect may be as large as or even larger than direct embezzlements.

To solve or to clarify the puzzle, corporate governance variables such as cash flow rights, gap between control and cash flow rights, percentage of board members occupied by the controlling shareholders and percentage of shares pledged for bank loans by the controlling shareholders are chosen to measure the quality of corporate governance.

Rose, Andrews and Giroux (1982) advocate the inclusion of macroeconomic variable into early warning systems to increase the prediction power[5]. Tirapat and Nittayagasetwat (1999) include economic sensitivity of individual firms in addition to financial variables to build a macro-related micro-crisis investigation model through logit regression. They find macroeconomic sensitivity of firms represents a key set of indicators of financial difficulties. Deteriorating macroeconomic environment increases the systematic risk of all firms, but firms with higher sensitivity to macroeconomic volatility tend to be more vulnerable to financial distress. Thus several measures of firms' sensitivity to macroeconomic situation are incorporated into our model.

In sum, the purposes of the paper are:

1. to search for variables that are capable of explaining corporate financial failures;
2. to build a financial distress prediction model that integrates accounting, corporate governance and macroeconomic sensitivities;
3. to investigate the effects that over-sampling financial distressed firms has on the percentage of correct classification.

[5] They find nine macroeconomic indicators to be highly correlated with the likelihood of corporate financial failures, namely, Dow Jones Industrial Average Index, unemployment rate, market-wide profitability, coupon rate of AAA-rated bonds, gross savings rate, changes in corporate investments,

The remainder of the paper is organized as follows. Section II describes our sample and the definitions of the operating variables. Section III introduces binary logistic regression model and summarizes the resulting empirical findings. We analyze the classification accuracy of our model and discuss the possible upward bias in classification accuracy due to choice-based sample bias of different sample-matching schemes in Section IV, followed by a brief conclusion in Section V.

II. Samples and Operating Variables

1. The sample

When a listed company gets into financial distress, the trading of its shares is automatically changed into cash basis (with 100% margin requirement), or it may be subject to trading halt, or even get delisted by Taiwan stock Exchange. We search for financially distressed firms between 1998 and 2001 from the Central Communication Briefing System as well as other newspapers, and collect 57 firms that satisfy our definition of financial distress.

Matching samples or financially healthy firms are those which had been listed for at least five years before 1998, and had not been qualified as financially distressed firms defined by Whitaker (1999) and Hopwood et al. (1994)[6]. In addition, financial industry as a whole is excluded from our sample due to their different financial and business nature. Those with insufficient data to compute ownership structure and board composition are also discarded. The final samples are summarized in Table1.

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averages output per hour, new orders on durable goods, and free reserves.

[6] Financial distress is defined as either (1) insufficient net operating cashflows to repay maturing debts and loss of corporate market value, or (2) the occurrence of at least three out of the following four types of events: negative operating cash flow in the current year; operating loss in any of the last three years; negative retained earnings in any of the last three years; net loss in any of the last three years.

Table 1: The sample of financially distressed and healthy firms

Year	Number of Firms		Ratio of Distressed to healthy firms
	Distressed	Healthy	
1998	15	94	0.160
1999	17	99	0.172
2000	15	125	0.120
2001	10	137	0.073
	57	455	0.125

2. The Operating Variables

Our integrated prediction model incorporates three types of variables, namely, accounting information, corporate governance attributes and macroeconomic sensitivity. For the first two types of variables, we collect the related data for the year before the distress. Macroeconomic sensitivities are estimated using five-year stock returns and macroeconomic data prior to the distress.

A. Accounting information

The most commonly used accounting information in the related literature is collected from Taiwan Economic Journal (TEJ). They include

(1) debt ratio＝total liabilities/total assets
(2) return on asset(ROA) ＝EBIT/average assets
(3) Current ratio＝current assets/current liabilities
(4) Quick ratio＝quick assets/current liabilities
(5) Interest coverage ratio＝EBIT/interest expense
(6) Fixed ratio＝fixed assets/total assets
(7) Inventory turnover＝cost of goods sold/ average inventory
(8) A/R turnover＝sales/accounts receivables
(9) Total asset turnover＝sales/average assets
(10) before tax profit margin＝ net income before tax/ net sales

B. Macroeconomic sensitivities

We regress five-year monthly share returns against several macroeconomic variables with monthly data to obtain estimated sensitivities of stack returns to macroeconomic conditions. These estimated sensitivities are then incorporated into our prediction model, to be discussed later. Five macroeconomic variables are selected: (1) annualized growth rate of manufacturing production index (F1), (2) annualized growth rate of CPI (F2), (3) monthly changes in interest rate of 30-day commercial paper in the primary market (F3), (4) annualized growth rate of money supply (M2) (F4), and (5) the general scoring of economic situation (F5) provided by the Council of Economic Development. The higher the estimated sensitivities, the more vulnerable the company is to the changing economic environment, thus the more likely the company is going to get into financial distress facing worsening economic situation.

C. Corporate governance variables

The concept of ultimate control proposed by La Porta et al. (1999) is applied to compute cash flow right and voting right. The voting right of the largest shareholder constrains both direct and indirect control rights. Direct control refers to the ownership registered under the shareholder's own name while indirect control refers to the ownership registered under a third party which is in turn controlled by the same shareholder. Indirect control is usually achieved through cross-shareholding and/or pyramid ownership structure. If the largest shareholder is a family, then shares registered under the names of relatives, either by blood or marriage ties, to the second order are all included to compute the total voting rights.

For a multiple control chain structure, we follow the methodology employed by

Claessens et al. (2000) and add up the minimum voting right along all control chains. On the other hand, cash flow right is the sum of the products of ownerships along all control chains. Voting rights, or control rights measures the degree of control of the largest shareholder over corporate decisions. Cash flow right, on the other hand, measures the share of profit or loss resulting from their decisions.

Figure 1 demonstrates the computation of voting right and cash flow right. Suppose family A owns 30% of the shares of company Z, which in turn owns 20% of company Y. In addition, family A also owns 40% of company X who is a 10% owner of company Y. Two control chains are involved in the pyramidal structure. By Claessens et al. (2000) definition, the control right of family A over company Y through company Z is the minimum of 30% and 20%, which is 20%, the control right through company X is the minimum of 40% and 10%. Summing up these two control rights, we have 30% of control rights over company Y by family A.

The cash flow rights of family A over company Y is 30%×20%=6% through the first chain, and 40%×10%=4% through the second chain. The total cash flow right comes to 10%. We see immediately the discrepancy of voting right away from cash flow right to be 30%-10%=20%. This provides a measure of the possibility of minority shareholder wealth expropriation in Claessens' sense.

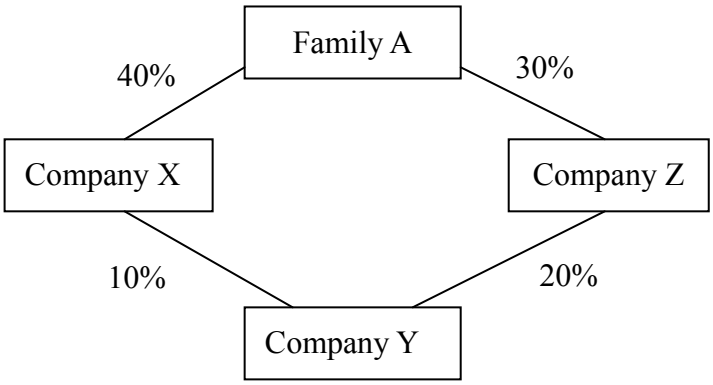

Figure 1: An example of pyramid structure and multiple control chains

Sometimes we find the intermediate companies are private companies whose ownership structures are not disclosed to the public. Under these circumstances, we first identify the control chain by looking at the representatives these intermediate companies send to the board of the controlled company. If the representatives belong to the family, the implicit control chain is confirmed. These information can be found from "The Research on Business Conglomerates in Taiwan" published by China Credit Corporation. The ownership of these intermediate companies over the sample companies can be collected from the prospectus of the target companies.

Although the above procedure enables us to identify the control chains, we still don't know how much the largest shareholder owns the intermediate companies. We are therefore forced to make an assumption that these intermediate private companies are 100% owned by the largest shareholder and his affiliates.

For the composition of the board of directors and supervisors, we search through the identities of all board members, include representatives sent by institutionals. The percentage of board members affiliated to the controlling shareholder is then computed to measure the degree of control over the board of directors and supervisors.

We also collect the percentage of shares pledged for bank loans by the controlling shareholder and all board members. It is meaningful in the sense that the higher the pledge ratio, the lower the stake the controlling shareholder has on the target firms, and therefore the more likely they would do something harmful to the minority shareholders. In effect, it provides leverage over the cash flow right.

Two dummy variables are defined to measure management participation by the controlling shareholder and to identify the existence of a second largest shareholder.

The management participation dummy takes the value of one if both chairman and CEO are affiliated with the controlling shareholder, and zero otherwise. The second dummy variables takes the value of one if a second largest shareholder exists with at least 5% ownership, and zero otherwise. It represents the existence of an outside monitoring function.

III. Binary Logistic Regression Model and the Empirical Results

Binary Logistic Regression Model (BLRM) was first applied by Ohlson (1980) to predict corporate financial distress. It is superior to linear probabilistic model in the sense that it doesn't require normality assumption and it guarantees the estimated probability to be between zero and one. Let Y measures the occurrence of financial distress. It takes the value of one if the sample firm falls into financial distress and zero otherwise. The probability of firm *i* being financially distressed is denoted as P_i^1.

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

Where

$$Z_i = \hat{a} + \sum_k \hat{b}_k \beta_{k,i} + \sum_j \hat{c}_j X_{j,i} + \sum_m \hat{d}_m G_{m,i} \qquad (2)$$

And

$\beta_{k,i}$ = the sensitivity of firm i to k_{th} macroeconomic variable

$X_{j,i}$ = the j_{th} accounting variable of firm *i*

$G_{m,i}$ = the m_{th} corporate governance variable of firm *i*

$\hat{a}$,$\hat{b}_k$,$\hat{c}_j$,$\hat{d}_m$ are regression coefficients

It follows that

$$Logit\left(P_i^1\right) = \log_e\left[\frac{P_i^1}{1-P_i^1}\right] = Z_i \qquad (3)$$

If the predicted probability of financial distress, $P_i^1 < 1 - P_i^1$, then firm i will be classified as a healthy firm, otherwise it will be classified as a financially distressed one.

1. The Descriptive Statistics of the Sample

We first summarize the sample characteristics a year before the financial distress in Table 2. The results of tests on the differences in means of all three types of variables are also provided.

Table 2：Basic statistics and tests of differences in means

Variables	Type of firms	mean	std. dev.	t-stat	p-value
A. Accounting variables					
Debt ratio (%)	healthy	39.42	13.70	-10.71	0.000***
	distressed	61.11	19.29		
ROA (%)	healthy	6.07	6.96	10.20	0.000***
	distressed	-6.94	18.92		
Current ratio (%)	Healthy	180.44	124.08	3.61	0.001***
	distressed	117.68	119.94		
Quick Ratio (%)	Healthy	110.20	99.33	4.34	0.000***
	distressed	50.99	75.85		
Inventory turnover	healthy	7.48	9.97	2.14	0.030**
	distressed	4.60	4.84		
A/R turnover	healthy	8.64	11.45	1.04	0.293
	distressed	7.01	7.05		
Asset turnover	healthy	0.62	0.39	1.73	0.081*
	distressed	0.52	0.35		
Fixed asset ratio (%)	healthy	30.22	18.93	-0.84	0.390
	distressed	32.50	20.81		
Before tax profit margin (%)	healthy	2.69	43.46	4.94	0.000***
	distressed	–28.61	56.24		
Interest coverage	healthy	216.05	2949.30	0.54	0.580

(times)	distressed	1.61	33.52		
B. Macroeconomic sensitivities [#]					
β_1	healthy	-0.05	0.29	-2.22	0.02**
	distressed	0.04	0.60		
β_2	healthy	-0.51	1.84	-1.60	0.10
	distressed	-0.10	1.74		
β_3	healthy	0.89	26	3.84	0.00***
	distressed	–0.53	4.77		
β_4	healthy	-0.16	1.46	-5.66	0.00***
	distressed	1.11	2.49		
β_5	healthy	0.26	0.56	-0.78	0.43
	distressed	0.32	0.61		

Table 2：Basic statistics and tests of differences in means (continued)

Variables	**Type of firms**	**mean**	**std. dev.**	**t-stat**	**p-value**
C. Corporate Governance					
Voting right of the largest shareholder (%)	healthy	23.53	14.08	1.325	0.185
	distressed	20.94	12.19		
Cash flow right of the largest shareholder (%)	healthy	14.92	10.74	0.510	0.610
	distressed	14.16	8.96		
Discrepancy of voting right and cash flow right	healthy	8.61	9.69	1.380	0.168
	distressed	6.78	6.99		
Existence of a second largest shareholder (dummy)	healthy	0.25	0.43	1.346	0.178
	distressed	0.17	0.38		
Directors controlled by the largest shareholder (%)	healthy	55.65	25.38	-5.701	0.000***
	distressed	76.00	25.58		
Supervisors controlled by the largest shareholder (%)	healthy	51.30	39.85	-4.265	0.000***
	distressed	75.07	38.07		
Management participation (dummy)	healthy	0.47	0.50	-3.259	0.001***
	distressed	0.70	0.46		
Shares pledged for loans by large shareholders (%)	healthy	25.91	27.46	-8.910	0.000***
	distressed	60.21	26.87		

*: significant at 10% , **: significant at 5% , ***: significant at 1%

#: β_1 through β_5 are the sensitivity of monthly stock returns to annualized growth rate of manufacturing production index, annualized growth rate of CPI, monthly changes in 30-day interest rate of commercial paper, annualized growth rate of money supply (M2) and general scoring of economic situation.

For the year before the financial distress occurs, financially distressed firm and healthy firm have quite different financial ratios[7]. For example, the average debt ratio for healthy firms is only 39%, compared with 61% for distressed firms. Average ROA for healthy firms and distressed firms are 6.1% and –6.9%, respectively. Average current (quick) ratio are 180% (110%) and 118% (51%) respectively. These differences are statistically significant at 1% level.

For all three turnover ratios, i.e., inventory turnover, A/R turnover and asset turnover, which represent the effectiveness of asset utilization, healthy firms again show better performance than distressed firms. However, the benchmark of operating leverage (i.e., fixed asset ratio) and cash flow coverage for interest expense are not significantly different between the two groups[8].

We see from Table 2, that healthy firms display more negative sensitivity to the annualized growth rate of manufacturing production index, and the monthly change in 30-day primary commercial paper rate. As to the sensitivity to the annualized growth rate of money supply, healthy firms are more positively sensitive to it than distressed firms.

The percentage of directors and supervisors controlled by the largest shareholder, management participation and pledge ratio are significantly higher for distressed firms than for healthy firms. For instance, 76% of the directors of the board are controlled by the largest shareholders of distressed firms, compared with only 55.7% for healthy

[7] Accounting data for the year prior to the financial distress are used to compute the statistics. Since the financial reports are not released until April of the next year, it is possible that some firms have already fallen into financial distress before their financial reports are released. We did try to use the accounting data tow years prior to the financial distress, but corporate governance variables were difficult to collect in this case.

[8] For interest coverage, or times interest earned, the mean and standard deviation for healthy firms look awfully large. Upon double check, we find many healthy firms incur little interest expense, which results in high interest coverage. This in turn causes high standard deviation and low t-statistics.

firms. Moreover, 75% of the supervisors of the distressed firms are affiliated with the largest shareholders, as opposed to 51% for healthy firms.

As to management participation, we see from Table 2 that in 70% of the distressed firms, the largest shareholders serve as the chairman and CEO at the same time. The percentage for healthy firms is only 47%. On average, large shareholders of distressed firms pledge 60% of the shares for bank loans while only 26% is pledged by the large shareholders of healthy firms.

These statistics show that the corporate governance structures of these two types of firms are quite different from each other. However, voting rights, cashflow rights, and the discrepancy between them do not significantly differ between these two groups. This suggests that board composition may play a more important role than ownership structure in explaining financial distress.

2. The Empirical Findings

We use a stepwise regression model which combines forward selection and backward elimination for empirical purposes. The significance level for forward selection is set at 0.25 while is 0.30 for backward elimination. For accounting information, debt ratio, ROA, quick ratio and before tax profit margin are selected by the stepwise regression. For corporate governance variables, the percentage of directors (supervisors) affiliated with the largest shareholders, management participation, pledge ratio and cash flow right of the largest shareholders are selected by the stepwise regression as the most important explanatory variables.

Model I includes accounting variables alone. From Table 3, we see all the signs of the accounting variables are as expected, i.e., debt ratio has positive coefficient, implying higher probability of financial distress for firms with higher debt ratio, all

the other three variables have negative signs, implying lower probability of financial failure for firms with higher ROA, quick ratio and before tax profit margin. However, quick ratio and before tax profit margin do not achieve the required significance level.

Model II includes macroeconomic sensitivities in addition to accounting information as suggested by Tirapat and Nittayagasetwat (1999). Again all the signs of accounting variables are in line with our expectation. Similar to model I, only debt ratio and ROA are significant statistically. The only significant macroeconomic factor is the firm's sensitivity to the growth rate of money supply (β_4). The higher the firm's sensitivity to the growth rate of money supply, the higher is the probability of the firm's financial distress. As shown in Table2, the average sensitivity to money supply is positive (1.11) for distressed firms while is negative (-0.16) for healthy firms. Positive coefficient of β_4 for model II implies that slowing down in money supply growth rate represents a bad signal for distressed firms which increases the probability of their falling into financial distress. Other macroeconomic sensitivities, however, either do not enter the regression at all or are insignificant in statistical sense.

Model III incorporates both accounting and corporate governance variables. The results of binary logistic regression model are in accordance with our expectation. From Table 3, again we see debt ratio and ROA have strong explanatory power (significant at 1% level). The most powerful corporate governance variables are the percentage of directors controlled by the largest shareholders (significant at 5% level), and pledge ratio (significant at 1% level). Management participation obtains weak support for being a negative factor toward financial healthiness (significant at 10% level). Cash flow right and the structure of supervisory board, though correct in sign, do not show explanatory power significantly. Thus the results show that the quality of corporate governance does contribute to the probability of financial distress. When the

board of directors are effectively controlled by the largest shareholder, negative entrenchment effect or minority expropriation tends to be stronger, which in turn leads to higher probability of financial failure. Higher pledge ratio effectively lowers the cash flow right of the largest shareholder, in the sense that losses of the firms are shared by the banks (as the collaterals, i.e., the shares pledged will shrink in value) who provide credit to finance the shareholding. Thus, the probability of financial failure would be higher. Management participation weakens the monitoring function that the board of directors is supposed to have, and hence increases the probability of financial distress.

Finally, Model IV further adds in macroeconomic sensitivity of firms to enhance the explanatory by running multinomial logistic regression. In this model, we select two accounting variables, debt ratio and ROA, two corporate governance variables, percentage of directors controlled by the largest shareholder and pledge ratio, as well as all five macroeconomic sensitivities for empirical purposes. The accounting and corporate governance variables are all significant at 1% level by Wald test as in Model I, Model II and Model III , and will not be discussed further.

For macroeconomic sensitivities, firms with share returns more sensitive to growth rate in production index and money supply are more vulnerable to financial distress. Thus when the economy slows down or when the money supply grows at a slower pace, these firms are the first group to suffer. However, negative contribution of the sensitivity with respect to changes in CP interest rate to the probability of financial distress is hard to explain. At a first glance, it may imply that higher short term interest rate protects firms against financial distress, which sounds contradictory to common knowledge. But if we analyze further, we will see this is not necessary the case. Recall from Panel B of Table 2, β_3, on average is positive (0.89) for healthy

firms. In this case, the above argument may be acceptable, since healthy firms may be

Table 3: Empirical results of the binary logistic models

	Model I	Model II	Model III	Model Ⅳ
Intercept	-4.736 (0.000)***	-5.366 (0.000)***	-8.884 (0.000)***	-7.537 (0.000)***
Debt ratio	0.072 (0.000)***	0.078 (0.000)***	0.068 (0.000)***	0.061 (0.000)***
ROA	-0.087 (0.009)***	-0.091 (0.013)**	-0.096 (0.005)***	-0.100 (0.000)***
Quick Ratio	-0.232 (0.370)	-0.086 (0.744)	-0.134 (0.643)	
Pretax profit margin	-0.137 (0.682)	-0.156 (0.668)	-0.135 (0.708)	
Cash flow right of the largest shareholder			-0.005 (0.804)	
% of directors controlled by the largest shareholder			0.020 (0.022)**	0.025 (0.003)***
% of supervisors controlled by the largest shareholder			0.007 (0.192)	
Management participation (dummy variable)			0.676 (0.100)*	
Pledge ratio			0.021 (0.001)***	0.019 (0.006)***
β_1		0.704 (0.315)		1.495 (0.063)*
β_2				-0.203 (0.145)
β_3				-0.226 (0.003)***
β_4		0.342 (0.003)***		0.318 (0.004)***
β_5		0.113 (0.819)		0.197 (0.726)

(1) Numbers in parentheses are p-values

(2) *: significant at 10% , **: significant at 5% , ***: significant at 1%

(3) β_1: sensitivity to annualized growth rate of production index ; β_2: sensitivity to annualized growth rate of CPI ; β_3: sensitivity to 30 day CP interest rate; β_4: sensitivity to money supply growth rate (M2); β_5: sensitivity to general scoring of economic situation.

able to reduce short term financing in a rising interest rate environment. On the other hand, β_3 for distressed firms is negative (-0.53) on average. With negative coefficient of β_3 in Model III, the probability of financial distress will be higher as a result of higher rate.

3. Test of Goodness of Fit

Loglikelihood ratio test, Cox and Shell R^2 Nagelkerke R^2 and Hosmer and Lemeshow test are applied to test the goodness of fit of our models. The results are summarized in Table 4.

First of all, loglikelihood tests reject the null hypothesis that all coefficients are zero at 1% level, for all three models. Secondly, Cox and Shell R^2 is 0.212 for Model I. It increases to 0.239 when macroeconomic sensitivities are included (Model II). If corporate governance variables instead of macroeconomic sensitivities are incorporated, the R^2 further rises to 0.258 (Model III). This implies that corporate governance variables are more capable of explaining the probability of financial distress than macroeconomic sensitivities marginally. Higher Cox and Shell R^2 is achieved (0.288) when all three groups of variables enter into the model (Model Ⅳ), suggesting that each group of variables has its own merits in explaining the probability of financial distress. Similar results obtain with respect to Nagelkerke R^2. It increases from 0.423 for Model I, 0.476 for Model II, 0.514 for Model III to 0.573 for Model Ⅳ.

Finally, Hosmer and Lemeshow test is useful in testing the difference between model-predicted values and observed values. If the statistics is large enough to reject the null hypothesis that predicted values equal observed values, then the model may not be good enough. For our three models, none of them is rejected at 10% level.

Therefore we can be confident about our models.

Table 4: Results of the tests of goodness of fit

Model	Log likelihood ratio test	Cox & Shell R^2	Nagelkerke R^2	Hosmer and Lemeshow test
I	122.286 (0.000)***	0.212	0.423	12.439 (0.133)
II	139.909 (0.000)***	0.239	0.476	14.138 (0.178)
III	152.996 (0.000)***	0.258	0.514	5.036 (0.754)
IV	173.805 (0.000)***	0.288	0.573	3.933 (0.863)

(1) Numbers in parentheses are P-value
(2) *: significant at 10% , **: significant at 5% , ***: significant at 1%

IV. Prediction and Classification

1. In-Sample Predication and Choice-Based Sample Bias

In this section, we assess how choice-based sample bias pointed out by Zmijewski (1984) affects the percentage of accurate classification. Existing literature usually employ 1:1 or 1:2 matching sample. In other words, for every financial distressed firm, one or two healthy firms are chosen as matching samples. In the real world, financially distressed firms are far less than one half or one third. Therefore these matching techniques may induce over-sampling of financially distressed firms, which in turn may artificially inflate the classification accuracy.

We apply 1:1 and 1:2 matching techniques as well as the entire sample (without matching) to compute the accuracy of classification. We first calculate the estimated probability of financial distress for each firm using the three fitted binary logistic regressing models. Under a cutoff rule of 0.5, i.e., firms with estimated probability greater than 0.5 are classified as financially distressed firms, we summarize the classification accuracy of all three models in Table 5.

It is obvious from Table 5 that the classification accuracy for financially distressed firms deteriorates when more healthy firms are mixed into the sample. For example, the classification accuracy for distressed firms in Model I drops from 77.2% and 61.4% down to 38.6% when 1:1, 1:2 matching sample and the entire sample are used respectively. On the other hand, the classification accuracy for healthy firms increases when the sample is enlarged.

Table 5: Classification accuracy of the fitted models

Models	Firms	1: 1 matching	1: 2 matching	Entire sample
I	Healthy	82.5%	92.1%	98.9%
	Distressed	77.2	61.4	38.6
	All	79.8	81.9	92.2
II	Healthy	82.5	93.0	98.5
	Distressed	80.7	64.9	43.9
	All	81.6	83.6	92.4
III	Healthy	84.2	91.2	97.8
	Distressed	82.5	77.2	49.1
	All	83.3	86.5	92.4
IV	Healthy	89.5	93.9	97.8
	Distressed	86.0	77.2	61.4
	All	87.7	88.3	93.8

*Cutoff probability is set to be 0.5

No matter what sampling technique is used, the classification accuracy increases when more variables are included in the fitted model. Take the entire sample as an example, the classification accuracy for distressed firms increases from 38.6% for Model I, 43.9% for Model II, 49.1% for Model III up to 61.4% for Model IV. This provides strong evidence to support the superiority of our integrated model, which integrates accounting, corporate governance and macroeconomic variables in it.

Moreover, the marginal benefit of our integrated model also increases with the sample size. For example, the prediction accuracy for distressed firms under 1:1 matching principle gains 8.8% (from 77.2% in Model I to 86.0% in Model Ⅳ), but it gains 22.8% when the entire sample is applied (from 38.6% in Model I to 61.4% in Model Ⅳ). Thus the inclusion of corporate governance and macroeconomic variables in addition to accounting variables are especially beneficial in the entire-sample case.

2. Out-Sample Prediction

For the purposes of obtaining more realistic and practical prediction, we use the samples of 1998 to 2000 to fit the estimated models, which are in turn applied to the samples of 2001. The resulting classification accuracies are tabulated in Table 6.

We see from Table 6 that the prediction accuracy for distressed firms increases from 30% for Model I, 60% for Model II, 40% for Model III, up to 80% for Model Ⅳ. Again we demonstrate better results of prediction with the proposed integrated model.

Table 6: Out-sample prediction accuracy, 2001

Models	Healthy firms (137 firms)	Distressed firms (10 firms)	Whole sample (147 firms)
I	98.54%	30%	93.88%
II	96.35%	60%	93.88%
III	96.35%	40%	92.52%
Ⅳ	94.89%	80%	93.88%

*cutoff probability is set to be 0.5.

3. The Choice of Cut-off Points

The predicted probability of financial distress for each firm in Model Ⅳ is calculated with the fitted logistic model using the samples from 1998 to 2001. The frequencies of the resulting probabilities are tabulated in Table 7 in which probabilities are categorized into five intervals of equal size.

We find 93.19% of healthy firms to have an estimated probability of financial distress below 0.1999, and 36.84% of distressed firms to have an estimated probability over 0.8000. The cumulative distributions for the two groups of firms can be seen from Figure 2 in which strong discriminating power is visualized.

Table 7: The frequency distribution of the estimated probability of financial distress

Probability Interval	No. and % of healthy firms	No. and % of distressed firms	Difference in %	Cumulative % of healthy firms	Cumulative % of distressed firms
0-0.1999	424(93.19)*	11(19.30)	73.89%	93.19%	19.30%
0.2000-0.3999	16(3.52)	5(8.77)	-5.26%	96.70%	28.07%
0.4000-0.5999	12(2.64)	11(19.30)	-16.66%	99.34%	47.37%
0.6000-0.7999	1(0.22)	9(15.79)	-15.57%	99.56%	63.16%
0.8000-0.9999	2(0.44)	21(36.84)	-36.40%	100.00	100.00%
Total	455(100.00)	57(100.00)	0.00		

* Numbers in parentheses are percentages

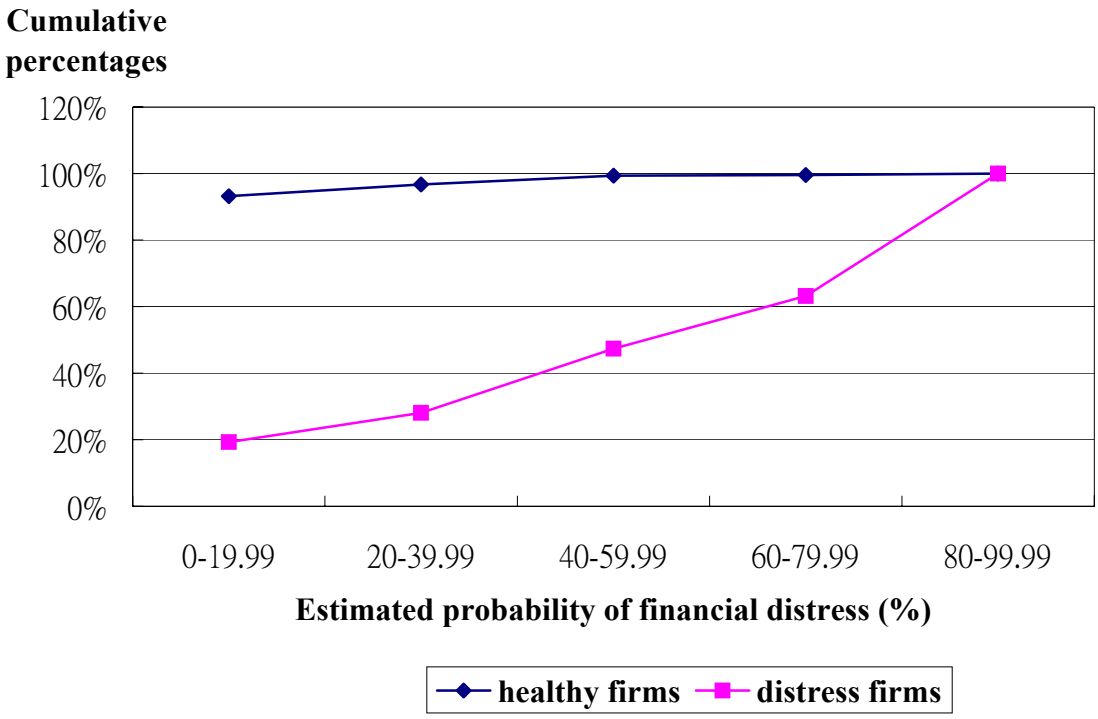

Figure2: The cumulative percentage of firms in all intervals of estimated probability of financial distress in the integrated prediction model.

The choice of cutoff point represents a trade-off between type I and type II error. If we maximize the sum of percentages of correct classification for the two groups of firms, the optimal cutoff point falls around 0.2000. In this case, the percentage of correct classification will be 93.19% for healthy firms and 80.70% for distressed firms. Thus we propose a cutoff point of 0.2000 whereas firms with estimated probability greater or equal to 0.2000 are classified as potential distressed firms, as shown in Table 8.

Table 8: In-sample classification accuracy under a cutoff point of 0.2000

		Predicted outcome	
		Healthy	**Distressed**
Actual outcome	**Healthy**	424 (93.19%)	31 (6.81%)
	Distressed	11 (19.30%)	46 (80.70%)

We then try out-sample prediction under the proposed cutoff scheme. Using

samples between 1998 and 2000 to fit the integrated model and plugging in data of 2001, we find 90% of distressed firms are accurately classified as such and 85.40% of healthy firms are predicted as healthy with our model. In other words, nine out of ten financially distressed firms in year 2001 are accurately predicted to be so using an integrated model built upon samples between 1998 and 2000.

V. Conclusions

We integrated accounting, corporate governance, and macroeconomic variables to build up a binary logistic regression model for the prediction of financially distressed firms. Debt ratio and ROA are found to be the most explanatory accounting variables while the percentage of directors controlled by the largest shareholder (which measures negative entrenchment effect), management participation, and the percentage of shares pledged for loans by large shareholders are shown to have positive contribution to the probability of financial distress. For macroeconomic sensitivities, firms with higher sensitivities to the annualized growth rates of manufacturing production index and money supply (M2) are more vulnerable to financial distress.

On the issue of sampling technique, we find that oversampling of distressed firms is subject to the problem of choice-based sample bias pointed out by Zmijewski (1984). The classification accuracy is overstated consequently. To tackle the problem, we try to include as many healthy firms as possible in our sample instead of following the traditional 1: 1 or 1: 2 matching principle. The results show that the classification accuracy is mostly significantly improved in our integrated prediction model when the sample is closest to the actual population.

For the trade-off between type I and type II errors in the predicted probability classification, we maximize the sum of classification accuracy for both groups of

firms (the healthy and the distressed). It is found that an estimated probability of financial distress of 0.2000 represents the optimal cutoff point for predicting financial distress. Under such a cutoff scheme, our integrated model produces an in-sample classification accuracy of 80.7% for distressed firms and 93.2% for healthy firms. For out-sample prediction, 90% of the distressed firms and 85.4% healthy firms in 2001 are correctly identified using an integrated model built upon samples from 1998 to 2000.

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