

**Financial Distress and Bankruptcy Prediction:
An Appropriate Model for Listed Firms in Vietnam**

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Abstract

This paper aims to develop a comprehensive model, which is the first of its kind in Vietnam, for the purpose of financial distress and bankruptcy prediction of the Vietnamese listed firms. The entire research period from 2003-2016, which is then sub divided into the pre-global financial crisis (GFC) period (2003-2009) and the post-GFC period (2010-2016) to consider the impact of the GFC on the financial distress likelihood, are considered in this study. Various factors are utilized in this study, including (i) the accounting model, the Emerging Scoring Model (ESM); (ii) the market-based model, the distance to default model (DD); and (iii) two macroeconomic indicators, the inflation and short-term interest rate. The Area Under the Receiver Operating Characteristics (ROC) Curve (the AUC) is utilized to compare the usefulness of various default prediction models.

Empirical findings from this study present evidence to support the view that factors derived from the accounting model, the market-based model, and typical macroeconomic fundamental factors have all contributed effect to the financial distress of Vietnamese listed firms for the research period when they are considered in isolation. However, when a comprehensive model is developed, the effect from accounting factors appear to be stronger in comparison with the market-based models. Findings from this study also confirm that the model of default prediction including accounting factors and macroeconomic factors appear to be performing much better than the market-based models and the market-based models with macroeconomic fundamentals.

Keywords: Financial Distress, Bankruptcy, Distance to Default, Fundamentals, Vietnam.

JEL Classification: F62, F65, G01, G31, G33, G34

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1. Introduction

The liberalization of the financial institutions among countries has stimulated a regional competition and this process has also provided an immeasurable effect from one country to another. The Global Financial Crisis (GFC) in late 2008 had left various nations to the great exposure of economic activities. Viet Nam is no exception. Nations around the world had witnessed various macroeconomic problems, including a sharp spike in unemployment due to a free fall of economic growth/output. In particular, credit risk has substantially increased leading to the bankruptcy of many businesses. In Vietnam, new business establishment were 68,350 firms whereas a number of firms stopped doing business or went bankrupt were over 7,000 firms. In addition, a record of 47,600 firms had faced substantially financial difficulties to warrant the decisions to stop operating temporarily. These numbers of firms continued rising considerably in the first six months of 2016. In 2016, 18,916 firms went bankrupt and this figure represents an increase of 4.2 percent compared to the same period of the previous year 2015.

Standard approaches to measuring credit risks for listed firms in Vietnam and other countries include the accounting based approach and the market-based approach. In this regard, the accounting-based models (such as the Altman Z-score and the ESM models) and the market-based models (such as the Merton models) are employed to estimating the default probability of listed firms in the country of interest.

This study departs from the current practice. It is the intention of this study to develop a new model in which the three pillars of credit risks are considered: (i) factors from the market-based models; (ii) factors derived from the accounting-based models; and (iii) selected macroeconomic factors which are landed on a strong theoretical ground. This approach is expected to provide a comprehensive evidence in relation to financial distress and bankruptcy of listed firms in Vietnam. Our intensive literature review indicates that this study is the first of this kind in Vietnam and probably one of the first few studies in the region.

2. Literature review

There are four stages of the corporate bankruptcy. The initial and first step is an incubation that the financial situation of the firm is developing. Then, firm's manager realizes financial distress condition of the firm which is generally called the financial embarrassment. The next is financial insolvency when the company is likely not to have enough funds to meet its financial obligation. Finally, insolvency is finally confirmed. The firm is official bankrupted by the

decision of the courts as well as all of its assets must be sold to pay the creditors or debtors (Poston et. al., 1994). The financial distress is, therefore, different from the bankruptcy. In particular, financial distress occurs when firms may not be able meet financial obligations from their creditors due to a loss in firm's business operating, illiquid assets, high fixed cost. On the other hand, bankruptcy is a final state when firms stop doing business because businesses still cannot meet their financial obligations in the financial distress. In some case, financial distress is likely to be detected before the company falls into insolvency. As such, it is noted that financial distress does not warrant for a bankruptcy.

Numerous studies have been conducted to predict corporate financial distress early in the world. The first accounting-ratio-based model was developed in Beaver (1966) study. In this study, dichotomous classification test was utilized to recognize financial ratios for the bankruptcy prediction. In particular, the best discriminant components in the study include working capital/debt ratio, which estimated 90 percent accurately one year before bankruptcy happens, and the net income/total assets ratio, which correctly identified 88 percent.

The multivariate statistical model discriminating the failed firms from non-failed firms was developed by E. I. Altman (1968). 22 financial ratios were examined and they were classified into five categories including profitability, activity, liquidity, solvency, and leverage. The multivariate discriminant analysis (MDA) was conducted among five ratios. E. I. Altman, Haldeman, and Narayanan (1977)' s study explored a new financial distress model (ZETA) with the focus on specific sectors. E. I. Altman (2000) improved models in 1968 and 1977 with an introduction of the Z'' -score model which includes four financial ratios.

The decline of the asset value or a reduction in liquidity and a decrease in the capability of raising capital is major causes of the insolvency. There are three components for the default of a business: (i) a value of the asset; (ii) the asset value of the uncertain risk; and (iii) financial leverage. The option based approach has been widely adopted in the commercial world. Black & Scholes (1973) and Merton (1974) discussed the call option theory that is a fundamental theory for a market-based approach. Their contingent claimed approach has been widely used for the corporate default prediction.

The Metron model has become the fundamental analysis of the Distance-to-Default model (DD). In the previous works, Vasicek (1984)' study compared the value of assets with its liability to determine the probability of corporate default. In Delianedis & Geske (2003) and H.

Leland (2002)' study, the theoretical probability was a powerful predictor on the credit rating and credit transition. Several papers illustrated the usefulness of the structural model as well as the development of the option-based model. Crosbie and Bohn (2003) demonstrated that the probability of the bankruptcy is one of the most powerful predictors to manage credit portfolio. Some recent researchers employed the structural model to measure the default risk and then, the examination of the correlation between default risk and other variables. As discussed in Vassalou and Xing (2004), Stein (2005), Bharath and Shumway (2008), Koutsomanoli-Filippaki and Mamatzakis (2009), Huang and He (2010) , D. E. Allen and Powell (2012) and Agrawal, Maheshwari, Khilji, and Swinkels (2016), the market-based approach has played a key role of predicting the default probability.

The market-based has been appealing on several grounds. *First*, the timeliness of the corporate bankruptcy prediction may be risen exponentially by the combination of the market-based variables. *Second*, the volatility of the market-based variables is calculated directly using the market index to enhance the powerful indicator of the default risk. The fluctuation plays a key role of the default prediction. *Third*, the information from the financial statement and others do not belong to accounting statement which are reflected generally by the market price. *Fourth*, the market price is likely to be more suitable to the default prediction because it reflects the forward-looking information or the future expectation of the cash flow whereas the accounting-based model only reveals the backward looking or past performance. In addition, Hillegeist, Keating, Cram, and Lundstedt (2004) indicated that the stock market contains almost all information from the accounting statements.

3. Comparing the Multivariate Discriminant Analysis & the Distance to Default models

Among various models for default prediction, including the accounting-based, the market-based model and even the comprehensive model, which model is the most appropriate to default prediction? The usefulness of three models depends on the Pseudo R^2 as well as the Receiver Operating Characteristics area (ROC). The ROC curve is the popular technique which can be used to rank the usefulness of different models of default prediction. The ROC score is built by changing the cutoff probability. For each cutoff probability, the ROC curve is defined by the percentage of bankruptcy that the model accurately classifies as the bankruptcy on the vertical axis (y-axis) whereas the false positive rate or the percentage of bankruptcy that the model wrongly classifies as the bankruptcy on the horizontal axis (x-axis). Therefore, the good model

will have the ROC curve straight up from (0,1) to (1,1) afterward across (1,1). The accurate ratio of the model is defined by the area under the ROC curve (AUC).

$$\text{Accuracy ratio by ROC curve (AR)} = 2 \times (\text{Area under ROC curve of the model} - 0.5)$$

The perfect model may have the AR of one or the ROC score is equal to unity while the model that has no discriminatory power has the AR of zero or the ROC is equal to 0.5. As a result, the model with the higher AR (accuracy ratio) will outperform on the default prediction.

4. Data and definition of variables

This study is conducted on a dataset which covers approximately 800 listed firms in Hanoi stock exchange (HNX) and Ho Chi Minh stock exchange (HOSE) for the period from 2003 to 2016. All data are collected from Bloomberg for all 10 different sectors. Macroeconomic data is collected from the World Bank website. Two periods are considered, including: (i) the pre-GFC for the 2003-2009 period; and (ii) the post-GFC for the 2010-2016 period.

4.1. The dependent variable

Expenditure is covered by operating business revenue of the firm. The major cause of financial distress and bankruptcy is the financial obligations to the companies' creditors. In this regard, many researchers attempted to estimate the probability of default. They used the indicators of business operating efficiency and financial expenses. For instance, the financial distress is defined as the deficit between the earnings before interest, tax, and depreciation (EBITDA) and interest expense. The firms may not generate sufficient funds to cover its financial obligation leading to the default. For the public companies in the US, Asquith, Gertner, and Scharfstein (1994) added the depreciation back to the earnings because they considered that the depreciation is a non-cash expenditure in the accounting cycle. Tinoco and Wilson (2013) and Andrade and Kaplan (1998) used EBITDA when it is less than the interest expense as an indicator for financial distress (Interest Coverage). Whitaker (1999) used the disparity between the firm's cash flow and the current maturities of long-term debt. In Vietnam, when listed firms face the shock or the sudden debt requirement, it is not easy for them to mobilize capital to meet the sudden obligation.

On balance, in this study, the probability of default of the firms is measured by the *Interest Coverage ratio* between the return earnings before interest and taxes (EBIT) and interest expense. If this ratio is lower than one or the EBIT is less than interest expense, the firm falls in the financial distress zone.

4.2 *Independent variables*

4.2.1 *Accounting variables*

Four accounting variables representing the financial liquidity, productivity of assets, solvency, and sales generating ability of assets are utilized in this study. *First*, the working capital over total assets (WC/TA) measures the net financial liquidity of the assets. *Second*, the profitability is estimated by the retained earnings over total assets (RE/TA). The RE relative to TA presents cumulative profitability in the business's entire life. *Third*, the earnings before interest and taxes over the total asset (EBIT/TA) presents the productivity of the company's assets excluding the tax and leverage components or the earning power of the asset. *Finally*, the book value of equity over the total liability (BVE/TL) indicates the capability of covering the financial debt by the firm's asset. The higher the BVE/TL, therefore, the lower default probability or the negative relation between BVE/TL and financial distress.

4.2.2 *Market variables*

Four independent variables from the market-based models are employed in this study. *First*, the market value of equity is calculated as the multiple of the stock price to the number of shares outstanding. *Second*, the higher equity volatility (σ_E) leading to greater volatility of the asset is used. *Third*, it is the leverage which is computed as the total debt over the total of the market value of equity and total debt. *Fourth*, the price indicates for the market base which is calculated as the average price of the stock price of that firm in one year.

4.2.3 *Macroeconomic variables*

The effect of the macroeconomic environment on the default model is very significant in two major aspects. Our research examines the interest rate of the short-term Treasury bill in one year (SHTBRDEF). The higher value of Treasury bill leading to interest rate climb sharply, the bankrupt rate will hike. Another variable is the inflation. The high inflation indicates that the economy falls into the unstable status and weak macroeconomic environment and that inflation is positively related to the probability of financial distress for firms.

In summary, in this study, the combination of the accounting-based, market-based and macroeconomic variables impacting on the financial distress is used to cover various aspects of the default risk. Thus, the comprehensive model is established as follows:

$$Y = \beta_1 \frac{WC}{TA} + \beta_2 \frac{RE}{TA} + \beta_3 \frac{EBIT}{TA} + \beta_4 \frac{BVE}{TL} + \beta_5 \ln(MVE) + \beta_6 \ln LEVERAGE + \beta_7 \sigma_E + \beta_8 PRICE + \beta_9 Treasury\ bill + \beta_{10} Inflation + \varepsilon$$

Where:

Y (*Classify*): The binary of the non-default ($Y=0$) and default ($Y=1$)

$\frac{WC}{TA}$: Working capital to Total assets

$\frac{RE}{TA}$: Retained Earnings to Total Assets

$\frac{EBIT}{TA}$: Earnings before interest and taxes (operating profit) to Total Assets

$\frac{BVE}{TL}$: Book value of equity to Total liabilities

MVE : Market value of equity

$LEVERAGE$: Leverage ratio

σ_E : Volatility of equity

$PRICE$: Price

Treasury bill: A one-year short-term Treasury bill

Inflation: Inflation

ε : Error term

4. Empirical results and Analysis

Table 1 presents that the data is divided into two groups with non-financial distress including 5161 observations (accounting for 76 percent the total number of observations) and the financial distress with 1575 observations.

Table 1: Description statistics of the independent variable

Classify	Freq.	Percent	Cum.
0	5,161	76.62	76.62
1	1,575	23.38	100
Total	6,736	100	

Source: Authors' analysis

As presented in Table 2, 6,736 observations are utilized in this study for each of the following independent variables: WCTA - the working capital over total asset, RETA – Retained earnings over total asset, EBITTA- Earnings before interest and taxes (operating profit) to Total assets, BVETA - Book value of equity to Total liabilities, MVE - Market value of equity, PRICE - the stock price, VOL_MVE- Volatility of market value of equity, LEVERAGE - Leverage

ratio, INFLATION- inflation, SHTBRDEF - the short-term treasury bill in one year, the Z-score – Z-score index and DD - Distance to default of firms.

Table 2: Summary of statistics for independent variables

Variable	Obs.	Mean	Std. Dev.	Min	Max
<i>Working capital/total asset</i>	6736	0.211	0.242	-1	3
<i>Retained earnings /asset</i>	6736	0.039	0.134	-3	1
<i>Operating profit/ Total assets</i>	6736	0.033	0.108	-2	6
<i>Book value of equity / Total liabilities</i>	6736	0.665	0.307	-0.568	1
<i>Price</i>	6736	20853	24776	317	350000
<i>Market value of equity</i>	6736	12	2	7	22
<i>Volatility of equity</i>	6736	1701326	53500000	18	3360000000
<i>Leverage</i>	6736	1	1	0.003	13
<i>Inflation</i>	6736	9	6	1	23
<i>Treasury bill</i>	6736	8	3	4	12
<i>Z-Score</i>	6736	8	6	-11	102
<i>DD</i>	6736	0.002	0.006	0.000	0.113

Source: Authors' analysis

Table 3: Correlation matrix and multicollinearity diagnostic statistics

Variable	WCTA	RETA	EBITTA	BVETL	PRICE	MVE	VOL_MVE	LEVERAGE	INFLATION	SHTBRDEF
WCTA	1									
RETA	0.3908***	1								
EBITTA	0.1029***	0.1852***	1							
BVETL	0.4961***	0.3743***	0.1172***	1						
PRICE	0.1383***	0.2834***	0.0907***	0.127***	1					
MVE	0.0349***	0.2942***	0.0557***	0.0781***	0.4484***	1				
VOL_MVE	-0.0126	0.0121	0.0231*	0.0215*	0.0184	0.1068***	1			
LEVERAGE	0.2684***	0.2831***	0.1393***	0.5403***	0.4327***	0.3928***	0.1257***	1		
INFLATION	0.0606***	0.0929***	0.0672***	0.0494***	0.0496***	0.0812***	0.0213*	0.0224*	1	
SHTBRDEF	0.0366***	0.1048***	0.0404***	0.0332***	0.1225***	0.0801***	0.0142	-0.0303**	0.8598***	1

Source: Authors' analysis

Note: **WCTA:** The working capital over total asset; **RETA:** Retained earnings over total asset; **EBITTA:** Earnings before interest and taxes (operating profit) to Total assets; **BVETA:** Book value of equity to Total liabilities; **MVE:** Market value of equity; **PRICE:** Stock price; **VOL_MVE:** Volatility of market value of equity; **LEVERAGE:** Leverage ratio; **INFLATION:** Inflation; **SHTBRDEF:** Short-term treasury bill in one year.

Table 3 reports the correlation matrix of all independent variables. These variables are generally independent from each other except for the strong correlation between the inflation and The Short-term Treasury bill (SHTBRDEF) with the coefficient of 0.86.

Table 4: The relationship between the default probability and Z-score, DD

Classify	Coef.	Std. Err.	z	P>z	95% Conf. Interval	
Z_Score	-0.0407	0.0082	-4.97	0.000	-0.0568	-0.0247
Distance to default	-16.2379	7.8814	-2.06	0.039	-31.685	-0.7907
_cons	-1.434	0.0997	-14.38	0.000	-1.6295	-1.2385

Source: Authors' analysis

It is generally accepted that the Z-score and Distance to default are two key proxies for the bankruptcy of firms. Table 4 presents that Z-score is negatively significant at 1 per cent while the Distance to default (DD) is at 5 per cent level of significance. This result also indicates that the larger the Z-score and Distance to default, the lower the probability of default.

Table 5: Credit rating of Z-score model

Rating	No. of Observations	Percentage
Safe zone	3669	54.5
Grey zone	1801	26.7
Bankruptcy zone	1266	18.8
	6736	100

Source: Authors' analysis

Table 5 reports specifically the credit rating provided by the Standard & Poor in period 2003-2016. 81.2 percent of firm belongs to the safe zone with no probability of default and gray zone or the low level of default whereas only 18.8 per cent falls in the high probability of bankruptcy zone. These statistics confirm that most Vietnamese firms have a good and stable economic operation.

Table 6 presents the result from a xtlogit regression of financial distress. Various models have been used to consider the separate effects from accounting factors; market-based factors; and macroeconomic factors on financial distress and bankruptcy for Vietnam's listed firms. In addition, because of the correlations between the Retail Price Index and the Short-term Treasury bill, various models are run concurrently to overcome the correlation among variables.

Table 6: Financial distress of Vietnam's listed firms: various models

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
WCTA	-0.473 (1.76)*		-0.497 (1.82)*	-0.479 (1.76)*			-0.502 (1.83)*	-0.486 (1.78)*
RETA	-2.984 (4.87)***		-3.479 (5.32)***	-3.483 (5.35)***			-3.153 (4.75)***	-3.156 (4.76)***
EBITTA	-151.610 (26.13)***		-156.427 (26.01)***	-155.181 (26.02)***			-156.442 (25.79)***	-155.524 (25.79)***
BVETL	-0.486 (2.22)**		-0.508 (2.29)**	-0.503 (2.27)**			-0.784 (2.99)***	-0.786 (3.00)***
PRICE		0.000 (7.94)***			0.000 (7.89)***	0.000 (8.04)***	0.000 -0.760	0.000 -0.430
MVE		-0.124 (3.48)***			-0.149 (4.08)***	-0.136 (3.77)***	-0.073 (1.75)*	-0.084 (2.03)**
VOL_MVE		0.000 -0.180			0.000 -0.130	0.000 -0.140	0.000 -0.140	0.000 -0.240
LEVERAGE		-0.190 (3.22)***			-0.173 (2.91)***	-0.182 (3.08)***	0.164 (1.95)*	0.167 (2.00)**
INFLATION			0.051 (6.70)***		-0.027 (4.70)***		0.049 (6.41)***	
SHTBRDEF				0.090 (5.94)***		-0.046 (4.07)***		0.087 (5.68)***
_cons	0.839 (5.68)***	0.394 -0.970	0.498 (3.17)***	0.224 -1.240	0.889 (2.11)**	0.873 (2.06)**	1.461 (2.77)***	1.316 (2.45)**
Insig2u_cons	0.368 (2.42)**	0.940 (9.64)***	0.404 (2.65)***	0.385 (2.50)**	0.950 (9.71)***	0.946 (9.69)***	0.447 (2.93)***	0.439 (2.86)***
N	6736	6736	6736	6736	6736	6736	6736	6736

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Note: **WCTA:** The working capital over total asset; **RETA:** Retained earnings over total asset; **EBITTA:** Earnings before interest and taxes (operating profit) to Total assets; **BVETA:** Book value of equity to Total liabilities; **MVE:** Market value of equity; **PRICE:** Stock price; **VOL_MVE:** Volatility of market value of equity; **LEVERAGE:** Leverage ratio; **INFLATION:** Inflation; **SHTBRDEF:** Short-term treasury bill in one year; **Z-score:** Z-score index; and **DD:** Distance to default of firms.

In summary, the following models are considered in this study.

- Model 1 includes all the independent accounting variables;
- Model 2 includes all market variables;
- Model 3 includes all accounting variables *plus* the inflation variable;

- Model 4 includes all accounting variables *plus* the short-term Treasury bill in one year;
- Model 5 includes the market variables *plus* the inflation variable;
- Model 6 includes the market variables *plus* the short-term treasury bill in one year;
- Model 7 includes the accounting and market variables *plus* the inflation variable; and
- Model 8 includes the accounting and market variables *plus* the short-term Treasury bill in one year.

Table 7: Marginal effect

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
WCTA	0.0039375		0.003744	0.003664			0.003786	0.003723
RETA	0.0248527		0.026197	0.026661			0.023797	0.024168
EBITTA	-1.262741		1.177922	1.187857			1.180723	1.190785
BVETL	0.0040471		0.003823	0.003851			0.005920	0.006020
PRICE		0.000003			0.000003	0.000003	0.000000	0.000000
MVE		0.014512			0.017227	0.015781	0.000550	0.000646
VOL_MVE		0.000000			0.000000	0.000000	0.000000	0.000000
LEVERAGE		0.022235			0.020083	0.021230	0.001238	0.001281
INFLATION			0.000385		0.003111		0.000373	
SHTBRDEF				0.000687		0.005385		0.000667

Source: Authors' analysis

Note: **WCTA:** The working capital over total asset; **RETA:** Retained earnings over total asset; **EBITTA:** Earnings before interest and taxes (operating profit) to Total assets; **BVETA:** Book value of equity to Total liabilities; **MVE:** Market value of equity; **PRICE:** Stock price; **VOL_MVE:** Volatility of market value of equity; **LEVERAGE:** Leverage ratio; **INFLATION:** Inflation; **SHTBRDEF:** Short-term treasury bill in one year; **Z-score:** Z-score index; and **DD:** Distance to default of firms.

In the logit regression, the magnitude of the marginal effect is presented in Table 7 in Vietnam from 2003 to 2016. The largest impact on financial distress comes from earnings before interest and taxes over the total asset (EBITTA) while the smallest impact is from the volatility of the market value of equity (Vol_MVE).

Table 8 illustrates the summary of model performance for eight models utilized in this study. All of the models are statistically significant. As such, they are all useful for measuring the financial distress for listed firms in Vietnam. The area under the ROC curve (AUC) is used directly to estimating the predictive accuracy of the models. The good model will have the ROC curve straight up from (0,1) to (1,1) afterward across (1,1). While the model that has no discriminatory power will have the AR of 0 or the ROC of 0.5; the perfect model in terms of its

usefulness for measuring financial distress will have the ROC of 1. While other models are generally good, Models 2, 5 and 6 including market variables indicate the low predictability of the market variables on default probability. This evidence is similar to the marginal effect analysis in that when market variables are added into the model, the magnitude of impact factors on the default decreases.

Table 8: A measurement of model performance

Measure	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
<i>ROC</i>	0.9337	0.6878	0.9354	0.9352	0.6849	0.6848	0.9341	0.9336
<i>-2 likelihood R²</i>	3983	6891	3941	3947	6869	6875	3939	3946
<i>Prob > LR</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Cox & Snell's R²</i>	0.391	0.063	0.395	0.394	0.066	0.065	0.395	0.395
<i>Nagelkerke's R²</i>	0.59	0.094	0.596	0.595	0.099	0.098	0.596	0.595

Source: Authors' analysis

In order to understand the effect of the GFC on the financial distress of the Vietnamese listed firms, the dataset is divided into two sub-periods: pre-crisis (2003-2009) and post-crisis (2010-2016).

Table 9 presents the result from a financial distress in pre-crisis periods. While the Earnings before interest and taxes to Total assets (EBITTA) is negatively significant at 1 per cent, two macroeconomic variables involving the inflation and Treasury bill are positively significant at 5 per cent with the financial distress. In addition, all of the market variables are insignificant, this result reveals that the market factors do not affect the default probability of firms.

Table 9: Financial distress of Vietnam's listed firms: various models in pre-crisis period (2003-2009)

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
WCTA	-0.787		-0.79	-0.782			-0.775	-0.762
	(2.53)**		(2.48)**	(2.46)**			(2.43)**	(2.39)**
RETA	-2.645		-3.075	-3.147			-2.845	-2.858
	(4.34)***		(4.73)***	(4.80)***			(4.30)***	(4.33)***
EBITTA	-181.406		-185.497	-186.217			-185.101	-185.488
	(22.98)***		(22.78)***	(22.79)***			(22.58)***	(22.61)***
BVETL	-0.699		-0.701	-0.713			-1.009	-1.002
	(2.65)***		(2.62)***	(2.67)***			(3.21)***	(3.20)***
PRICE		0.000			0.000	0.000	0.000	0.000
		(6.19)***			(6.29)***	(6.15)***	-0.71	-1.09
MVE		-0.295			-0.306	-0.309	-0.051	-0.052
		(6.01)***			(6.17)***	(6.23)***	-1.04	-1.05
VOL_MVE		0.000			0.000	0.000	0.000	0.000
		-0.76			-0.82	-0.82	-0.08	-0.12
LEVERAGE		-0.181			-0.181	-0.171	0.189	0.176
		(2.26)**			(2.25)**	(2.12)**	(1.88)*	(1.76)*
INFLATION			0.054		-0.02		0.053	
			(5.46)***		(2.60)***		(5.28)***	
SHTBRDEF				0.096		-0.048		0.094
				(5.42)***		(3.62)***		(5.28)***
_cons	1.139	2.507	0.788	0.494	2.795	3.019	1.509	1.251
	(6.43)***	(4.58)***	(4.17)***	(2.32)**	(4.98)***	(5.30)***	(2.44)**	(1.98)**
Insig2u_cons	0.625	1.298	0.653	0.649	1.302	1.308	0.677	0.675
	(3.79)***	(12.38)***	(3.92)***	(3.89)***	(12.39)***	(12.46)***	(4.06)***	(4.03)***
N	5077	5077	5077	5077	5077	5077	5077	5077

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Note: **WCTA:** The working capital over total asset; **RETA:** Retained earnings over total asset; **EBITTA:** Earnings before interest and taxes (operating profit) to Total assets; **BVETA:** Book value of equity to Total liabilities; **MVE:** Market value of equity; **PRICE:** Stock price; **VOL_MVE:** Volatility of market value of equity; **LEVERAGE:** Leverage ratio; **INFLATION:** Inflation; **SHTBRDEF:** Short-term treasury bill in one year; **Z-score:** Z-score index; and **DD:** Distance to default of firms.

Furthermore, the ROC score in Table 10 indicates also the best model belong to the model 3 and 4 including the accounting and market variables. Table 10 provides evidence to confirm that Models 2, 5, 6 including mainly market variables appear to be the worst performing models in comparison with other models including accounting factors and/or macroeconomics factors.

Table 10: Model performance measure in the pre-crisis period (2003-2009)

Measure	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
ROC	0.908	0.609	0.909	0.908	0.596	0.601	0.909	0.908
-2 likelihood R^2	772	1263	765	766	1262	1260	764	765
Prob > LR	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cox & Snell's R^2	0.265	0.012	0.268	0.268	0.013	0.014	0.269	0.268
Nagelkerke's R^2	0.493	0.022	0.498	0.497	0.024	0.026	0.499	0.498

Source: Authors' analysis

In the post-crisis stage, Table 11 displays that all of the accounting variables are statistically significant and only the leverage variable of the market variable is positively significant. In addition, the ROC score in Table 12 also illustrates that Models 3 4 including accounting and macroeconomic have a highest ROC score (0.9394 for both). Therefore, they are the best models in post-crisis case. The worst models still belong to Models 5 and 6 including the market as well as macroeconomic variables with the lowest ROC score (0.682 and 0.681 relatively).

Table 11: Financial distress of Vietnam's listed firms: various models in post-crisis period (2010-2016)

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
WCTA	-0.787		-0.79	-0.782			-0.775	-0.762
	(2.53)**		(2.48)**	(2.46)**			(2.43)**	(2.39)**
RETA	-2.645		-3.075	-3.147			-2.845	-2.858
	(4.34)***		(4.73)***	(4.80)***			(4.30)***	(4.33)***
EBITTA	-181.406		-185.497	-186.217			-185.101	-185.488
	(22.98)***		(22.78)***	(22.79)***			(22.58)***	(22.61)***
BVETL	-0.699		-0.701	-0.713			-1.009	-1.002
	(2.65)***		(2.62)***	(2.67)***			(3.21)***	(3.20)***
PRICE		0.000			0.000	0.000	0.000	0.000
		(6.19)***			(6.29)***	(6.15)***	-0.71	-1.09
MVE		-0.295			-0.306	-0.309	-0.051	-0.052
		(6.01)***			(6.17)***	(6.23)***	-1.04	-1.05
VOL_MVE		0			0	0	0	0
		-0.76			-0.82	-0.82	-0.08	-0.12
LEVERAGE		-0.181			-0.181	-0.171	0.189	0.176
		(2.26)**			(2.25)**	(2.12)**	(1.88)*	(1.76)*
INFLATION			0.054		-0.02		0.053	
			(5.46)***		(2.60)***		(5.28)***	
SHTBRDEF				0.096		-0.048		0.094
				(5.42)***		(3.62)***		(5.28)***
_cons	1.139	2.507	0.788	0.494	2.795	3.019	1.509	1.251
	(6.43)***	(4.58)***	(4.17)***	(2.32)**	(4.98)***	(5.30)***	(2.44)**	(1.98)**
Insig2u_cons	0.625	1.298	0.653	0.649	1.302	1.308	0.677	0.675
	(3.79)***	(12.38)***	(3.92)***	(3.89)***	(12.39)***	(12.46)***	(4.06)***	(4.03)***
N	5077	5077	5077	5077	5077	5077	5077	5077

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Note: **WCTA:** The working capital over total asset; **RETA:** Retained earnings over total asset; **EBITTA:** Earnings before interest and taxes (operating profit) to Total assets; **BVETA:** Book value of equity to Total liabilities; **MVE:** Market value of equity; **PRICE:** Stock price; **VOL_MVE:** Volatility of market value of equity; **LEVERAGE:** Leverage ratio; **INFLATION:** Inflation; **SHTBRDEF:** Short-term treasury bill in one year; **Z-score:** Z-score index; and **DD:** Distance to default of firms.

Table 12: A measurement of model performance in the post-crisis period (2010-2016)

Measure	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
ROC	0.938	0.682	0.939	0.939	0.682	0.681	0.938	0.939
-2 likelihood R ²	3155	5474	3126	3126	5466	5463	3122	3121
Prob > LR	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cox & Snell's R ²	0.417	0.08	0.421	0.421	0.082	0.082	0.421	0.421
Nagelkerke's R ²	0.608	0.117	0.612	0.612	0.119	0.12	0.613	0.613

Source: Authors' analysis

5. Conclusions

This paper examines various models of default prediction on the large sample of 800 Vietnamese firms in the period of 2003-2016. Total 6,735 observations are utilized in this research. Logistic regression is adopted on a comprehensive model in which the following key aspects of financial distress for firms are included: (i) accounting proxies of the Emerging Scoring Model (ESM); (ii) a number of market variables from the distance to default model (DD); and (iii) two macroeconomic indicators. Furthermore, the Area Under the ROC Curve (AUC) is utilized to comparing various models of default prediction. In particular, in order to consider the potential impact of the GFC on the financial distress of the Vietnamese firms, two sub-periods are considered including: (i) the pre-GFC period (2003-2009); and (ii) the post-GFC period (2010-2016).

Empirical findings from this study present evidence to support the view that the accounting model (ESM), market model (DD) and market variables have provided effects to the financial distress likelihood of the Vietnamese firms for the research period. In particular, four accounting proxies derived from the ESM model present a negative relationship with the default probability. These findings mean that the higher the financial liquidity, the productivity of assets, solvency, and sales generating ability of assets, the lower the financial distress likelihood of the Vietnamese firms. When the market-based variables are considered, a negative relationship between the market value of equity (MVE) and the financial distress likelihood is observed. This finding confirms the view that firms with large scale will have a low default probability whereas the leverage ratio has a positive relationship with the financial distress of firms. It is worthwhile mentioning that the inflation and the interest rate of short-term Treasury bill have a positive relation to the financial distress.

The intention of this study is to develop a comprehensive model, which is the first of its kind in Vietnam, to include various factors derived from strong ground of accounting models; market-based models; and macroeconomic factors to consider the effect of these factors on the financial distress likelihood of the Vietnamese firms. The entire research period from 2003-2016, which is then sub divided into the pre-GFC period (2003-2009) and the post-GFC period (2010-2016) are considered in this study.

On balance, proxies from accounting models, the market-based model, and typical macroeconomic factors have all contributed effect to the financial distress of Vietnamese listed firms for the research period when they are considered in isolation. However, when a comprehensive model is developed, the effect from accounting factors appear to be stronger in comparison with the market-based models. Findings from this study also confirm that the model of default prediction including accounting factors and macroeconomic factors appear to be better than the market-based models and the market-based models with macroeconomic fundamentals.

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