Business Failure Prediction for Publicly Listed Companies in China

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This study uses data from Chinese publicly listed companies for the period of September 2000-September 2008 to test the accuracy of Altman's Z-score model in predicting failure of Chinese companies. Prediction accuracy was tested for three Z-score variations: Altman's original model, a reestimated model for which the coefficients in Altman's model were recalculated, and a revised model which used different variables. All three models were found to have significant predictive ability. The reestimated model has higher prediction accuracy for predicting nonfailed firms, but Altman's model has higher prediction accuracy for predicting failed firms. The revised Z-score model has a higher prediction accuracy compared with both the reestimated model and Altman's original model. This study indicates that the Z-score model is a helpful tool in predicting failure of a publicly listed firm in China.

Developing countries are attracting more foreign investment than ever before. Since 2000, foreign direct investment inflows have rocketed from $165.5 billion to an estimated $470.8 billion in 2007. According to the World Bank, China draws the most foreign investments, attracting $84 billion of investment in 2007 and representing 18% of the total. Although China is an attractive place for investment, publicly listed Chinese companies suffer credibility issues. All three stock exchange markets – Shanghai, Shenzhen, and Hong Kong – are to varying degrees, known for government intervention and a club type atmosphere. Investors need guidelines to distinguish low-risk investments from higher-risk ones. The objective of this study is to determine if the

information available in the annual reports of Chinese publicly listed companies is useful to predict which companies are likely to fail.

The following research questions are considered in this paper: Is Altman's Z-score model effective for predicting company failure in China during the period of 2000-2008? Is the model effective for predicting company failure for many different types of firms, not solely for manufacturing companies? Will recalculation of the coefficients of Altman's variables result in more accurate failure prediction? Can other variables be substituted in the basic Z-score model to create a more accurate model?

Previous Studies

The prediction of company failure has been well-researched using developed country data (Beaver, 1966; Altman, 1968; Wilcox, 1973; Deakin, 1972; Ohlson, 1980; Taffler, 1983; Boritz, Kennedy & Sun, 2007). A variety of models have been developed in the academic literature using techniques such as Multiple Discriminant Analysis (MDA), logit, probit, recursive partitioning, hazard models, and neural networks. Summaries of the literature are provided in Zavgren (1983), Jones (1987), O'Leary (1998), Boritz et al. (2007) and Agarwal and Taffler (2007). Despite the variety of models available, both the business community and researchers often rely on the models developed by Altman (1968) and Ohlson (1980) (Boritz et al., 2007). A survey of the literature shows that the majority of international failure prediction studies employ MDA (Altman, 1984; Charitou, Neophytou & Charalambous, 2004).

Beaver (1966) presented empirical evidence that certain financial ratios, most notably cash flow/total debt, gave statistically significant signals well before actual business failure. Altman (1968) extended Beaver's (1966) analysis by developing a discriminant function which combines ratios in a multivariate analysis. Altman (1968) found that his five ratios outperformed Beaver's (1966) cash flow to total debt ratio and created the final discriminant function:

$$Z=1.2X1+1.4X2+3.3X3+0.6X4+0.999X5$$

where,

X1 = working capital/total assets
X2 = retained earnings/total assets
X3 = earnings before interest and taxes/total assets
X4 = market value of equity/book value of total liabilities
X5 = sales/total assets

Firms with Z-scores less than 2.675 are predicted to be bankrupt, and firms with Z-scores greater than 2.675 are predicted to not be bankrupt.

Boritz et al. (2007) reestimated the model using Canadian company data and obtained the following:

$$Z=2.149X1-0.624X2+1.354X3-0.018X4+0.463X5$$

The cutoff point is 0.27.

Taffler (1983) developed a UK-based Z-score model as follows:

$$Z=3.20+12.18X1+2.50X2-10.68X3+0.029X4$$

where,

X1 = profit before tax/current liabilities
X2 = current assets/total liabilities
X3 = current liabilities/total assets
X4 = (quick assets-current liabilities)/daily operating expenses with the denominator proxied by (sales-PBT-depreciation)/365

Sandin and Porporato (2007) use data from a developing country, Argentina, and retain 2 out of 13 ratios after stepwise selection and come up with the final model:

$$As=15.06R5+16.11S3-4.14$$

where,

R5 = operative income/net sales
S3 = shareholder's equity/total assets

Despite the popularity of the MDA technique in constructing failure classification models, questions were raised regarding the restrictive statistical requirements imposed by the models (Ohlson, 1980). To overcome the limitations, Ohlson (1980) employed logistic regression to predict company failure, but the model was suggested to be insensitive to financial distress situations (Grice & Dugan, 2001).

Boritz et al. (2007) question the suitability of using the Altman (1968) and Ohlson (1980) models for Canadian companies since the Altman-Ohlson models were developed using data from U.S. firms. They contend that new models must be developed and validated for use with Canadian firms because of various differences in the environments in which firms of the two countries operate. This argument applies equally well to the need to develop and validate new models for evaluating Chinese firms. Along these same lines, Grice and Ingram (2001) argue that original Z-score coefficients should be reestimated when examining firms of different time periods or in different industries.

Methodology

As mentioned earlier, the majority of international failure prediction studies employ MDA (Altman, 1984; Charitou et al., 2004). This study employs MDA to allow better comparison with other international studies. This research plan avoids one previous criticism of MDA analysis. Ohlson (1980) is concerned about using predictors of failure

that are derived from information published after bankruptcy has occurred. In this study, all information is from reports published at least three months before a company was delisted. Agarwal and Taffler (2007) emphasize the importance of testing the predictive ability of models against an entire population instead of using only a relatively small sample. The authors plan to address this issue in a subsequent study. The current research plan is to test the predictive ability of three Z-score based models using the matched pair technique. Two of the models are actually developed in this study.

Selection of Failed Firms

In order to select failed firms, we must define "failure" first. "Failure" is defined as the inability of a firm to pay its financial obligations as they mature (Beaver, 1966). In another words, insolvency. In the analysis in this paper, we work exclusively with firm insolvencies on the basis that these are clean measures. Because firm insolvency is such a stringent criterion, this approach potentially weakens the predictive ability of the Z-score model, in particular in terms of increasing the type II error rate – misclassification of nondelisted firms as delisted.

The failed firms in this sample are firms that were publicly listed in Shanghai Stock Exchange Market (SHSE) or Shenzhen Stock Exchange Market (SZSE) for at least two consecutive years and then were delisted during 2000-2008 due to financial problems. According to the "Public Listing Regulation" published in 2000 by the China Securities Regulatory Committee, four situations will lead to the delisting of a publicly listed company. The first situation is privatization or other changes of shareholders composition. The second situation is failing to disclose financial information or financial fraud. The third situation is illegal activities by the listing firm. The fourth is being unprofitable for three consecutive years. This study selected only those firms that were delisted for either situation two or four. For firms delisted because of situation one, the company is not considered failed, only that the shareholders have decided to privatize the company or the company is merged into another company. For situation three, this study believes that firms delisted because of illegal activities are different from firms delisted because of financial problems. Firms delisted because of illegal activities might still be financially sound and thus cannot be predicted with financial ratios. We treat the event of being delisted as a clear signal of firm failure. We look at firm failure from the investors' standpoint. Once the firm is delisted, its stocks become worthless since there is no platform for exchange of the stocks any more. The delisted firm in general will continue operating for a period of time, but shareholders have essentially lost their investment. Although there have been continuous demands for establishing platforms for exchanges of stocks of delisted firms, no such platform has been created.

Selection of matching firms

The selection process was based upon a paired-sample design. For each delisted firm in the sample, a nondelisted firm of the same industry and asset size was selected. If the exact match of asset size could not be found, the firm which had the closest asset size was chosen. The asset size was based upon the asset size reported on the last financial statement of the delisted firm and the asset size of the matching firm reported for that same year.

Data Collection

For every delisted and matching nondelisted firm, the financial data were manually collected for up to two years prior to delisting from www.sina.com.cn. According to Altman (1968), the bankruptcy prediction model is an accurate forecaster of failure for up to two years prior to bankruptcy. Accuracy diminishes substantially as the lead time is increased. A total of 42 delisted firms (16 manufacturing companies) were collected along with 42 (16 manufacturing companies) matching nondelisted firms. We then randomly selected 12 out of the 42 delisted firms along with their matching nondelisted firms as the prediction or hold out sample to test the validity of our Z-score model. The final sample was divided into two subsamples: the estimation sample which includes 30 delisted firms and 30 matching nondelisted firms, and the prediction sample which includes 12 delisted firms and 12 matching nondelisted firms.

Results

Descriptive statistics

The average time between the actual delisting date and submission of the last financial report prior to the delisting for the 30 failed firms was eight months, ranging from three months to 23 months. The average asset size for the delisted firms was 466,629,673 Chinese dollars versus 747,952,379 for the nondelisted firms for the first year prior to failure. The respective numbers are 882,387,177 and 693,322,301 for the second year prior to delisting. There was a sharp decrease of mean total asset size of the delisted firms between the two financial reporting periods prior to delisting, while the total assets of the nondelisted firms increased.

The sizes of the firms vary. The total assets of the delisted companies range from RMB 21,514,900 to RMB 1,211,942,318 the first year before delisting. The sales of the delisted firms range from 0 to RMB 433,961,140 in the first year before delisting. The total assets of the nondelisted firms range from RMB 208,295,652 to RMB 2,394,944,689 for the corresponding year. The sales of the nondelisted firms range from RMB 5,918,570 to RMB 986,715,195 for the corresponding year.

The means of the financial ratios using the financial reports one and two years prior to delisting are summarized in Tables 1 and 2, respectively. The results are consistent between the estimation and prediction groups for both years. A comparison of the delisted and nondelisted variable means indicates that working capital/total assets (X1), retained earnings/total assets (X2), earnings before interest and taxes/total assets (X3), market value of equity/book value of total debt (X4) and sales/total assets (X5) are lower in the delisted than in the nondelisted group. The p-values for the test of mean differences between delisted and nondelisted companies are significant for each of these variables. The results are similar to those reported by Altman (1968) for his estimation sample except for the sales/total assets variable (X5), which is not significantly different between his bankrupt and non-bankrupt groups. The results reported by Grice and Ingram (2001) do not find significant differences between the distressed and nondistressed groups for variables X4 and X5.

Table 1: *Descriptive statistics for estimation subsample and prediction subsamples using the annual financial report one year prior to delisting*

2000–2008

Sample	Statistics	X1	X2	X3	X4	X5
Estimation Subsample						
Delisted[a]	Mean	-3.8060	-6.4800	-1.7070	1.3655	0.1292
	Standard Deviation	5.7129	10.8130	3.4943	1.8542	0.2324
	Minimum	-23.5000	-41.5900	-15.3700	0.0515	0
	Maximum	0.3009	-0.0030	0.1691	9.8279	0.9960
Non-delisted	Mean	0.1526	-0.0440	0.0304	8.6376	0.4441
	Standard Deviation	0.2633	0.2225	0.1022	8.9549	0.2721
	Minimum	-0.3340	-0.6840	-0.3350	0.9679	0.0284
	Maximum	0.6760	0.2123	0.1728	31.0670	1.0498
	P-value[b]	0.0004	0.0019	0.0085	<.0001	<.0001
Prediction Subsample						
Delisted	Mean	-3.144	-5.08	-2.806	1.0308	0.1822
	Standard Deviation	4.5547	6.2127	4.01	0.576	0.226
	Minimum	-13.4	-19.52	-12.61	0.2707	0
	Maximum	1.9063	-0.372	-0.077	1.8592	0.6967
Non-delisted	Mean	0.1839	-0.083	0.0458	6.076	0.728
	Standard Deviation	0.2153	0.2864	0.0551	5.2537	0.4479
	Minimum	-0.173	-0.911	-0.112	1.3816	0.178
	Maximum	0.4881	0.0964	0.0952	16.532	1.7758
	P-value[b]	0.0192	0.0108	0.0220	0.0032	0.0011

X1 = working capital/total assets;
X2 = retained earnings/total assets;
X3 = earnings before interest and taxes/total assets;
X4 = market value of equity/book value of total liabilities;
X5 = sales/total assets.

[a] The delisted group includes companies that experienced delisting due to financial reasons.

[b] p-value of t-test of differences in variable means between the delisted and non-delisted groups. T-tests are performed to compare the means of the delisted (non-delisted) estimation subsample and the delisted (non-delisted) prediction subsample. No significant differences are found.

Table 2: *Descriptive statistics for estimation subsample and prediction subsamples using the annual financial report two years prior to delisting*

2000–2008

Sample	Statistics	X1	X2	X3	X4	X5
Estimation Subsample						
Delisted[a]	Mean	-0.934	-1.49	-0.61	1.7728	0.1601
	Standard Deviation	1.8575	3.4335	1.6534	1.2925	0.2135
	Minimum	-9.78	-19	-9.244	0.1023	0
	Maximum	0.4672	0.0839	0.0236	4.0526	0.8299
Non-delisted	Mean	0.1566	-0.038	0.0458	11.911	0.3973
	Standard Deviation	0.322	0.2544	0.0667	13.277	0.245
	Minimum	-0.408	-0.919	-0.167	1.4318	0.0399
	Maximum	0.7888	0.2499	0.1514	60.976	1.0194
	P-value[b]	0.0024	0.0245	0.0340	0.0001	0.0002
Prediction Subsample						
Delisted	Mean	-0.429	-0.69	-0.389	2.7046	0.2094
	Standard Deviation	0.6203	0.6121	0.3852	1.9312	0.2912
	Minimum	-1.696	-1.937	-1.366	0.3736	0
	Maximum	0.3104	-0.015	-0.057	5.6978	1.0587
Non-delisted	Mean	0.261	-0.149	0.0484	9.0555	0.639
	Standard Deviation	0.2188	0.3669	0.0538	8.4319	0.389
	Minimum	-0.212	-0.936	-0.111	1.3875	0.0369
	Maximum	0.4982	0.1115	0.0927	27.913	1.5436
	P-value[b]	0.0015	0.0155	0.0008	0.0185	0.0057

X1 = working capital/total assets;
X2 = retained earnings/total assets;
X3 = earnings before interest and taxes/total assets;
X4 = market value of equity/book value of total liabilities;
X5 = sales/total assets.

[a] The delisted group includes companies that experienced delisting due to financial reasons.

[b] p-value of t-test of differences in variable means between the delisted and non-delisted groups. T-tests are performed to compare the means of the delisted (non-delisted) estimation subsample and the delisted (non-delisted) prediction subsample. No significant differences are found.

Classification accuracy of Altman's (1968) Z-score model

We evaluated the classification accuracy of Altman's (1968) Z-score model using the estimation sample and prediction sample respectively. The Z-scores are derived for both samples using two years of financial data. The accuracy of the Z-score model is calculated by dividing the number of firms correctly predicted by the total number of firms in the sample.

Table 3 reports results of tests of Altman's (1968) model. The model does fairly well for predicting the delisting of a firm, with accuracy ranging from 91.67% to 100%. The model tends to misclassify a nondelisted firm into the delisted group with Type II error ranging from 16.67% to 43.33%. The model does well using financial data 2 years prior to delisting, with an overall accuracy of 85% for the estimation sample and 87.5% for the prediction sample. The tendency to misclassify a nondelisted firm into the delisted group persists.

Table 3: *Comparisons of classification accuracies using coefficients from Altman's (1968) model*

	One year prior to delisting				
Sample	Accuracy				
	Overall	Delisted firms	Non-delisted firms	Type I Error	Type II Error
Estimation Sample	76.67%	96.67%	56.67%	3.33%	43.33%
	46	29	17		
Prediction Sample	83.33%	100%	66.67%	0%	33.33%
	20	12	8		
	Two years prior to delisting				
Estimation Sample	85%	100%	70%	0%	30%
	51	30	21		
Prediction Sample	87.5%	91.67%	83.33%	8.33%	16.67%
	21	11	10		

Classification accuracy of the reestimated model (one year prior to delisting)

Additional evidence of the stationary nature of the Z-score model is obtained by reestimating the model's coefficients using our estimation sample, then testing the prediction accuracy of our model using the prediction sample. Table 4 reports results for the reestimated model.

The sample of 30 delisted firms and the 30 corresponding nondelisted firms is examined using MDA. Since the discriminant coefficients and the group distributions are both derived from this sample, a high degree of successful classification is expected.

The Z-score model derived is:
$Z=0.8059X1-0.2898X2+0.0440X3+0.1971X4+6.3327X5$

Firms with Z-scores less than 2.2373 are predicted to be delisted and Z-scores greater than 2.2373 are predicted to be nondelisted.

Table 4: *Comparisons of classification accuracies using newly derived coefficients*

	One year prior to delisting				
Sample	Accuracy				
	Overall	Delisted firms	Non-delisted firms	Type I Error	Type II Error
Estimation Sample	90%	90%	90%	10%	10%
	54	27	27		
Prediction Sample	87.5%	83.33%	91.67%	16.67%	8.33%
	21	10	11		
	Two years prior to delisting				
Estimation Sample	86.67%	90%	83.33%	10%	16.67%
	52	27	25		
Prediction Sample	87.5%	83.33%	91.67%	16.67%	8.33%
	21	10	11		

The model correctly predicted 90% of firms (54 out of 60), with both type I and type II error at 10%. This is higher than 76.67% overall accuracy for the estimation sample using Altman's (1968) model. However, the Type I error is lower using Altman's (1968) model (3.33%) compared with our model. Altman's (1968) model misclassified 13 out of 30 nondelisted firms into delisted group while it only misclassified 1 out of 30 delisted firms into nondelisted group. The model this study derives misclassified 3 out of 30 nondelisted firms into the delisted group and 3 out of 30 delisted firms into the nondelisted group.

Classification accuracy of the reestimated model (two years prior to delisting)

The second test is made to observe the discriminating ability of the model for firms, using data from two years prior to delisting. Fifty two out of 60 firms are properly classified (86.67%), with a Type I error of 10% and a Type II error of 16.67%. The prediction power of the model is quite constant across the two years. The prediction accuracy is 85% using Altman's (1968) model with a Type I error of 0 percent and Type II error of 30%. Our model correctly classified 27 out of 30 delisted companies and 25 out of 30 nondelisted firms, while Altman's (1968) model correctly classified all the 30 delisted firms and misclassified 9 out of the 30 nondelisted firms.

Cross-validation

It is important to cross-validate the result using hold out data. Using data one year prior to delisting, 21 out of 24 of the prediction group firms (87.5%) are correctly classified using the derived Z-score model, with a Type I error of 16.67% and a Type II error of 8.33%. The model misclassified 2 out of the 12 delisted firms and 1 out of the 12 nondelisted firms. Altman's (1968) model has an overall accuracy of 83.33%. It correctly classified all the delisted firms and misclassified 4 out of the 8 nondelisted firms.

Using two years prior to delisting data, our model arrives at exactly the same results as using one year prior to delisting data. Altman's (1968) model has an overall

accuracy of 87.5% and it misclassified 1 out of the 12 delisted firms and 2 out of the 12 nondelisted firms.

Analysis

During the process of data collection, we noticed that the delisted firms' total assets decreased over the two year period, while the nondelisted firms' total assets increased. Although no previous research has taken this into consideration, we believe it worth further exploration. We thus added another variable into the discriminant function. The sixth variable is defined as follows: (Total assets one year prior to delisting – Total assets two years prior to delisting)/Total assets two years prior to delisting. We then applied a backward elimination procedure. Three variables remained after the procedure with a significance level of $p<0.05$. The specific p values are shown in Table 5. The three variables are: *X4, X5* and *X6*. Using these three variables, we created another Z-score model, the revised Z-score model.

$$Z=0.2086X4+4.3465X5+4.9601X6$$

Table 5: *Variables retained after backward elimination procedure*

X4	$p<0.0007$
X5	$p<0.0082$
X6	$p<0.0001$

X4 = market value of equity/book value of total liabilities;
X5 = sales/total assets;
X6= (Total asset the first year prior to delisting-total asset the second year prior to delisting)/Total asset the second year prior to delisting

Firms with a Z-score smaller than 1.5408 are predicted to be delisted, while firms with a Z-score larger than 1.5408 are predicted to be nondelisted. The prediction results using the revised Z-score model are reported in Table 6. The revised model correctly classified 95% of the firms in the estimation sample. It misclassified 3 out of the 30 delisted firms and correctly classified all the nondelisted firms. The estimation sample overall accuracy rates of the revised model are 95% and 91.67% respectively for one year and two years prior to delisting. These rates were comparatively more accurate than those of Altman's model at 76.67% and 85% and the re-estimated model at 90% and 86.67%. The cross validation results are also reported in Table 6. Using the prediction sample, the revised model yields superior results one year prior to delisting, and all 3 models yield the same overall accuracy for two years prior to delisting.

Relatively few studies of this type have been done in emerging countries. Sandin and Porporato (2007) did a study for Argentine companies. New Z-score variables specific to Argentine companies were developed. Then, both the new model and Altman's original Z-score model were tested. Both models were found to have predictive ability, with the new model enjoying enhanced predictive power. Thus, both the current study on Chinese companies and Sandin and Porporato (2007) support the contention that the Z-score model is an effective predictor of company

failure in emerging countries, especially when the model is revised based on data from the specific country being studied.

Table 6: *Comparisons of classification accuracies using revised Z-score model*

	One year prior to delisting				
Sample	Accuracy				
	Overall	Delisted firms	Non-delisted firms	Type I Error	Type II Error
Estimation Sample	95%	90%	100%	10%	0%
	57	27	30		
Prediction Sample	95.83%	91.67%	100%	8.33%	0%
	23	11	12		
	Two years prior to delisting				
Estimation Sample	91.67%	90%	93.33%	10%	6.67%
	55	27	28		
Prediction Sample	87.5%	83.33%	91.67%	16.67%	8.33%
	21	10	11		

Because of the relatively small number of failed firms during the period under study, all failed firms were included regardless of their industry. As mentioned earlier, of the 84 firms used in this study, only 32 (16 failed and 16 healthy) were manufacturing firms. It is interesting to note that even though Altman's original Z-score model was developed based only on manufacturing firms, it performed well on this cross section of Chinese firms.

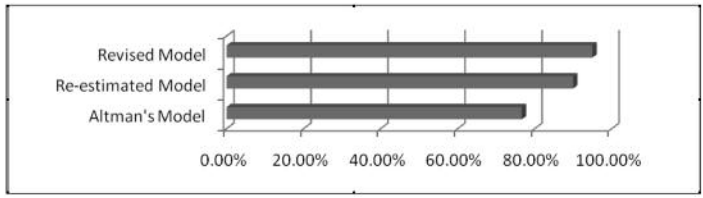
Our study shows that the revised model with three variables has a comparatively more accurate prediction than both the Altman's model and the reestimated model using one year prior to delisting data for both the estimation and the prediction sample. The revised model also has comparatively more accurate prediction than both the Altman's model and the reestimated model using two years prior to delisting data for the estimation sample. The three models perform the same using two years prior to delisting data for the prediction sample. Table 7 summarizes the results. Table 8 shows the results in separate charts to facilitate a comparison.

Table 7: *Comparison of classification accuracies of different models*

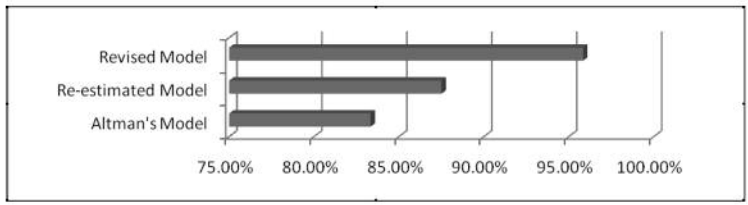
One year prior to delisting			
	Altman's Model	Re-estimated Model	Revised Model
Estimation Sample	76.67%	90%	95%
	46	54	57
Prediction Sample	83.33%	87.50%	95.83%
	20	21	23
Two years prior to delisting			
Estimation Sample	85%	86.67%	91.67%
	51	52	55
Prediction Sample	87.50%	87.50%	87.50%
	21	21	21

Table 8: *Comparison of classification accuracies of different models (Chart presentation)*

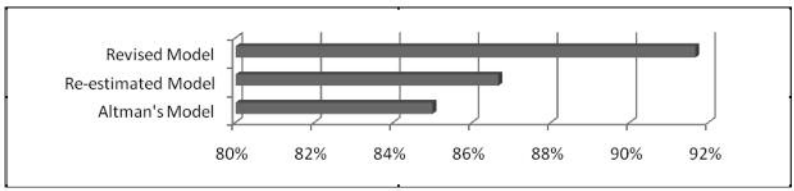
Estimation Sample: One year prior to delisting



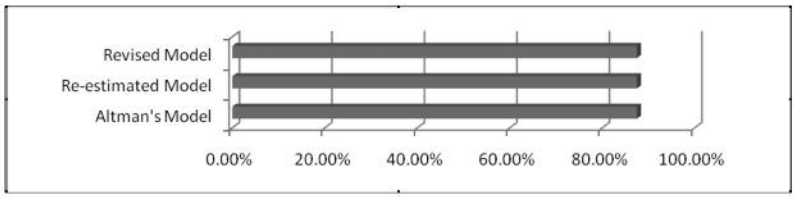
Prediction Sample: One year prior to delisting



Estimation Sample: Two years prior to delisting



Prediction Sample: Two years prior to delisting



Conclusion

Our study supports the effectiveness of the Z-score methodology for predicting company failure in China. Overall, the re-estimated model with recalculated coefficients but the same five financial ratios as Altman's model has a higher prediction accuracy for the nondelisted group, while Altman's (1968) model has higher prediction accuracy for the delisted group. Our revised model with three financial ratios has higher overall prediction accuracy than both the re-estimated model and Altman's model. The revised model includes a financial ratio that is not considered in the other two models. It is defined as follows: *X6* = (Total assets one year prior to

delisting – Total assets two years prior to delisting)/Total assets two years prior to delisting. This variable indicates the extent of asset decrease from two years to one year prior to delisting.

Our models use companies from various industries. The models developed should apply to a wide variety of firms. Due to the limitations of data access and the matched sample method when estimating Z-score model, this study uses a relatively small sample. One of the criticisms of failure prediction models in general, is that they have not been tested on an entire underlying population (Agarwal & Taffler, 2007). Future research is planned to test the 3 models in this paper against the entire population of Chinese listed companies for a longer period. Future research also is planned to employ Ohlson's (1980) logit model with a large sample or whole population. It then may be possible to compare the efficacy of MDA versus logit for Chinese listed companies.

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