SCHOOL OF ECONOMIC AND MANAGEMENT

CREDIT RISK MANAGEMENT OF THE CHINESE BANKS BASED ON THE KMV MODEL

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ABSTRACT

Due to the increasing need for advanced credit risk management and lacking of quantitative credit risk measurement modeling at the Chinese banks, the purpose of this dissertation is to study the feasibility of applying the Western credit risk model, the Moody's KMV (MKMV), to China.

Because of the particular Chinese considerations, such as pricing the temporary non-tradable restricted shares and lacking of default data, a modified MKMV model is suggested and tested. Firstly, the samples of Chinese public listed companies are classified into two groups: special-treated with high default risk and non-special treated with low risk. Then, the adjustments of various parameters are determined. After that, a validation test on the findings is carried out. Finally, the results are discussed from three approaches: horizontal analysis, vertical analysis and regression analysis.

In according to the results of regression, the theoretical expected relationships among the model parameters are significantly found in the Chinese samples. For both horizontal and vertical analysis, the positive signs showing that the model's abilities in discriminating the good companies from bad ones and in predicting the default risk of the distress companies in China are found, but they are not significant. Therefore, it is hard to infer the practicability of the MKMV model in China as a consequence of the statistical limitations. Further studies on the unique Chinese factors, including the pricing non-tradable ordinary share, the unclear definition of default and the absent of extensive historical default database are suggested.

Keywords: Chinese Banks, Credit Risk, Moody's KMV, Risk Management of Banks

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ABBREVIATIONS

BIS	Bank of International Settlements
CBRS	China Banking Regulatory Commission
CSRC	China Securities Regulatory Commission
DD	Distance-to-Default
DPT	Default Point
EDF	Expected Default Frequency
LTD	Long-Term Debt
MKMV	Moody's KMV
NAV	Net Asset Value
NPL	Non-Performance Loan
SOE	State-Owned Enterprises
ST	Special Treated
STD	Short-Term Debt

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CHAPTER 1: INTRODUCTION

1.1 Background

Although there are various types of risk found in the banking industry, it is well-known with six major risks which include credit risk, market risk, operational risk, liquidity risk, and legal and reputation risk[1]. Credit risk is also named as default risk which is the uncertainty about the likelihood that the obligator is unable to serve his / her obligations. Credit risk has received increasing attentions and its measurement has also gone through a process of revolution during the last two decades due to a number of reasons: increased number of bankruptcies (defaults); declining and more volatile asset prices particularly for collateral; increased amount of off-balance sheet exposure such as the derivative instruments; advanced technology such as electronic database and computerization; urge from of Bank of International Settlement (BIS) capital requirements (New Basel Capital Accord, BIS II); keen industrial competition for loan portfolio studies; and so forth. In addition, the current credit risk crisis shows evidence that a better risk management at banks is highly essential (Saunders, 2002).

China's planned economy system has been open since 1978. The Chinese financial market, which has been dominated by the banking sector, commenced in the late 1980's and has since then developed remarkably and undergone continuous notable reforms. Given the dominated market shares of four stated owned commercial banks[2] and three state-owned "policy banks"[3], the banking sector in China is mainly state-controlled and less competitive. In order to support the stated-owned enterprises (SOEs) and to finance the infrastructure investments and exports, most bank loans taken during the last decades were based on political objectives or connections rather than creditworthiness (which is based on credit risk measurement system) leading to the problems of excessive non-

[1] The types of risk are classified by Federal Reserve System of the Unite State

[2] China's four state-owned commercial banks, which differed according to the sector in which they are directed to specialized, comprise of the Bank of China, the China Construction Bank, the Industrial and Commercial Bank, and the Agricultural Bank of China

[3] China's three state-owned policy banks are the State Development Bank, the Export and Import Bank, and the Agricultural Development Bank.

performance loan (NPL) and loan concentration for most of the local banks. On top of the increasing problem of NPLs, the accession of the WTO in 2001, which requires China to open up its banking system to foreign competition, has demanded gradual reforms in the local banking system. Therefore, how to accurately assess credit risk in order to lower the proportion of bank's NPLs, and reform the banking system in China have become a hot topic among the Chinese and international scholars since the late 1990s.

In short, the budget constraints, government intervention and asymmetric information are the main causes of the large amount of NPLs in the Chinese banking system. Therefore, the credit risks arising from NPLs and loan concentration, and lack of efficient credit risk measurement and management are the center concerns of the regulators, practitioners and scholars. Although Western quantitative credit risk modeling were introduced in China in the 1990's, the traditional subjective judgments based on certain specific local documents and their own experience are still the mainstream credit risk analysis methodologies in the Chinese banking sector.

This paper will narrow down the scope of study to test the feasibility of one of modern credit risk qualitative measuring models, Moody's KMV model (MKMV), for the Chinese banks. Various modifications will be considered and suggested.

1.2 Problems and purposes

As mentioned previously, although the urge for applying the advanced credit risk management at the Chinese banks has been increasing, there is still a lack of recognized quantitative credit risk modeling in China. Hence, the purpose of this dissertation is to assess whether the western credit risk model, the Moody's KMV credit risk model, can be applied to the Chinese banks. China's financial market is still in its developing stage (see Chapter 3 under the subsection of 3.3 regarding the Chinese researchers on the application of the MKMV model in China), so there are various constraints on the application of the MKMV model in China and the model therefore need to be modified and improved further. To justify the feasibility of applying the KMV model in China, we have to consider the following problems:

(a) Underdeveloped financial market

The MKMV credit risk model has been developed based on the developed, deep and liquid Western financial markets which are relatively more efficient than that of China. For only about 2 decades' development, the Chinese stock market has been classified as the weak-form market efficient by researchers (see Darrat and Zhong, 2000; Ma and Barnes, 2001; Seddighi and Nian, 2004; Lima and Tabak, 2004; Gao and Kling, 2005). The general comments from these studies are that, in China, the market data is hardly to reflect investors' expectation on the future performance of the companies, and the problems of internal trading and information asymmetry are commonly found as well. In addition, the quality of the corporate financial disclosure system, which affects the accuracy of the parameters in the MKMV model, is still in doubt. Therefore, to what extent the MKMV model can be applied in the financial system of an emerging economy, like China, is an interesting issue for the authors.

(b) Absence of a reliable historical default database

As asserted by Moody's, the default risk indicator of their MKMV model is derived from an extensive global historical default database. This large size of data set determines the credit risk prediction power and evaluation ability of the MKMV model. However, in China, the default information is difficult to collect due to the difference in bankruptcy code and culture and historical background. This problem will be elaborated in details in Chapter 3.

(c) Non-tradable ordinary shares in China

In China, there are still a large proportion of temporary non-tradable ordinary shares held by the Chinese corporations. Under the situation of this share segmentation of "different price of one stock" in China, it is not appropriate to assume the prices of both tradable and non-tradable are equivalent. Since the precise market value of the equity is one of the input variables in the MKMV mode, so the pricing of those non-tradable price is another technical problem we have to solve.

In brief, this dissertation aims to study the appropriateness of implementing the MKMV model in China by taking the above mentioned problems (for instance lacking default information, non-tradable share pricing, default-point's designation and so forth) into consideration.

1.3 Methodology

In order to test the feasibility of the MKMV model on Chinese companies, we construct a four step model in our study, refer to Figure 1.1.

Firstly, we classify our sample of companies into two groups: (a) *special treated (ST) companies* that earn negative net profit for two consecutive years and (b) *ordinary (non-ST) companies.* By theory, we assume the former group has higher credit risk than the latter one. Secondly, we make relevant adjustments in the MKMV model in order to make it fit to the particular environment in China. Thirdly, we implement the MKMV model into the two groups of companies in order to see whether the estimated default risk (distance-to-default) can discriminate the high- credit risk companies from the low-credit companies. If the result from our testing is consistent with our assumption, thereby implying that it is feasible to imply the KMV model in China, otherwise not. Finally, implications of our findings are analysed and validation of our testing will also assessed. A thorough explanation of the procedures in our Methodology will be stated in the Chapter 4.

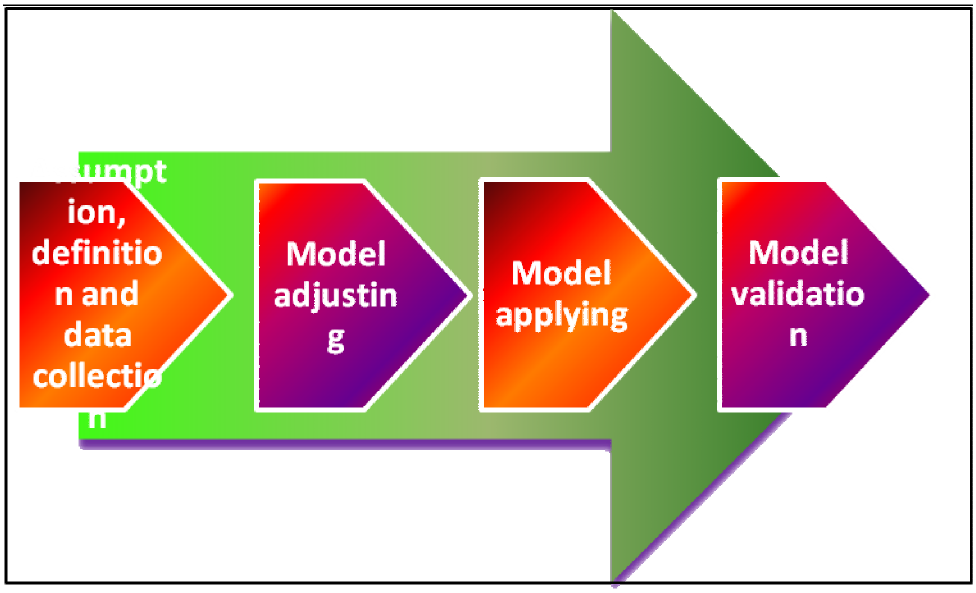

Figure 1.1: Testing model for applying the MKMV model in China

1.4 Delimitations

To make the scope of study more apparent, we do not take into consideration the following two stocks: (i) shares of Chinese companies listed on the stock exchange of the special administration regions of Hong Kong and Macau and abroad[4], (ii) the local shares denominated in foreign currencies[5] instead of domestic currencies (RMB). In other words, only "A" shares of the Chinese company are considered in our empirical study. In addition, due to the limited time and resources, samples are conditionally selected in our study.

1.5 Organization

This dissertation is comprised of five chapters which summaries are as follows.

Chapter One: Introduction

In this chapter, the background, and the problem and purposes are firstly described. Afterwards, the research methodology and delimitation are explained. Finally the structure of this report is outlined.

Chapter Two: Theoretical Basis of Merton and KMV's credit risk model

To test the KMV model in China, the detailed theoretical basis of the Merton and KMV model is discussed. Firstly, the assumptions and the fundamental principles of Merton are stated. Secondly, how KMV model was constructed and implemented are illustrated.

Chapter Three: Application of the KMV Model in China

Having a clear picture of the credit risks which the Chinese banks are facing provides an important backdrop to study the feasibility of implementing the MKMV model in China. Therefore the credit risk for the Chinese banks is firstly highlighted in this chapter follow by a description of the Chinese default or bankruptcy legislation. Finally the Chinese research concerning the application of KMV model in China is summarized.

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[4] Shares listed on the Hong Kong Stock Exchange and the New York Stock Exchange are named as "H" shares and "N" shares.

[5] Shares denominated in foreign currencies are names as "B" shears

Chapter Four: Empirical Study

This chapter is the backbone of the report. In the beginning, the detailed assumptions and methodology are described. Then, the thorough procedures of implementation our modified MKMV credit model are illustrated. Afterwards, our results are analyzed in three approaches: horizontal, vertical and regression. Finally, a discussion on the practicability of the modified MKMV model in China is carried out.

Chapter Five: Conclusion and Further Study

Conclusion of our empirical test on the feasibility of our modified MKMV model is drawn in this chapter.

CHAPTER 2: THEORETICAL BASIS OF THE MKMV CREDIT RISK MODEL

In this chapter, we firstly summarize the Merton and the Moody's KMV in detail. Next, we outline the empirical assessments on the model.

2.1 Theoretical notations of the Merton's bond pricing and the MKMV model

Moody's KMV model, which is a structural quantitative approach, applies the bond pricing concepts of Merton (1974) to credit risk predicting. The detail notations of both Merton's concepts and KMV's model are further explained respectively in this chapter.

Merton's bond pricing model

Merton (1974) implemented the option pricing model of Black-Scholes (1973) into a bond pricing model. Equity holder is the residual claimer for the firm's assets after all other obligations have been met. The holder of a call option on the firm's assets has a claim on the assets after meeting the strike price of the option, which is the book value of the firm's total liabilities. If the firm's asset value is larger the firm's face value of liabilities, the shareholders will not let the company default, this equals to "exercising the option right", then they can get the residual claims after paying the debts. If the opposite situation occurs, shareholders will let the company default, this means "not exercising the option right". See Figure 2, where B is the face value of liabilities and -L is the initial invested capital:

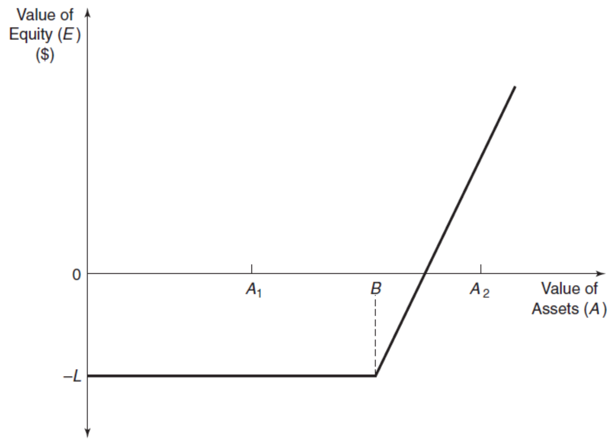

Figure 2.1: Equity as a call option on the firm

There are mainly two assumptions in Merton's model. Firstly, the market value of the firm's underlying assets follows the stochastic process:

$$dV_A = \mu V_A\, dt + \sigma_A V_A\, dz \ , \tag{1}$$

where V_A is asset value of the firm, μ is the expected continuously compounded return of V_A , σ_A is the firm's asset value's volatility, dz is a standard Gauss-Wiener process.

The second assumption is that the firm has only one discount bond maturing in T periods. By the put-call parity, the value of the firm's equity is equal to the following:

$$V_E = V_A\, N(d_1) - e^{-rT} F\, N(d_2) \ , \tag{2}$$

where V_E is the market value of equity, F is the face value of the firm's debt, r is the risk-free rate, N(•) is the cumulative standard normal distribution function, d_1 and d_2 are :

$$d_1 = \frac{\ln(\frac{V_A}{F}) + (r + 0.5\,\sigma_A^2)T}{\sigma_A \sqrt{T}} \ ; \quad d_2 = d_1 - \sigma_A \sqrt{T} \tag{3}$$

In brief, the Merton concept of risky debt is the original structural model of credit risk, and perhaps the most significant contribution to the area of quantitative credit risk research.

Moody's KMV model

Oldrich Vasicek and Stephen Kealhofer, practitioners employed by KMV Corporation, extended the Merton model's assumptions that value of a firm's equity as a function of the firm value, as well as related the volatility of the firm value to the volatility of equity, so it follows directly from Ito's lemma (Shumway and Bharath, 2004):

$$\sigma_E = (\frac{V_A}{V_E}) \frac{\partial V_E}{\partial V_A} \sigma_A , \qquad (4)$$

since $\frac{\partial V_E}{\partial V_A}$ is a hedge ratio which is equal to $N(d_1)$, so that the volatility relationship between total asset value of the firm and the equity is :

$$\sigma_E = (\frac{V_A}{V_E}) N(d_1) \sigma_A \qquad (5)$$

In short, there are five variables used in both Merton and MKMV models:

Value of a default option on the risky loan = f (V_A, F, r, σ_A, T) *(6)*

The Vasicek-Kealhofer (VK-model) is widely used in the commercial purposes. In April 2002, Moody's acquired KMV and implemented VK-model of KMV and renamed it as Moody's KMV (or MKMV) model, which calculates an Expected Default Frequency (EDF) as the default probability. Merton model assumes there is only a single debt with zero-coupon payment, while the MKMV takes short-term, long-term, convertible and preferable debts into account. In other words, Merton model focuses on the debt valuation while the MKMV center on the research on Expected Default Frequency (EDF) or default probability in the coming year.

There are three major factors in determining the default probability of a firm stated in the MKMV (Crosbie 2003, Moody's) :

(a) *Value of asset*: the market value of the firm's assets which is a measure of the present value of the future cash flows discounted at an appropriate discount rate;
(b) *Asset Risk:* the uncertainty and risk of the asset value which is a measure of a firm's business and industry risk;

(c) *Leverage:* the extent of the firm's contractual liabilities whereas the relevant measure of the firm's asset is always their market value, while the book value which is relevant to the market value of asset is the pertinent measure of the firm's leverage, since that is the amount the firm must repay.

Table 2.1 : Example of market net worth and default risk

	Anheuser-Bush	Compaq Computer
Market value of asset	44.1	42.3
Default point	5.3	12.2
Market Net Worth ($bn)	38.8	30.1
Asset volatility	21%	39%
Distance to Default	4.2	1.8
Default Probability (per annual)	.03%	1.97%

Source: Moody's KMV

As Table 2.1 indicates, the difference in the default probability among the two companies is driven largely by the asset volatility, standard deviation (or the risk) of the annual percentage change in the asset value, not the respective asset value or leverage.

To estimate the default probability, there are three steps in the MKMV model: (1) estimate asset value and asset volatility; (2) calculate the distance-to-default; (2) scale the DD to the EDF.

Step 1: Estimating asset value (V_A) and asset volatility (σ_A)

Given the option nature of the equity, V_A and σ_A can be inferred by solving the two nonlinear equations (2) and (5) with the market value and the estimated volatility of the firm's equity.

Step 2: Calculating distance-to-default (DD)

To get the Expected Default Frequency (EDF) or default probability, the distance-to-default (DD) has to be computed (refer to Figure 2.2) DD is the number of standard deviations between the mean of asset value's distribution, and a critical threshold, the "default point" (DPT). According to the studies of the MKMV, some of the companies will not default while their firm's asset reach the level of total liabilities due to the different debt structure. Thus DPT is somewhere between total liabilities and current liabilities, as below:

$$DPT = STD + \alpha LTD \quad , \quad 0 \leq \alpha \leq 1, \tag{7}$$

where STD and LTD are book value of short-term and long-term debt, respectively. In practice, the MKMV set the DPT as the short-term liabilities plus half of the long-term debt (LTD), that is DPT = STD + 0.5 LTD. For commercial reason, Moody's does not disclose this empirical findings ($\alpha = 0.5$) of DPT. After getting the implied V_A and σ_A, the distance-to-default (DD) can be computed as follows:

$$DD = \frac{E(V_A) - DPT}{E(V_A)\,\sigma_A} \quad , \tag{8}$$

where $E(V_A)$ is $V_0 \exp^{(\mu t)}$, which is log-normality distributed. Thus, the DD expressed in unit of asset return standard deviation at the time horizon T is

$$DD = \frac{\ln\left(\frac{V_{A0}}{DPT_T}\right) + (\mu - 0.5\sigma_A^2)T}{\sigma_A \sqrt{T}} \quad , \tag{9}$$

where V_{A0} is the current market value of asset, DPT_T is the default point at time horizon T, μ is the expected annual return on the firm's assets, σ_A is the annualized asset volatility.

Step 3: Mapping the EDF with DD

If the assumption of normal distribution of the firm's asset value of Merton model holds (see Figure 2.2), the corresponding theoretical implied default probability or expected default frequency (EDF) at one year interval is

$$EDF_{Theoretical} = N\left(-\frac{\ln\left(\frac{V_{A0}}{DPT_T}\right) + (\mu - 0.5\sigma_A^2)T}{\sigma_A \sqrt{T}} \right) = N(-DD) \tag{10}$$

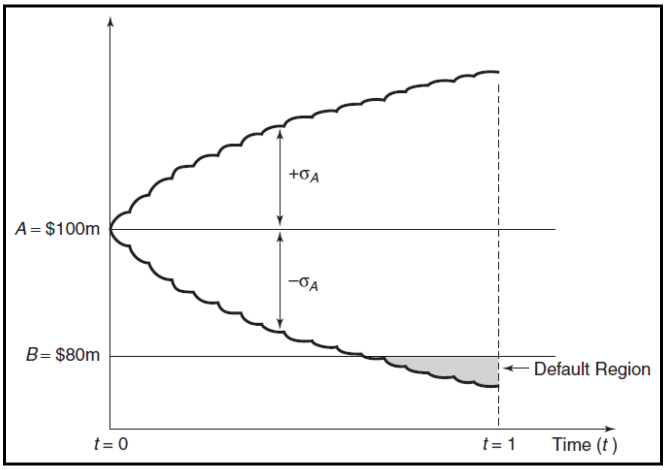

Figure 2.2: Theoretical EDF with normally distributed asset value

However, Moody claims that the distribution of asset value is not normal in practice since the default point (DPT) in reality is a random variable. Firm will often adjust their liabilities as they are close to default. Crosbie and Bohn (2001) explain that "in practice the market leverage moves around far too much for (equation 5) to provide reasonable results." To solve this problem, the MKMV generates an empirical EDF, which is derived from Moody's historical database of firm's defaults and loan payments:

$$EDF_{Empirical} = \frac{\begin{array}{c} No\ of\ \ firms\ that\ defaulted\ within\ a\ year\ with\ asset\ vlalue \\ of\ \ a\ certain\ DD\ \ from\ DPT\ \ at\ the\ beginning\ of\ \ the\ year \end{array}}{\begin{array}{c} Total\ \ population\ of\ \ firms\ with\ asset\ value\ of\ \ DD\sigma \\ from\ the\ DPT\ \ at\ the\ beginning\ \ of\ \ the\ \ year \end{array}} \tag{11}$$

For a numerical example, given DD are 2, by which only the firms with a distance of 2σ away from default are considered. Suppose, based on Moody's worldwide database, it was estimated that 50 of 1000 possible firms default, the empirical EDP is 50/1000 = 5%. (see Figure 2.3)

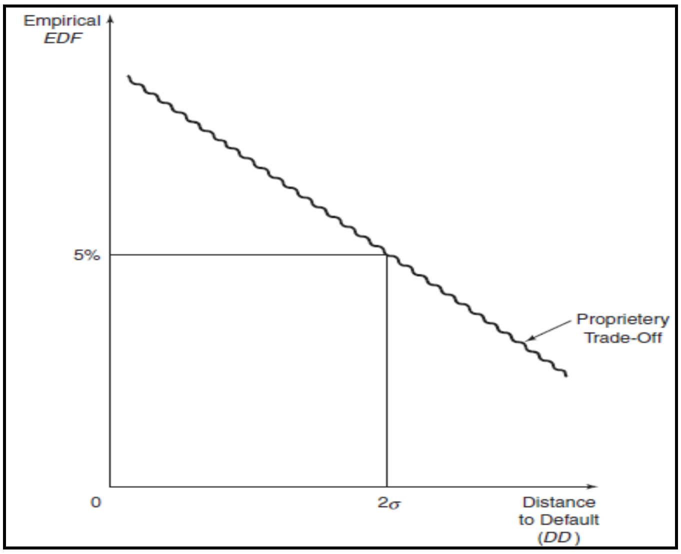

Figure 2.3: Empirical DEF and the distance-to-default (Source: Saunders, 2002)

Figure 2.4 shows the relationship of the parameters in the MKMV model with the following keys:

1. The current asset
2. The distribution of the asset value at time H
3. The volatility of the future asset value at time H
4. The level of the default point, the book value of the liabilities
5. The expected rate of growth in the asset value over the horizon
6. The length of the horizon, H

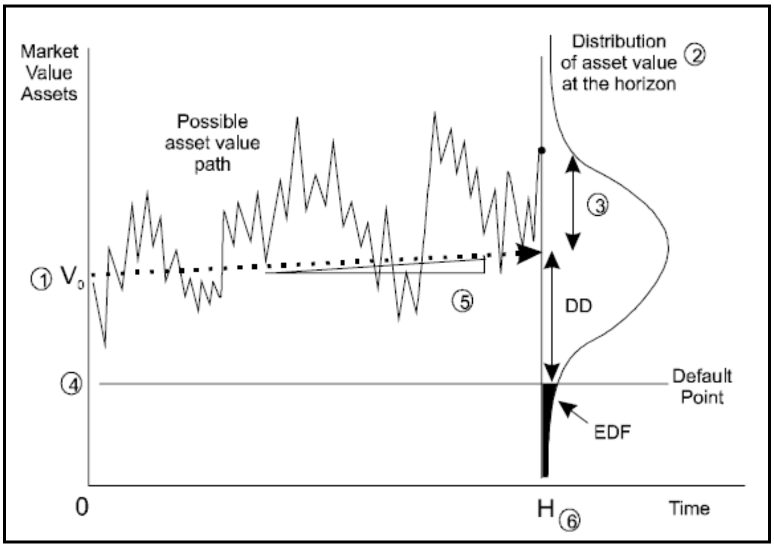

Figure 2.4: Parameters' relationship in the MKMV model (Source: Crosbie 2003, Moody's)

According to Moody's current publishes, the MKMV has assembled the largest public and private company default and loss database in the world. It contains globally 30 years of information on over 6000 public, and 170,000 private default events for a total of 50,000 public and 2,200,000 private companies.

In short, the final step in the MKMV model is to estimate the default probability by the relationship between it and the distance-to-default from the historical database, which covers the likelihood of default according to various levels of distance-to-default.

2.2 Western Empirical Assessments on the KMV-Merton model

Since Moody's acquired KMV, it is difficult to find earlier electronic papers critically assess the KMV-Merton models (Sreedhar et al, 2004). Early paper Jones et al (1981) mentioned that the Merton model has been failed to fit observed bond or yield spreads. Crosbie and Bohn (2002) summarized the MKMV's default probability model is a modified model of the Black-Scholes-Merton framework. Sobehart and Stein (2000): commented that Moody's model is a successful hybrid default risk model, and discovered that the Type I and Type II errors[6] of the MKMV –Merton model is significantly low. Crosbie & Bohn (2001): argued that the firm's asset value is not normal distributed which is one of the core assumptions of Merton's model. Also, Kealhofer and Kurbat (2002): claimed that KMV's implementation of the Merton model is more accurate than Moody's approach by taking the median EDF instead of the mean one. Vassalou and Xing (2003): define the face value of debt as the "debt in current liabilities plus one half of the long term debt", which notation is commonly used in the MKMV model. Hillegeist, Keating, Cram & Lundstedtt (2004), Du & Suo (2004) and Duffic & Wang (2004) showed that KMV-Merton model has significant predictive power for default probability. Campbell, Hilscher and Szilagyi (2004) estimated the hazard models that incorporate KMV-Merton model and other variables for bankruptcy, and found that KMV model has relatively little forecasting over after conditioning on

[6] Type I error is the: percentage of actual default companies classified as "non-default", while type II error is the percentage of non-default companies classified as "default"

other variables. Bharath & Shumway (2004): examined the KMV-Merton model and concluded it is not a statistical sufficient forecasting model for default probability.

In summarization, the ultimate strength of the MKMV model is that all the three main model elements (asset value, asset volatility and leverage) are determined by the equity price and publicly disclosed financial data which are observable, obtainable and highly responsive to the firm's condition. Such accurate and timing information from equity market provides a continuous credit monitoring process. According to Moody's, their EDF was proved to outperform the traditional credit rating, in particular the Enron default case, which EDF fell immediately alone with the drop of Enron stock price while it takes several days for credit agent to downgrade Enron's credit. Therefore, the MKMV's EDF could be a lending reference for any credit decision of any financial institution.

However, EDF was significantly lower then the standard credit rating when Enron's share price is substantially high. If the markets are not perfectly efficient, the plausibility of the EDF predictive power will be questioned. Moreover, another important constraint of the model is the normal distribution assumption as mentioned above. Although Moody's derive an empirical instead of theoretical EDF with reference to extensive historical credit information, this default database is closed for commercial use only. This therefore limits the academic research and development on the model.

CHAPTER 3: THE MKMV MODEL IN CHINA

Before testing the feasibility of applying the MKMV model for the Chinese banks, the localized factors which anchor to the assumptions and implementation of the model should be considered. Hence, in this chapter, we firstly highlight the credit risks of the Chinese banks following with the description of the Chinese bankruptcy /default legislation. After having the general picture of the Chinese particular environment, we finally review the Chinese researches on the MKMV model in China.

3.1 Credit risks to the Chinese banks

As mentioned in our research background in Chapter one, the problems of non-performance loans (NPLs), loan concentration and lacking of scientific credit risk management have amplified the credit risk to the Chinese banking sector which is the dominated pillar in the entire Chinese capital (or financial) system. However, thanks to the continuous economic and financial growth; demands for banking reforms in terms of credit quality, internal support system, risk management and governance standards have accelerated.

The Western credit risk analysis models have received mounting attentions from the Chinese regulators, practitioners and scholars. The authority of China has emphasized on the importance of credit risk for banks numerous times. For instance, there was enforcement of removal system for "distress firm" in the China's securities market in 2001. In addition, recently the China Banking Regulatory Commission (CBRS) specially remarked that *"Chinese banks must be on high alert for the accumulation of hidden risks as loans surge and balance the business growth and risk control",* in the CBRC statement issued on April 17, 2009.

3.2 Chinese legislation of company bankruptcy or default

The first Chinese bankruptcy law was introduced in 1988. However, the bankruptcy is seldom found among the Chinese companies during the transition period of the Chinese economy due to a number of reasons. Among the numerous reasons, the most important one is the balance between the level that the society can afford to let companies go bankruptcy in terms of security and stability and the opportunity loss in keeping distress companies alive. It is because that most of those problem companies are the backbone industries in China, they do not run for profit making, but keep the people employed.

With the accelerating development of open and market economy, to improve the situation by bringing up the awareness of default/credit risk to the investors, China's Security Regulatory Commission (CSRC) launched a new policy in March 1998 to differentiate companies with certain financial difficulties as "special treated" [7] one (hereinafter called "ST" companies). Zhang et al (2006) summarized the definitions of the "ST" companies as:

(i) companies that had negative cumulative earnings over two consecutive years or net asset value (NAV) per share is below it par value (book value)

(ii) Companies that had a negative earning for one year, but the current year shareholder's equities are below its registered capital[8].

(iii) Companies that received the registered auditor's "going concern opinions"

The ST companies are forced to improve their financial situation such as reorganization and mergers. If the companies do not make any financial improving, they will receive a "particular transfer" warning given by CSRC. If they are still unable to revitalize in the next year, they will be delisted from the Stock Exchange or transfer to the Asset Management Companies[9] for disposal.

[7] Special treatment is a daily price limitation of 5% applied to those firms with financial difficulties, according to CSRC)

[8] Registered capital equals to the share capital initially committed in accordance with the Article of Association of China's Security Regulatory Commission (Zhang et al, 2006)

[9] In 1999, four Asset Management Corporations were set up by the Chinese government in order purchase and deal with those non-performance loans or bad debts transferred by state banks.

In short, the "special treated" companies will be marked with the letters of "ST" in front of their names on the stock exchange (for instance the "ST Zhongnong Corporation") in order to offer a warning for both individual and institutional investors.

3.3 Chinese researches on the application of the MKMV in China

Since the late 90's, the local Chinese regulators, practitioners and scholars have initiated KMV-Merton for the credit risk analysis based on two different approaches: testing without and with localized modification.

(a) The MKMV testing without modification

In this approach, the Chinese scholars apply the KMV-Merton's theoretical model as a foundation in their empirical studies by using the Western parameters relationships together with the Chinese samples. The only differences among the researches are the size and classification of the samples. Some of the researches used one list company while the others took different companies which are classified into different categories as study sample. For instance, Wang Qiong, Chen JinXian(2002) compared KMV to the other modern credit risk models which relies more financial data, and argued that the KMV-Merton model is relatively suitable for evaluating the credit risk of the Chinese public companies. The conclusion of most of the findings of this approach is that the MKMV model can be served a supplementary reference for the traditional credit risk analysis which has constraints of accuracy, reliability and consistency.

(b) The MKMV testing with modification

There are numerous studies modifying the MKMV model for the particular Chinese financial environment of the banking industry.

Wu ChongFeng, Cheng Peng (2002), examined the credit conditions of the 15 listed Chinese companies and stated that the well-performed stock companies have the best credit quality, followed by the high-tech companies, and the credit situation of ST companies are the worst. Lu Wei, Zhao HengYan, and Liu JiYun(2003) specified that relationship between σ_A and σ_E vary according to the market changes, so the V_A and σ_A were re-calculated based on the sustainable growth FCFF (Free Cash Flow) model, giving better predictive power of default probability than the MKMV's EDF. Zheng Mao (2005) recognized that KMV-Merton model overestimates the asset value of the risky (junk) stock companies, although the corresponding estimation of the well-performed company is relatively accurate. Ma RuoWei (2006) proved with empirical studies that the MKMV model is applicable in China as a default reference.

In addition, many listed companies in China are originally the state-owned enterprises (SOEs), and a certain significant percentage of shares in such companies are not tradable in the market. Therefore, summing of both tradable and non-tradable of the equity as the total share outstanding, which then is multiplied by the market share price as the firm's equity value is not appropriate in China. Lu Wei, Zhao HengYan, and Liu JiYun (2003) proposed additive approach as $V_E = P_{Market} \times S_C + \frac{P_{Book\ Value} \times (S_{TOTAL} - S_C)}{P_{Initial\ Cost}}$[10]. There are various ways suggested to cope with such particular equity structure of the Chinese listed companies, and we come across this issue again under the subsection of "empirical testing" in next chapter.

In summarization, there are a certain number of local researches on applying the MKMV model as a credit risk management reference in China. However, various modifications are suggested in practice. Although most of the studies found positive results on the feasibility test on the MKMV model in China, there is still no common concession on the ways of modifications.

[10] V_E = value of equity; P_{Market} = market share price; $P_{Book\ Value}$ = book price of share; $P_{Initial\ Cost}$ = Price of initial cost when issuing; S_{Total} = Total nr of shares S_C = Total nr of circulated shares

CHAPTER 4: EMPIRICAL STUDY

In this "Empirical Study" chapter, we firstly define our assumptions and describe our methodology. Then, the thorough procedures of implementation our modified MKMV credit model are illustrated. Afterwards, our results are analyzed in three approaches: horizontal, vertical and regression. Finally, we discuss the practicability of the modified MKMV model in China.

4.1 Assumptions

By the definition of the Chinese "special treatment" (ST) listed companies mentioned in Chapter 3, we assume that the credit risk of the companies which was coded as ST on both Shanghai and Shenzhen stock exchanges are higher than those non-ST companies. In fact, the Chinese empirical studies illustrate that a large number of ST companies were default within the coming year after being classified as "ST". For instance, in a study of Zhu LuXiu (2006), 22 ST companies in 2004 were observed and 11 of them found failure in serving debt obligations in terms of amount and time. However, in accordance with the default classification of BASEL II, there were 34 default incidents in Zhu LuXiu's paper.

4.2 Methodology

To study the feasibility of applying the Moody's KMV credit model in China, we construct four steps in our empirical study. (See Figure 1.1)

4.2.1 Sample definition

Firstly, we classify our data samples into two groups: special-treated (ST) and non-special treated (non-ST) companies. Ideally, the study sample should include one group of companies which were actually default and another one of corresponding credit healthy companies. However, due to insufficient information transparency, it is difficult to spot out the default companies from any financial institutions or the authority in China. In other word, it is really hard to collect Chinese default data for our study. Under such circumstance, another alternative is to take the special treated instead of actual default companies as our data sample.

Taking the comparability between samples and the minimum empirical result errors into account, selection of a non-ST company is based on three requirements: (i) being listed on the same stock exchange as the corresponding ST company[11]; (ii) belong to the same industry as the ST company;[12] (iii) well-performed in terms of earning per share and net asset return.

The time horizon of our study is 4 years, from January 1, 2005 and December 31, 2008. All calculations are based on the data of the last trading day of each year, otherwise it is further clarified in this report.

4.2.2 Model adjustments

Secondly, we determine the required adjustments for the variables in the MKMV model due to the localised economic, financial and social environment in China. The detail modifications are discussed in next session later.

4.2.3 Model application

Thirdly, we apply the modified MKMV model to our two group of samples and try to examine if the default indicator (distance-to-default) can discriminate the credit exposure level among the ST and non-ST companies as what we have assumed. If consistent results are found, it implies that it is feasible to implement the MKMV model in China, otherwise it is not.

4.2.4 Model Validation

Finally, we perform the statistical test on our findings and try to assess the extent of statistical significance of our results.

[11] Stock price is different in different stock exchange market for the same companies

[12] Volatility is different in different industry

4.3 Model Testing:

4.3.1 Data collection

In order to have a broader and complete scope of study, we select one ST and non-ST listed companies from the Shanghai Stock Exchange or Shenzhen Stock Exchange for each industry classified in accordance with the China's Security Regulatory Committee (CSRC). It is not that every industry has ST or matched non-ST companies, for instance the Financial and Insurance Sector and the Construction Industry do not have any ST companies. In our samples, there are total 13 pairs of companies in 13 industries, with total 26 companies. The 13 industries include Tourism, Property and Real Estate, Pharmaceutical Industry, Home Appliance, Electronics and Machinery, Metal Refining, Chemical industries, Transportation Facilities Production, Farming, Utilities (Electricity, Gas and Water), Information Technology Equipment and Facilities, and Wholesales and Retails. The range of the company's capitalization in our samples is 0.3 billions RMB to 22 billions RMB. For the details of the sample, refer to Appendix I.

The data of share price and liabilities are retrieved from the DataStream while the data of "number of non-tradable share" and "adjusted share price" are collected from the GF Securities Co., Ltd, a recognized Chinese security company (http://www.gf.com.cn/).

4.3.2 Estimate Equity value (Ve)

Given the historical unique structure of the Chinese equity, there is a large number of listed companies in China are state-owned enterprises (SOEs) with a significant amount of ordinary shares which are not tradable in the market. Hence, the classification between the tradable and non-tradable Chinese equities has to been taken into consideration. Although there is no market value of the non-tradable shares in China, their prices are normally lower than the tradable ones.

Due to the complexity of such internal "two different types of ordinary stocks" (tradable and non-tradable shares), the authority has accomplished the "Equity-Division" reform aiming to transfer all the non-tradable stocks to tradable ones in a controlled time frame in order to maintain the market stability. However, it takes time for those non-tradable shares to be traded in the market. Those temporary non-tradable shares are also named as “Restricted share” in China.

In this dissertation, two groups of equities (tradable and non-tradable) are concerned and their value will be calculated separately in order to get a more concise total equity value of the firm. At present, two methods are commonly used in calculating the value of non-tradable shares in China:

(i) number of tradable shares* market share price + number of non-tradable shares * net asset value per share ; and

(ii) number of tradable shares * market share price + number of non-tradable shares * market share price * 22%

However, we follow the result of one current paper of Peng Li, Zhang DingZhu, Wu Jian Zhu(2007) which study the pricing of the temporary non-tradable or “restricted share’ pricing, and calculate the price of firm’s non-tradable asset should be 58% of the market share price. In other words, the value of the total equity of a company in our study is:

(iii) number of tradable shares * market share price + number of non-tradable shares * market share price * 58%

4.3.3 Estimate Equity Volatility (σ_a)

In the MKMV model, the equity volatility is one of the critical data inputs in determining the credit risk. We, therefore, compute the volatility with cautionary consideration in order to ensure it suits the Chinese specific environment.

The research of equity volatility made substantial progress in recent decades. To sum up, there are two kinds of models: one is static and the other is dynamic. Static model generally assumes that the variance of the price or yield is constant. However, many empirical studies found that the characters of most financial variables’ variance in real market are heteroscedasticity and volatility clustering, and do not follow the assumption of static behaving. So in the practical application, the dynamic models are often used to estimate the volatility. The dynamic models include Moving Average Model (MA), Exponentially Weighted and Moving Average (EWMA) and the model family of the

Generalized Autoregressive Conditional Heteoscedasticity(GARCH). The first two models can not be a good reflection of financial data's characteristics. For instance, the MA model has the "Ghost Effect" that the extreme event on one day will keep the measured volatility at a high level for a long term. EMWA requires that the series should have significant self-correlation, and will perform badly to the non-significant ones. Due to the drawbacks mentioned above, the GARCH family model's (Bollerslev, 1986) testing result shows that they can capture the financial data's characteristics preferably. At present GARCH family model are widely developed and used in predictions and estimates in financial field. According to Kang JianLin, Zhu KaiYong, Zhou ShengWu, Han Miao(2005), the characteristics of hertoscedaticiy and volatility clustering are also obvious in the Chinese equity market, GRACH(1,1) is the best fit model to test the volatility. In fact, there is a large number of researches prove that China's financial market is significantly in line with the GARCH(1,1) model, which premises are as follows:

$$y_t = c + \varepsilon_t \,;\; t = 1,...,n, \qquad (12)$$

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 ;\; \omega \ge 0, \alpha, \beta \ge 0, \alpha + \beta < 1 \qquad (13)$$

This model forecasts the variance of date t return as a weighted average of a constant (ω-long-run variance), yesterday's squared error from the conditional mean equation (ε_{t-1}^2 - the ARCH term), and yesterday's forecast variance (σ_{t-1}^2 -the GARCH term).

In our study, the annual volatility of equity is estimated by using GARCH (1,1) with daily returns of adjusted share price for a time horizon of one year, from January 1st to December 31st. In our study, each year's volatility is estimated separately. We firstly get the stock's logarithmic returns by $r_i = \ln(\frac{P_i}{P_{i-1}})$, where P_i, P_{i-1} are stock's closing price after the adjustments for dividend payout and stock split. Then, we get the yearly volatility through: $\sigma_E = \sigma_d \times \sqrt{250}$

We use MATLAB to calculate our volatility, see table 4.1

Table 4.1: MATLAB code for volatility calculation

```
data = '***.txt';
y = load (data);
load garchdata;
[coeff,errors,LLF,innovations,sigmas]=garchfit(y);
garchdisp(coeff,errors)
[ sigmaForecase,meanForecast,sigamlTotal]=garchpred(coeff,y,250);
sigaml Total (250)
```

4.3.4 Define Default Point (DPT)

According to the MKMV model, when the firm's asset value is smaller than the default barrier (i.e. book value of the firm's liability), the company will default; otherwise, it will not. In reality, most of the companies do not default at the default point due to the longer term structure of long-term debts which allow the distress companies to continue their operations. Therefore, the actual default point should lie somewhere between the short-term debt and the total debt. See equation 7 in Chapter 2.

According to Moody's study and the empirical studies, the most frequent critical point is approximately equal to total current liabilities plus 50% of the long-term liabilities (i.e. $\alpha = 0.5$). However, due to different economic environment and lack of the historical data of defaulted listed companies, there is still not a consent conclusion that it is suitable to use $\alpha=0.5$ to determine the default point in China.

In order to indentify the extent of the influence of default point on the credit exposure of the Chinese listed companies, in our study, we perform 3 possibilities in our calculation as follows:

1) Default Point =Total Current Liabilities+ 25% of Long-term Liabilities
2) Default Point =Total Current Liabilities + 50% of Long-term Liabilities
3) Default Point =Total Current Liabilities + 75% of Long-term Liabilities

4.3.5 Determine Risk-free rate

Since the Chinese bond market is underdeveloped, the interest rate of treasury bill which is relatively illiquid cannot be used as the risk free rate in our study. We therefore use the bank's one-year interest rate of the saving deposit and withdrawal as the risk free rate based on the following two considerations [13] :

(i) The interest of the Chinese treasury bond is floating in regards to the one-year bank's savings deposit rate, and the difference of short-term bill yield and one-year bank's savings deposit rate is no more than 0.1 %.

(ii) The empirical study shows that the sensitivity of default rate to risk-free interest is small; even we can ignore the influence of the deviation of risk-free rate.

According to the figure published by the People's Bank of China (the central bank of China), http://www.pbc.gov.cn/detail.asp?col=462&ID=2479, and the risk rates used in our model are:

Table 4.2: The Chinese one-year interest rate of the saving deposit and withdrawal (%)

Year	2005	2006	2007	2008
Rf	2.25	2.52	4.14	2.25

4.3.6 Calculate Asset Value and Asset Volatility

After getting the market value of equity, volatility of equity and default point of the companies, we can solve the two equations, 2 and 5, which are mentioned in Chapter 2 with five input variables (equity value, equity volatility, time horizontal, risk free rate and default point) by using the MATHCAD to compute the asset volatility and asset values. See Figure 4.1 of an example of calculation for the company, ZTDC (002033), in the tourism industry.

[13] Zhao Bao Guo and Long Wen Zheng(2007)

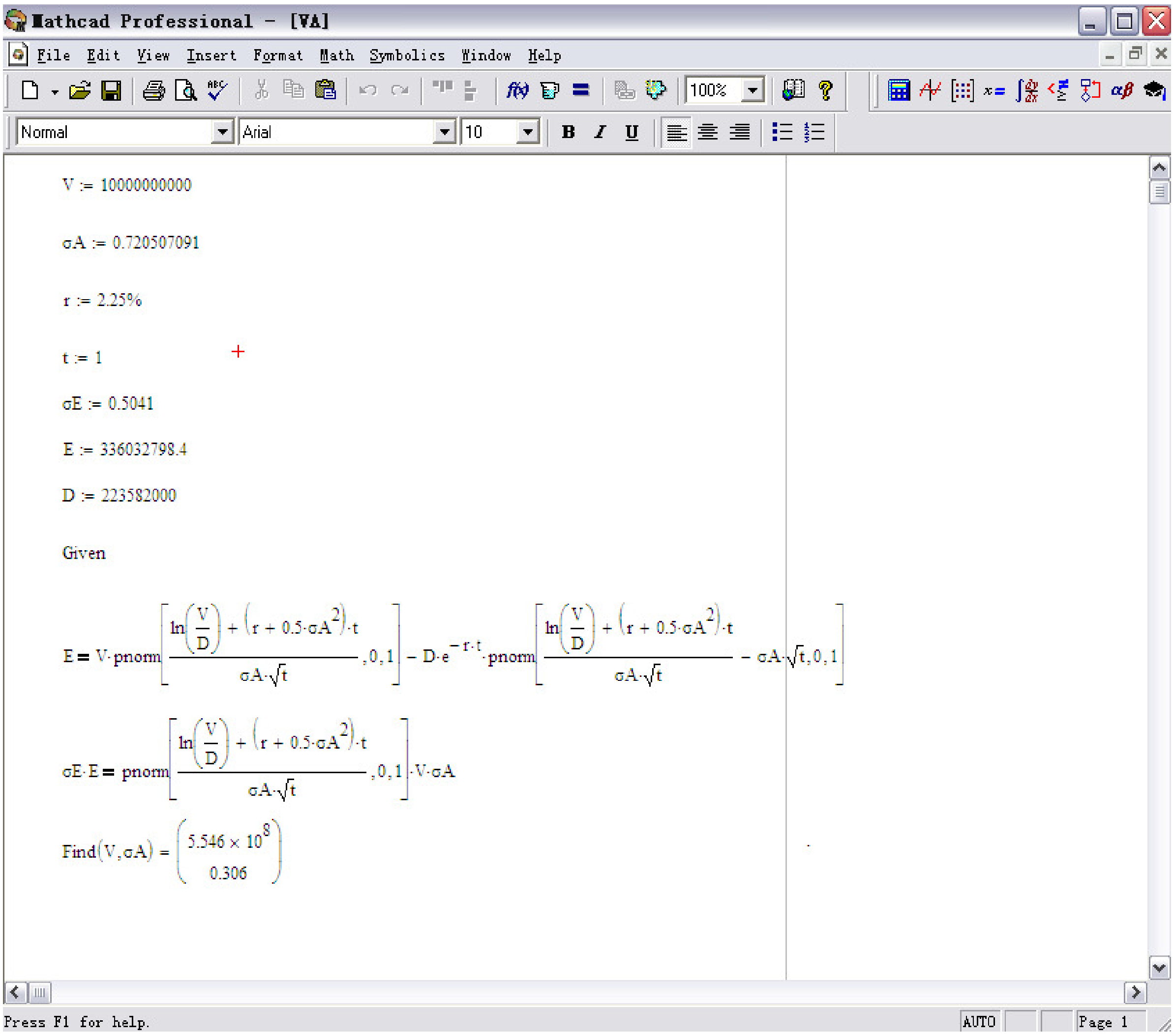

Figure 4.1: Asset value and Asset volatility calculated by MATHCAD

4.3.7 Calculate Distance-to-Default (DD)

After obtaining the value of asset value, asset volatility, and default point, we calculate the distance-to-default (DD) by the equation 7 of Chapter 2, where we assume the annual growth rate of the asset value is constant in order to predict the credit risk of the coming. Since we have three ways to compute the default point, there are various DD for different DPT at different time horizon accordingly. For the detailed results, see Appendix II.

4.3.8 Compute the Expected Default Frequency (EDF) or Default Probability

As stated in Chapter 2, the default probability is derived from Moody's global historical default database in the final step of its credit risk model. However in China, there is absent of such historical default database, so the empirical EDF cannot be derived. On the other hand, the theatrical EDF cannot be used as a reliable credit risk predictor due to the non-normally distribution of firm's asset value as explained under the subsection of "calculation distance-to-default" in the Chapter 2.

Therefore, in our study, we skip this step and use the distance-to-default (DD), which is expressed as the standard deviation, as an indicator to determine the credit risk level of a company.

4.4 Empirical Results and Implications

We analyze the results of our testing from 3 approaches: (i) horizontal analysis which looks at the pair comparison of the DD between ST and non-ST companies; (ii) vertical analysis which looks at the historical trend of DD; and (iii) regression analysis which looks at the magnitude of influence of the variables in our modified MKMV model.

4.4.1 *Horizontal Analysis- Discriminating capability of the modified MKMV model*

Given the definition of Distance-to-Default (DD), the higher the value of DD the company gets, the higher the ability of the company to repay the liabilities and the lower the chance the company becomes default. As our methodology explains previously, we have set the hypothesis to test the feasibility of applying the MKMV model as a credit risk analysis tool to the Chinese banks as below:

If the testing results show that ST companies get shorter DD (which implies higher credit exposure) than the non-ST companies, the adjusted MKMV model is able to discriminate the listed Chinese companies with higher credit risk from those ones with lower default risk, otherwise vice versa.

According to our findings (refer to Appendix I for detail results), although there are a few samples rejecting the above hypothesis found in different industries in different years, the

MKMV model can, on average, demonstrate its credit discriminating ability in all our testing periods except the year of 2008.

Table 4.3 shows that the average DD of ST companies are lower than the ones of non-ST companies for year 2005, 2006 and 2007. It is consistent with our hypothesis that the MKMV model is applicable in China. However, the findings are not statistically significant due to the limited sample size. The incoherent results of 2008 are mainly due to the atypical global financial turmoil, which brought inevitably extraordinary volatility to the capital market and struggles to corporations in China. We will look at the implications and causes of 2008 results in more details when we discuss the relationship between various parameters and the default risk later on.

Comparing with degree of absolute difference in the average DD across different default point's designation, the average DD difference at α=0.75 is the largest. This means that DD at α=0.75 is more apparent in reflecting the credit risk of the Chinese companies. Thereafter, we will discuss the rest of the empirical results based on the DD calculation with α=0.75.

Table 4.3: Average default distance by different default points

DPT (α=0.25)						
Years prior to ST	Average DD comparison					
	Year	ST	Non-ST	Difference	t-test	p-value
3	2005	2,355	2,646	-0,291	0,6693	0,5097
2	2006	1,961	1,991	-0,030	0,4258	0,6740
1	2007	1,646	1,821	-0,175	1,1421	0,2647
0	2008	1,602	1,504	0,098	0,9457	0,3537
DPT (α=0.5)						
Years prior to ST	Average DD comparison					
	Year	ST	Non-ST	Difference	t-test	p-value
3	2005	2,350	2,639	-0,289	0,6703	0,5091
2	2006	1,959	1,987	-0,028	0,4385	0,6649
1	2007	1,645	1,819	-0,175	1,1681	0,2542
0	2008	1,597	1,500	0,097	0,9246	0,3644
DPT (α=0.75)						
Years prior to ST	Average DD comparison					
	Year	ST	Non-ST	Difference	t-test	p-value
3	2005	2,353	2,631	-0,279	0,673	0,508
2	2006	1,917	1,980	-0,062	0,449	0,658
1	2007	1,627	1,820	-0,193	1,149	0,262
0	2008	1,581	1,461	0,120	1,033	0,312

While the MKMV model show its credit distinguishing ability in most of the Chinese listed companies, there is one industry to which it cannot apply at all. It is the "Property and Real Estate Industry. Figure 4.2 shows that the DD of the non-ST company in the Property and Real Estate industry is lower in all of our sample periods. Since the industry of Property and Real Estate is credit concentration, these phenomena can be explained by the asset value and the asset volatility, see Figure 4.3.

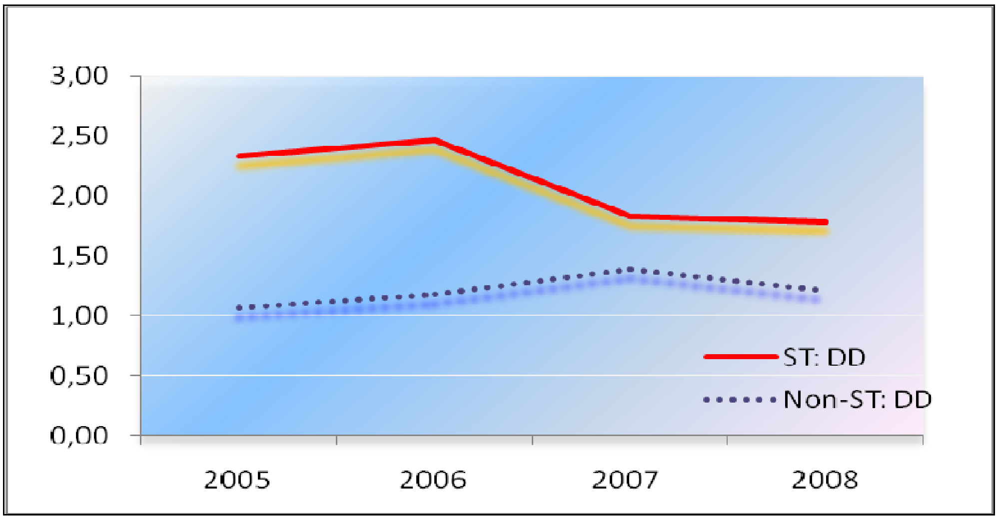

Figure 4.2: Default distance of the Property and Real Estate industry

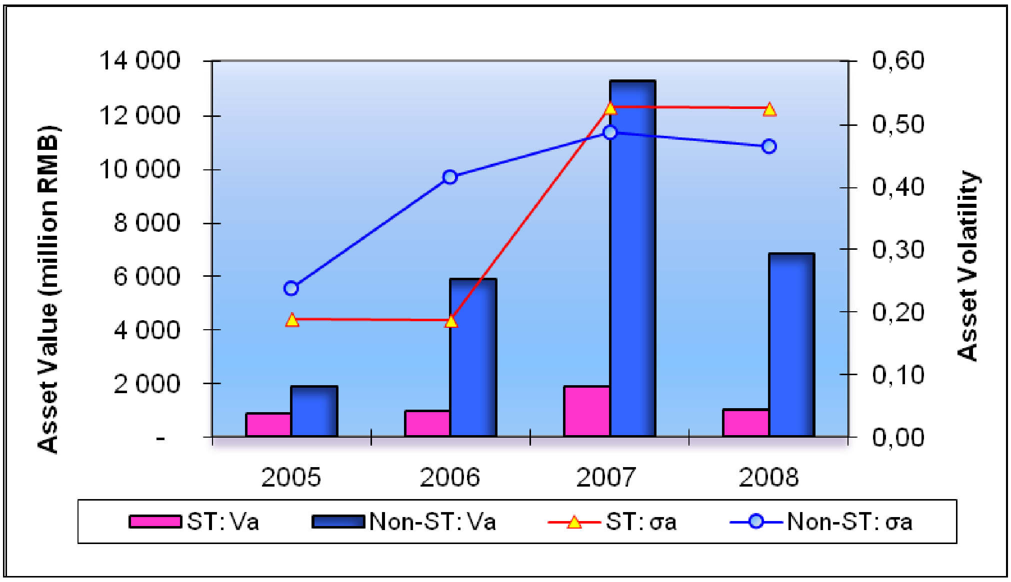

Figure 4.3: Asset value and volatility of the Property and Real Estate industry

In short, along with the previous empirical studies conducted locally, our findings demonstrate a positive sign that the MKMV model is compatible with the Chinese corporate distress classification system in differentiating the credit risk level of the public listed companies in most industries, leaving out the year of 2008 as the unique situation which is caused by the current financial crisis. However, it is hard to justify to what extent such discriminating power is due to the statistical limitations of our study.

4.4.2 Vertical Analysis – Credit risk predicting capability of the modified MKMV model

In China, the ST companies which have negative net earnings for two consecutive years have to improve their financial status by increasing operation efficiency, restructuring, or merge and acquisition etc within the following two years, otherwise they will be delisted accordingly. Hence, with a retrospective analysis observing the trend of DD of all the ST companies in our samples during the period of "pre-special treated, we can conclude whether the MKMV model has the warning capacity of indicating credit risk. With regards to the trend of average DD (see Figure 4.4), we can see that the ST companies experienced a large extent continuous decline in the default distance before receiving the classification of "special treatment" by the CSBS in 2008. This indicates that the MKMV's DD can serve as a credit risk warning signal of distress companies to the investors. In other word, DD can be a forward-looking indicator predicting potential credit risk of the distress companies.

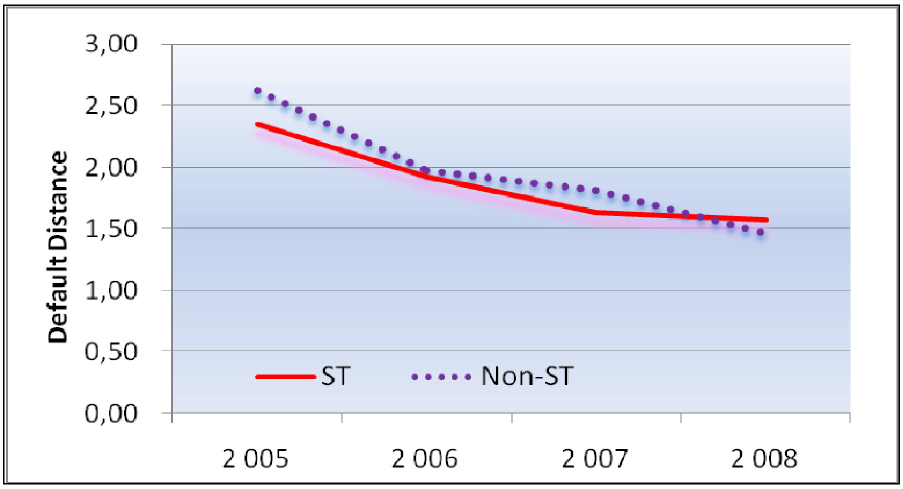

Figure 4.4: Trend of average default distance

To further illustrate the function of credit prediction, we generate 7 intervals (See Figure 4.5) of DD and check the distribution of the ST and non-ST companies. Taking 2007's result as an example, most of the ST Company's concentrate around the value of DD of 1.5 (see Figure 4.5). Loans to companies with smaller DD value of 1.5 will be probably rejected. That means 1.5 could be a credit warning signal for credit risk analysis. However, in practice, the statistical validation could be queried due to the limited sample size.

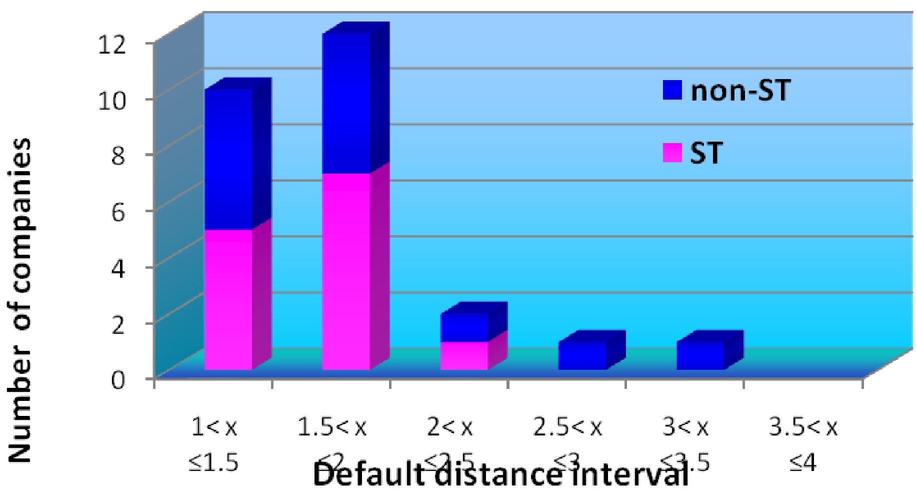

Figure 4.5: Company distribution of companies at various level of default distance

In short, the MKMV model can function as the dynamic credit monitoring by using the real time market data in order to keep track of the company's credit exposure. Providing with sufficient samples size, the MKMV credit model would be an influential indicator for the speedy, consistent and reliable credit risk analysis.

4.4.3 Regression Analysis – Influence of the parameters in the modified MKMV model

According to the MKMV, the three critical parameters (asset value, asset volatility and leverage) determine the company's credit exposure. Therefore, we use Eview to run a regression to test the degree of influence of each variable on the default distance for both ST and non-ST companies for each year with the following liner equation:

$$DD = C + \alpha \sigma_a + \beta V_a + \gamma L + \upsilon , \qquad (14)$$

where DD is the distance-to-default; C is constant; α, β and γ are coefficient; σ_a is asset volatility; V_a is asset value; L is leverage which is the relationship between asset value and equity value (Ve), equals to Va / Ve.

There are several implications from the results of our regressions, see Table 4.4. Firstly, the relationship between default distances and the asset volatility or leverage is negative, while the relationship between default distance and asset value is positive. Besides, coefficients of asset volatility of both ST and non-ST companies in all testing periods have very high means of -.3.06 and -5.15 respectively, with more than 90% significant level. This implies that the default distance is very sensitive to the asset volatility in China. Besides, the coefficient of leverage also show statistical significant while the one of asset value does not show significant results. Scatter plots of the regression results of the variables in different years are shown in the Appendix III.

Table 4.4: Results of regression on the default distance DD with the influential variables of the MKMV model

	2005		2006		2007		2008	
	ST	Non-ST	ST	Non-ST	ST	Non-ST	ST	Non-ST
α(σa)	-4,6794	-6,5175	-3,1408	-5,3215	-2,4583	-5,1294	-1,9696	-3,6229
t-statist	-1,2862	-3,9529	-5,3281	-5,8170	-5,0045	-12,8135	-6,5700	-9,4712
P-Value	0,2305	0,0033	0,0005	0,0003	0,0007	0,0000	0,0001	0,0000
β(Va)	0,0000	0,0000	-0,0000	0,0000	-0,0000	0,0000	-0,0000	-0,0000
t-statist	1,3686	3,0263	-1,1460	0,5106	-0,9192	1,2612	-3,3778	-0,1217
P-Value	0,2043	0,0143	0,2814	0,6219	0,3820	0,2390	0,0082	0,9058
γ(Va/Ve)	-0,3393	-0,7787	-0,1727	-0,8184	-0,4968	-1,7601	-0,2357	-0,7775
t-statist	-2,7992	-3,6349	-4,2455	-5,6977	-5,6155	-8,9998	-5,9604	-8,4792
P-Value	0,0207	0,0054	0,0022	0,0003	0,0003	0,0000	0,0002	0,0000

The coefficient parameters, therefore, explain why the average credit risk of non-ST companies (with a lower DD) is higher than the one of ST companies in 2008. Figure 4.6 below indicates the asset volatility differences between two groups of companies during our test periods. In 2008, the asset volatility of non-ST companies is higher than the ST companies.

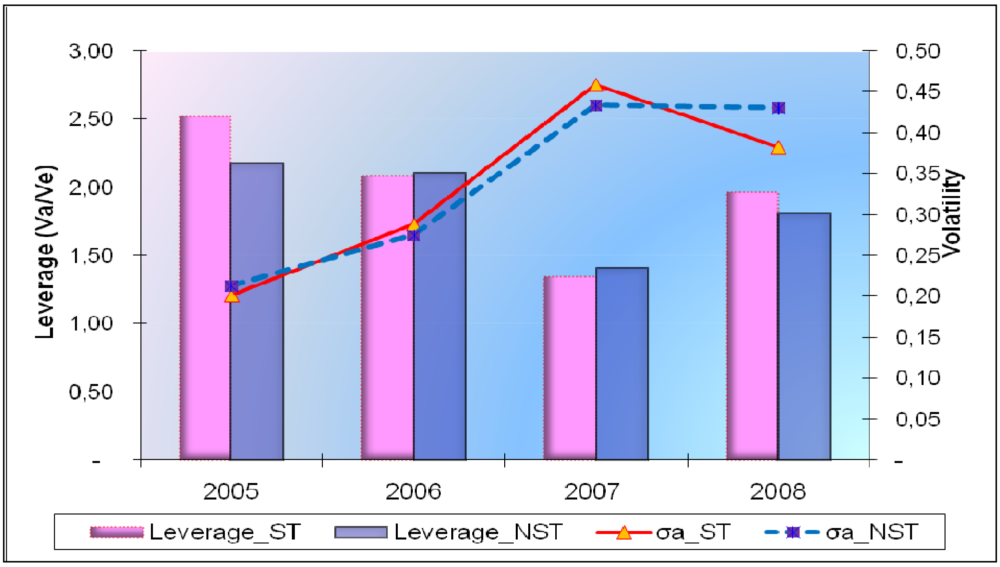

Figure 4.6: Asset volatility and leverage comparison between the ST and non-ST companies

To sum up, the asset volatility plays a critical role in determining the credit exposure of the listed companies in China. The level of leverage and the value of asset have the medium and least, respectively, impact on the credit risk of the companies in our observations. Our findings are consistent with the expectation of the MKMV's model.

4.5 Discussion on the practicability of the modified MKMV model in China

After reviewing our empirical findings, a discussion concerning the practicability of the MKMV model in China is highlighted. The possible benefits of the MKMV model to the Chinese banks are firstly conferred. Follow by, the constraints in applying the MKMV model in China are evaluated.

4.5.1 Benefits of the MKMV model to the Chinese banks

Moody's KMV credit model has a very strong theoretical foundation based on the Black-Scholes-Merton notations. The methodology and computation of the model are straight-ward and apparent simple; therefore it is very suitable for the Chinese banks owing to limited expertise in the credit risk quantitative measurement and resources in the risk management.

Besides, the model's implied variables, such as firm's asset market value and volatility can be derived from the market data which are available and easy accessible in China, so the plausibility and objectiveness of the results can be enhanced. In fact, the MKMV relies more on the market information than the data of financial statements from which liability is the only item needed. Since it is not unusual that some companies in China have more than one set of accounting books, models relying heavily on the figures from the accounting figures would be less competitive in this sense.

In theory, the value of the DD or EDF is computed relatively, so they can be the indicators of comparison among companies in the same industry or among industries. As mentioned previously regarding the relationship between the default likelihood and the firm's asset value, asset volatility and capital structure in our regression analysis, the derived default distance or the EDF could be a useful reference for credit decisions. Since the equity market data is available in the real time and the company's financial information is disclosed regularly, the DD or EDF computed on the dynamic basis. Thus, the MKMV model provides a consistent and immediate monitoring tool in the credit analysis for the banks.

4.5.2 Impediments of applying the MKMV credit risk model in China

Owing to the difference in economic prospects and business environment between countries, it is not appropriate to implement the western credit risk model such as the MKMV directly to the Chinese banks. To some extents, various modifications are suggested by Chinese scholars in order to test the possibility of employing the MKMV model as a credit risk analysis tool. After our empirical study, there are a few significant constraints which hinder the application of the MKMV in China at the moment.

(i) Chinese capital market

As mentioned in Chapter 2, the main criticism on the predicting power of Moody's KMV model is the problem of severe market efficiency. During the time of economy boom (recession), the MKMV's EDF often underestimates (overestimates) the firm's credit exposure in comparison to the standard credit rating. This weakness of the MKMV model is also found in our empirical result of 2008.

Although in more than one decade's time the Chinese financial markets' development has been mounting in a speedy pace (See Figure 4.7) , it is still short of market efficiency[14] which the market price can not reflect the actual health of the Chinese corporations. However, the market efficiency is not the major underlying assumption for the MKMV model in terms of credit exposure's prediction. Therefore, most of the past Chinese empirical studies show the positive results of the application of KKMV credit model in China. This phenomenon can be examined by referring the Chinese particular financial environment at that time.

As Figure 4.7 shows, the Chinese equity market was boosted up by 186% and 291% in 2006 and 2007, respectively. During the time, various international hot money flooded to the Chinese capital market with the expectation of economic boom driven by the forthcoming Olympic game. Prices of most of the Chinese blue chip stocks climbed to the historical high. With the adverse economic environment caused by the subprime mortgage crisis of the U.S. and the natural hazard of Sichuan, the Chinese equity market dropped by 60% in 2008. All these indicate high market volatility, thereby affecting the market value of the firm's asset value. Most of the non-ST companies in our sample recorded higher proportion fall in asset value than the ST companies. This also explains why our results show that the MKMV risk exposure of the non-ST companies is higher than the ones of ST companies in 2008.

[14] Efficient market hypothesis states that an efficient financial market processes the information available to investors and incorporates it into the prices of the securities

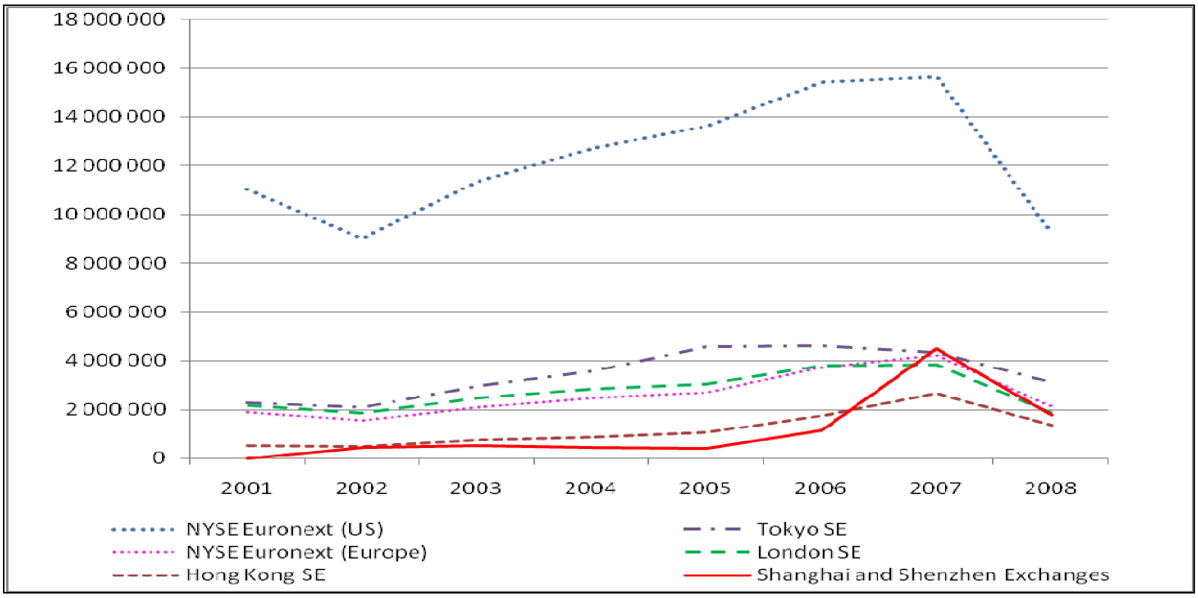

Figure 4.7: Market capitalization of the major stock exchanges, 2001 to 2008
(Source: Stock Exchange Federations

In brief, our findings explore that the MKMV credit computation is not consistent with the Chinese company's distress classification system in 2008. It is mainly due to irrational market behaviors. Although it is a drawback of the MKMV model in one hand, it give a serious warning signal of potential future credit to the Chinese investors and regulators on the other hand. Although most of the past literatures show the feasibility of Moody's KMV in China, its credit risk predicting power is still in question due to inefficiency of the Chinese capital market.

(ii) Chinese default database

With regards to our results, the firm's asset value is not normally distributed as the assumption of the Black-Scholes-Merton pricing concepts. Therefore, the theoretical relationship between default distance and default probability cannot be derived. Besides, the empirical EDF cannot be derived which relay heavily on en extensive historical default database. This historical default database of Moody's cannot apply to Chinese firm due to the difference in economic development, status, culture, bankruptcy code and so forth. To implement the entire MKMV model, a Chinese own default database is required.

In China, most of the public listed companies are state-owned-enterprises which offer a large proportion of employment to the country's citizens. Owing to the social security reasons, these companies will receive government bailout or merge and acquisition offer when they face the financial distress problems instead of going for default or bankruptcy. Therefore, the historical default data is very limited.

Besides, firm's bankruptcy has to go through a long process at different level of courts at different county, municipal and provincial level, it is impossible to retrieve those default companies' financial record.

In addition, the Chinese government intervene the bankruptcy definition. In a recent Moody's official research paper which validate the performance of their EDF in default predication in the regions of North America, Europe and Asia, China is excluded from Asia due to the government intervention in the definition of default code.

To sum up, to implement the complete credit model suggested by Moody's KMV, a unique Chinese default data is required. However, it takes time to complete such reliable default database due to China's specific political, economic and social environment particularly in the aspect of default definition and implications.

(iii) Tradable and non-tradable shares

As mentioned in our methodology, there is still certain amount of non-tradable shares of most of the listed companies in China. Since they are not 'mark-to-market', the accurate equity value as well as the asset value of the firm could not be precisely derived, thereby affecting the quality of the MKMV model. Thanks to the continuous reform, it is expected that most of the non-tradable stock will be transferred to be tradable in the near future. This constraint is only temporary in this sense.

4.6 Comparison with the previous studies

In the last section of this chapter, we would like to highlight the differences of our study on the feasibility of applying the MKMV credit risk model in China from the previous researches.

As outlined in Chapter 3, most of the previous researches conducted locally with the similar topic to us show supportive results that it is feasible for applying the MKMV model in China. However, the findings obtained in our empirical test are not strongly consistent with those of the earlier studies. We believe that there are three main reasons for the differences.

First, our samples, which have 13 out of 158 ST companies, are inadequate with less than 10% of the total population. In order to improve our results statistically, we could take two or more pairs (instead of one) of companies from each industry as the study samples.

Second, to the authors' knowledge, the time horizon of the previous studies is mainly from 2002 to 2006. However, the data of our study covers the years of 2007 and 2008, when a historical volatile Chinese stock market was evidenced during the time (see Figure 4.7).

Finally, our method used in calculating the value of tradable and non-tradable shares is also different from those of the previous studies, since the stock transfer reform implemented by the Chinese authority was completed in 2008. Since then, all the previous non-tradable shares have a restricted time period to be released back to the market for trading. For our adjustments, we therefore use the latest research result to estimate the equity value.

CHAPTER 5: CONCLUSION

For most of the banks in China, loans are the major source of credit risk. Thanks to the continuous banking reforms, the awareness of the need to identify, measure, monitor and control credit risk has been boosted up. Under the circumstance of lacking of a recognized internal credit rating system which is demanded by the BASAL II standard, the feasibility of applying the modern credit risk models to China becomes a hot subject for the local bankers. Among the Western credit risk modeling, the structural Moody's KMV model is assessed for justifying its applicability in China.

Due to the localized different political, economic, legislative and social environment of China, modifications of the MKMV credit model are necessary. Adjustments in calculation of equity value and default point are made in order to assess the applicability of the mode in China from the horizontal, vertical and regression perspectives of analysis. By testing our modified KMV model with a pair sample in each of the 13 industries in China from 2005 to 2008, a right sign showing that the model's abilities in discriminating the good companies from bad ones (horizontal analysis) and in predicting (or warning) the default risk of the distress companies (vertical analysis) in China is found. Although, according to the regression analysis, the expected relationships among the parameters emphasized in the MKMV are significantly found, the former two results in terms of credit discrimination and prediction are statistically insignificant. This means that a judgment, based on our findings, on the feasibility of applying the MKMV to China can not be made.

From the statistical aspect, the findings obtained in this study are probably as a result of insufficient sample size. Nevertheless, from the model valuation point of view, this might be also due to the unique Chinese factors which play the influential roles in our model adjustments. These Chinese considerations include the pricing non-tradable shares, the unclear definition of default, and the absent of extensive historical default database. Unfortunately, there is still not a general concession about the model adjustments for the Chinese localized factors. Because of the speedy development of the Chinese capital market and the continuous reforms in the Chinese banking sector, continuous and further studies on the applicability of the modern credit risk modeling are recommended.

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APPENDIX

APPENDIX I : SAMPLE DETAILS

Industry	ST companies		non-ST compaines	
	Stock Code	Name	Stock Code	Name
Tourism	000430	ZTDC	002033	LIJIANG TOURISM
Property and Real Estate	600603	S/XINGYE HOUSING 'A'CNY1	600246	BJ WANTONG REIT CO 'A'CNY1
Pharmaceutical Industry	600421	WUHAN NATIONAL PHA 'A'CNY1	600216	ZHEJIANG MEDICINE 'A'CNY1
Home Appliance	000561	CLGCL	000651	GREE
Electronics and Machinery	000922	ARC	002028	SIEYUAN
Metal Refining	000751	HLD ZINC	000630	TLYS
Chemical industries	600722	HEBEI JINNIU CHEMI 'A'CNY1	600141	HUBEI XINGFA CHEMI 'A'CNY1
Transportation Facilities Production	000738	NF SPACE NAVIGATION	000913	QJMT
Transportation and Couriers	600003	NORTHEAST EXPRESSW 'A'CNY1	600269	JIANGXI GANYUE EXP 'A'CNY1
Farming	600506	X/JIANG KORLA PEAR 'A'CNY1	600540	XINJIANG SAYRAM MO 'A'CNY1
Utilities (Electricity, Gas and Water)	000692	HUITIAN THERMALPOWER	000426	CFTP
Information Technology Industries	000035	KEJIAN	000547	CHINASCHOLARS
Wholesales and Retails	600891	HARBIN CHURIN GP J 'A'CNY1	600859	B/WFJ DEPTSTORE G 'A'CNY1

APPENDIX II: EMPIRICAL RESULTS

2005																
Industry		Stock Code	σe	Ve	DPT(0.25)	σa	Va	DD	DPT(0.50)	σa	Va	DD	DPT(0.75)	σa	Va	DD
Tourism	ST	000430	0,504	336 032 798	223 582 000	0,306	554 600 000	1,95	223 582 000	0,306	554 600 000	1,95	223 582 000	0,306	554 600 000	1,95
	NST	002033	0,255	563 491 369	41 846 600	0,238	604 400 000	3,91	41 846 600	0,238	604 400 000	3,91	41 846 600	0,238	604 400 000	3,91
Property and Real Estate	ST	600603	0,418	397 069 476	494 943 500	0,188	881 000 000	2,33	494 943 500	0,188	881 000 000	2,33	494 943 500	0,188	881 000 000	2,33
	NST	600246	0,789	523 722 400	1 397 953 200	0,238	1 874 000 000	1,07	1 397 953 200	0,238	1 874 000 000	1,07	1 397 953 200	0,238	1 874 000 000	1,07
Pharmaceutical Industry	ST	600421	0,474	441 183 360	270 393 450	0,297	705 500 000	2,08	272 558 800	0,296	707 700 000	2,08	274 724 150	0,295	709 800 000	2,08
	NST	600216	0,535	1 478 043 820	1 392 750 150	0,279	2 839 000 000	1,83	1 420 356 400	0,276	2 866 000 000	1,83	1 447 962 650	0,274	2 893 000 000	1,82
Home Appliance	ST	000561	0,534	540 980 296	1 221 349 575	0,169	1 734 000 000	1,75	1 229 344 050	0,168	1 742 000 000	1,75	1 237 338 525	0,167	1 750 000 000	1,75
	NST	000651	0,196	4 155 990 935	9 867 529 775	0,059	13 810 000 000	4,84	9 868 856 050	0,059	13 810 000 000	4,84	9 870 182 325	0,059	13 810 000 000	4,84
Electronics and Machinery	ST	000922	0,527	484 241 413	637 414 000	0,232	1 107 000 000	1,83	645 539 000	0,230	1 115 000 000	1,83	653 664 000	0,228	1 123 000 000	1,83
	NST	002028	0,718	1 026 761 672	340 949 300	0,543	1 360 000 000	1,38	340 949 300	0,543	1 360 000 000	1,38	340 949 300	0,543	1 360 000 000	1,38
Metal Refining	ST	000751	0,265	1 944 088 170	3 161 818 650	0,102	5 036 000 000	3,65	3 298 375 200	0,100	5 169 000 000	3,62	3 434 931 750	0,097	5 303 000 000	3,63
	NST	000630	0,286	2 984 891 492	3 424 607 725	0,135	6 333 000 000	3,40	3 778 550 450	0,128	6 679 000 000	3,39	4 132 493 175	0,121	7 025 000 000	3,40
Chemical industries	ST	600722	0,462	725 954 528	2 846 473 450	0,096	3 508 000 000	1,96	2 999 769 700	0,092	3 658 000 000	1,96	3 153 065 950	0,089	3 808 000 000	1,93
	NST	600141	0,489	515 120 000	1 063 840 300	0,163	1 555 000 000	1,94	1 280 344 900	0,144	1 766 000 000	1,91	1 496 849 500	0,128	1 978 000 000	1,90
Transportation Facilities	ST	000738	0,532	757 029 720	375 501 000	0,359	1 124 000 000	1,85	375 501 000	0,359	1 124 000 000	1,85	375 501 000	0,359	1 124 000 000	1,85
	NST	000913	0,353	837 967 386	1 248 954 100	0,144	2 059 000 000	2,73	1 248 954 100	0,144	2 059 000 000	2,73	1 248 954 100	0,144	2 059 000 000	2,73
Transportation	ST	600003	0,180	2 198 588 400	680 315 750	0,138	2 864 000 000	5,53	914 894 700	0,128	3 093 000 000	5,50	1 149 473 650	0,119	3 322 000 000	5,50
	NST	600269	0,378	5 237 017 519	1 665 169 550	0,288	6 865 000 000	2,63	1 895 291 300	0,279	7 090 000 000	2,63	2 125 413 050	0,271	7 315 000 000	2,62
Farming	ST	600506	0,499	327 438 300	42 930 925	0,442	369 400 000	2,00	63 170 450	0,419	389 200 000	2,00	83 409 975	0,399	409 000 000	2,00
	NST	600540	0,337	660 960 000	407 526 200	0,210	1 059 000 000	2,93	407 581 200	0,210	1 059 000 000	2,93	407 636 200	0,21	1 059 000 000	2,93
Utilities (Electricity, Gas	ST	000692	0,420	517 621 495	1 226 165 400	0,127	1 716 000 000	2,25	1 317 433 500	0,121	1 806 000 000	2,24	1 408 701 600	0,115	1 895 000 000	2,23
	NST	000426	0,383	728 420 230	734 875 125	0,193	1 447 000 000	2,55	906 702 450	0,173	1 615 000 000	2,54	1 078 529 775	0,156	1 783 000 000	2,53
Information Technology	ST	000035	0,605	193 976 440	1 878 538 600	0,061	2 028 000 000	1,21	1 881 663 600	0,061	2 031 000 000	1,21	1 884 788 600	0,061	2 034 000 000	1,20
	NST	000547	0,412	360 733 229	610 973 425	0,155	958 100 000	2,34	619 489 550	0,154	966 400 000	2,33	628 005 675	0,152	974 700 000	2,34
Retails	ST	600891	0,418	346 253 213	626 917 200	0,151	959 200 000	2,29	626 917 200	0,151	959 200 000	2,29	626 917 200	0,151	959 200 000	2,29
	NST	600859	0,357	687 499 497	663 854 141	0,183	1 337 000 000	2,75	693 509 806	0,180	1 366 000 000	2,74	723 165 470	0,176	1 395 000 000	2,74

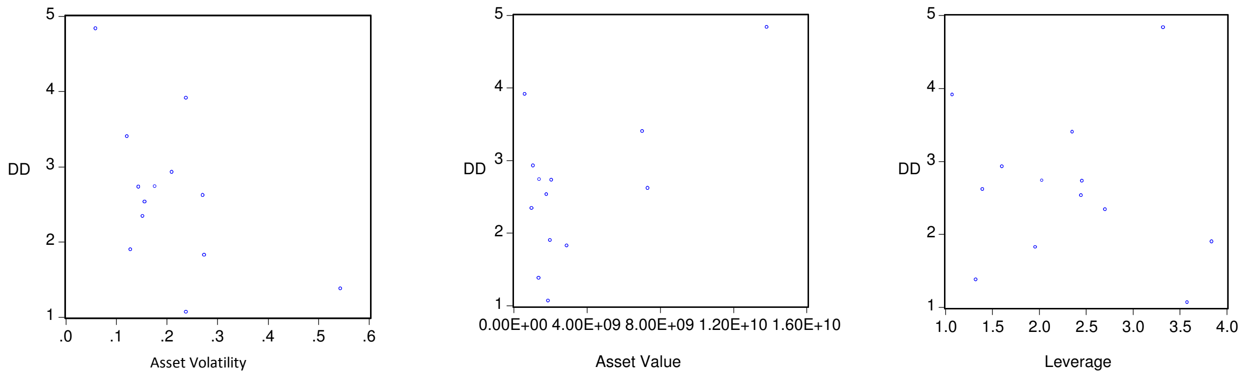
2006																
Industry		Stock Code	σe	Ve	DPT(0.25)	σa	Va	DD	DPT(0.50)	σa	Va	DD	DPT(0.75)	σa	Va	DD
Tourism	ST	000430	0,578	597 697 682	257212800	0,407	848400000	1,71	328947500	0,376	918300000	1,71	400 682 200	0,35	988 100 000	1,70
	NST	002033	0,449	1 007 640 298	58972250	0,424	1065000000	2,23	59194900	0,424	1065000000	2,23	59 417 550	0,424	1 066 000 000	2,23
Property and Real Estate	ST	600603	0,394	445 729 951	512214500	0,186	945200000	2,46	512214500	0,186	946500000	2,47	512 214 500	0,186	946 500 000	2,47
	NST	600246	0,789	2 825 834 040	2979002900	0,404	5699000000	1,18	3186502900	0,391	5898000000	1,18	3 394 002 900	0,379	6 097 000 000	1,17
Pharmaceutical Industry	ST	600421	0,589	554 023 200	290570050	0,39	837200000	1,67	292871000	0,389	839400000	1,67	295 171 950	0,388	841 700 000	1,67
	NST	600216	0,520	1 470 001 316	1646563750	0,25	3075000000	1,86	1681400000	0,247	3109000000	1,86	1 716 236 250	0,244	3 143 000 000	1,86
Home Appliance	ST	000561	0,451	726 957 671	1287643000	0,166	1982000000	2,11	1294301100	0,165	1989000000	2,12	1 300 959 200	0,165	1 995 000 000	2,11
	NST	000651	0,447	7 566 398 200	13017759425	0,167	20260000000	2,14	13040485450	0,167	20280000000	2,14	13 063 211 475	0,167	20 300 000 000	2,13
Electronics and Machinery	ST	000922	0,641	1 090 116 925	307305700	0,503	1390000000	1,55	308255700	0,503	1391000000	1,55	309 205 700	0,502	1 392 000 000	1,55
	NST	002028	0,506	2 339 179 027	726782875	0,388	3048000000	1,96	750119850	0,385	3071000000	1,96	773 456 825	0,383	3 093 000 000	1,96
Metal Refining	ST	000751	0,939	4 924 439 458	4325956700	0,537	9029000000	0,97	4452528300	0,531	9148000000	0,97	4 579 099 900	0,525	9 266 000 000	0,96
	NST	000630	0,545	4 971 870 474	8936053300	0,2	13680000000	1,73	9540956700	0,192	14270000000	1,73	10 145 860 100	0,185	14 850 000 000	1,71
Chemical industries	ST	600722	0,480	612 108 288	3744750200	0,07	4262000000	1,73	4214594200	0,063	4720000000	1,70	4 684 438 200	0,057	5 179 000 000	1,68
	NST	600141	0,494	825 682 000	1041873450	0,222	1841000000	1,96	1318280800	0,194	2111000000	1,94	1 594 688 150	0,172	2 380 000 000	1,92
Transportation Facilities	ST	000738	0,533	917 335 385	182133200	0,447	1095000000	1,87	182133200	0,447	1095000000	1,87	182 133 200	0,447	1 095 000 000	1,87
	NST	000913	0,506	1 213 440 678	1546551650	0,227	2721000000	1,90	1548758500	0,226	2723000000	1,91	1 550 965 350	0,226	2 725 000 000	1,91
Transportation	ST	600003	0,414	3 185 879 040	894718300	0,325	4058000000	2,40	1128968300	0,307	4287000000	2,40	1 363 218 300	0,292	4 515 000 000	2,39
	NST	600269	0,463	7 735 693 640	3356497150	0,326	11010000000	2,13	4103602500	0,305	11740000000	2,13	4 850 707 850	0,288	12 470 000 000	2,12
Farming	ST	600506	0,483	361 714 106	29956000	0,447	390900000	2,07	45188600	0,431	405800000	2,06	60 421 200	0,415	420 600 000	2,06
	NST	600540	0,413	648 397 440	503025650	0,235	1139000000	2,38	503102000	0,235	1139000000	2,38	503 178 350	0,235	1 139 000 000	2,38
Utilities (Electricity, Gas	ST	000692	0,422	558 305 894	1229009225	0,134	1757000000	2,24	1341944950	0,126	1867000000	2,23	1 454 880 675	0,119	1 977 000 000	2,22
	NST	000426	0,411	944 214 521	806293325	0,224	1730000000	2,38	988501450	0,204	1908000000	2,36	1 170 709 575	0,186	2 086 000 000	2,36
Information Technology	ST	000035	0,466	253 530 610	1647286875	0,064	1859000000	1,78	1717469650	0,062	1928000000	1,76	1 787 652 425	0,06	1 996 000 000	1,74
	NST	000547	0,521	795 036 030	488804100	0,326	1272000000	1,89	508094300	0,321	1290000000	1,89	527 384 500	0,317	1 309 000 000	1,88
				420 590 061												
Retails	ST	600891	0,400	420 590 061	613255400	0,165	1019000000	2,41	624731800	0,164	1030000000	2,40	636 208 200	0,162	1 041 000 000	2,40
	NST	600859	0,482	1 456 781 843	1006672900	0,288	2438000000	2,04	1036486400	0,285	2467000000	2,03	1 066 299 900	0,281	2 496 000 000	2,04

2007																
Industry		**Stock Code**	**σe**	**Ve**	**DPT(0.25)**	**σa**	**Va**	**DD**	**DPT(0.50)**	**σa**	**Va**	**DD**	**DPT(0.75)**	**σa**	**Va**	**DD**
Tourism	**ST**	000430	0,581	1 530 050 980	304034725	0,488	1822000000	1,71	346827550	0,477	1863000000	1,71	389 620 375	0,467	1 904 000 000	1,70
	NST	002033	0,512	2 200 962 220	121085400	0,486	2319000000	1,95	121085400	0,486	2319000000	1,95	121 085 400	0,486	2 319 000 000	1,95
Property and Real Estate	**ST**	600603	0,544	1 662 241 826	124157750	0,508	1781000000	1,83	195802100	0,489	1850000000	1,83	267 446 450	0,471	1 919 000 000	1,83
	NST	600246	0,703	8 684 112 148	4336146400	0,478	12830000000	1,39	4701146400	0,466	13180000000	1,38	5 066 146 400	0,454	13 530 000 000	1,38
Pharmaceutical Industry	**ST**	600421	0,752	1 423 949 182	335015650	0,614	1745000000	1,32	344113300	0,611	1754000000	1,32	353 210 950	0,608	1 762 000 000	1,32
	NST	600216	0,730	7 291 428 696	1816856300	0,590	9033000000	1,35	1868177800	0,586	9082000000	1,36	1 919 499 300	0,583	9 131 000 000	1,35
Home Appliance	**ST**	000561	0,621	2 775 053 027	912459775	0,473	3650000000	1,59	1011501450	0,461	3745000000	1,58	1 110 543 125	0,449	3 840 000 000	1,58
	NST	000651	0,382	34 634 924 188	19685838750	0,247	53520000000	2,56	19686498900	0,247	53520000000	2,56	19 687 159 050	0,247	53 520 000 000	2,56
Electronics and Machinery	**ST**	000922	0,600	2 354 425 613	320643900	0,531	2662000000	1,66	321706400	0,531	2663000000	1,66	322 768 900	0,531	2 664 000 000	1,66
	NST	002028	0,493	8 283 088 470	849892075	0,449	9099000000	2,02	897431050	0,447	9144000000	2,02	944 970 025	0,445	9 190 000 000	2,02
Metal Refining	**ST**	000751	0,730	16 181 060 665	5370444650	0,555	21320000000	1,35	5514886800	0,552	21460000000	1,35	5 659 328 950	0,548	21 600 000 000	1,35
	NST	000630	0,687	24 976 924 723	11817206450	0,474	36290000000	1,42	12465735100	0,466	36910000000	1,42	13 114 263 750	0,459	37 530 000 000	1,42
Chemical industries	**ST**	600722	0,647	1 595 191 296	1677313275	0,326	3200000000	1,46	2133427350	0,288	3635000000	1,43	2 589 541 425	0,259	4 071 000 000	1,41
	NST	600141	0,682	3 877 139 774	1323169725	0,514	5145000000	1,45	1525956950	0,496	5339000000	1,44	1 728 744 175	0,479	5 533 000 000	1,44
Transportation Facilities	**ST**	000738	0,531	2 401 100 161	155793000	0,500	2551000000	1,88	155793000	0,500	2551000000	1,88	155 793 000	0,5	2 551 000 000	1,88
	NST	000913	0,607	2 424 398 507	1859484200	0,352	4206000000	1,58	1861704800	0,351	4208000000	1,59	1 863 925 400	0,351	4 210 000 000	1,59
Transportation	**ST**	600003	0,455	5 410 375 560	1018463600	0,385	6388000000	2,18	1027878700	0,385	6397000000	2,18	1 037 293 800	0,384	6 406 000 000	2,18
	NST	600269	0,310	17 217 809 425	3441877575	0,260	20520000000	3,20	3909098750	0,255	20970000000	3,19	4 376 319 925	0,249	21 420 000 000	3,20
Farming	**ST**	600506	0,786	1 875 934 676	191157850	0,716	2059000000	1,27	194145600	0,715	2062000000	1,27	197 133 350	0,714	2 065 000 000	1,27
	NST	600540	0,516	1 567 274 989	867381450	0,337	2399000000	1,89	897510300	0,333	2428000000	1,89	927 639 150	0,329	2 457 000 000	1,89
Utilities (Electricity, Gas	**ST**	000692	0,602	2 134 976 542	1306886125	0,381	3388000000	1,61	1409700150	0,370	3486000000	1,61	1 512 514 175	0,36	3 585 000 000	1,61
	NST	000426	0,694	3 417 085 885	648536100	0,587	4039000000	1,43	825026100	0,564	4208000000	1,43	1 001 516 100	0,542	4 377 000 000	1,42
Information Technology	**ST**	000035	0,625	556 836 697	1537273725	0,177	2027000000	1,36	1590218950	0,173	2078000000	1,36	1 643 164 175	0,169	2 129 000 000	1,35
	NST	000547	0,660	2 647 142 318	390309300	0,587	3022000000	1,48	409288100	0,574	3040000000	1,51	428 266 900	0,571	3 058 000 000	1,51
Retails	**ST**	600891	0,544	2 097 081 604	537608000	0,437	2613000000	1,82	552971600	0,435	2628000000	1,82	568 335 200	0,42	2 642 000 000	1,87
	NST	600859	0,549	3 522 285 443	1457245475	0,393	4920000000	1,79	1473615950	0,392	4936000000	1,79	1 489 986 425	0,39	4 952 000 000	1,79

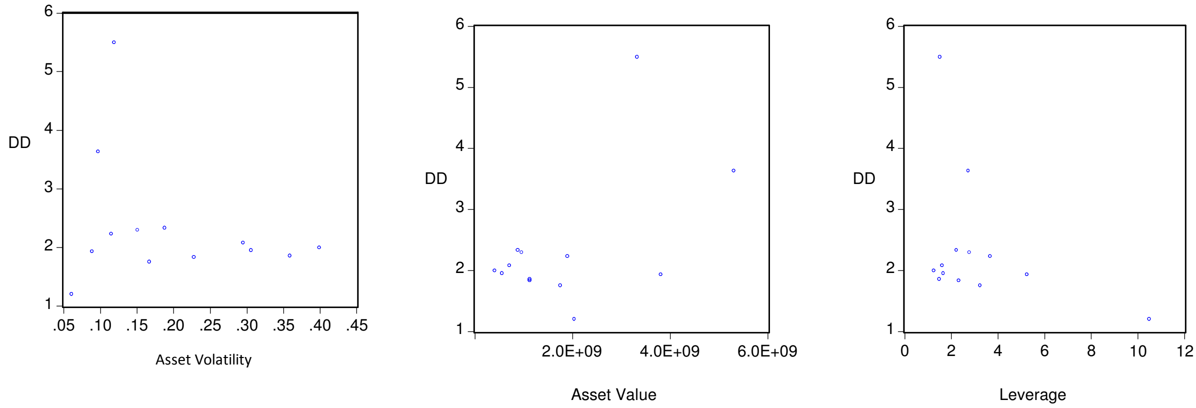
2008																
Industry		**Stock Code**	**σe**	**Ve**	**DPT(0.25)**	**σa**	**Va**	**DD**	**DPT(0.50)**	**σa**	**Va**	**DD**	**DPT(0.75)**	**σa**	**Va**	**DD**
Tourism	**ST**	000430	0,845	559 136 542	297867925	0,556	847300000	1,17	314350750	0,556	863000000	1,14	330 833 575	0,547	1 049 000 000	1,25
	NST	002033	0,677	796 096 057	209499602,3	0,539	1001000000	1,47	234265201,5	0,526	1025000000	1,47	259 030 801	0,514	964 400 000	1,42
Property and Real	**ST**	600603	0,556	831 120 913	108832050	0,493	937500000	1,79	168949000	0,464	996300000	1,79	229 065 950	0,438	1 055 000 000	1,79
Estate	**NST**	600246	0,781	3 407 207 969	2984475400	0,433	6298000000	1,22	3342662900	0,422	6830000000	1,21	3 700 850 400	0,403	7 175 000 000	1,20
Pharmaceutical	**ST**	600421	0,580	450 220 286	328487400	0,339	771100000	1,69	328687400	0,339	771300000	1,69	328 887 400	0,339	771 500 000	1,69
Industry	**NST**	600216	0,759	5 409 665 520	1388313100	0,608	6765000000	1,31	1409501800	0,606	6785000000	1,31	1 430 690 500	0,605	6 806 000 000	1,31
Home Appliance	**ST**	000561	0,575	1 390 845 955	356856800	0,46	1740000000	1,73	359773100	0,459	1743000000	1,73	362 689 400	0,458	1 745 000 000	1,73
	NST	000651	0,572	21 438 187 639	23070088350	0,28	43970000000	1,70	23070954800	0,28	43970000000	1,70	23 071 821 250	0,28	43 970 000 000	1,70
Electronics and	**ST**	000922	0,590	929 560 459	250715300	0,467	1175000000	1,68	252097800	0,467	1176000000	1,68	253 480 300	0,466	1 177 000 000	1,68
Machinery	**NST**	002028	0,555	6 643 466 424	696252775	0,503	7324000000	1,80	718631750	0,501	7346000000	1,80	741 010 725	0,5	7 368 000 000	1,80
Metal Refining	**ST**	000751	0,752	2 608 276 305	5079517925	0,274	7528000000	1,19	5227828650	0,269	7672000000	1,18	5 376 139 375	0,265	7 815 000 000	1,18
	NST	000630	0,715	6 549 548 478	10423914350	0,291	16670000000	1,29	11089872200	0,28	17320000000	1,28	11 755 830 050	0,271	17 960 000 000	1,27
Chemical	**ST**	600722	0,602	789 278 964	1677313275	0,2	2425000000	1,54	2133427350	0,17	2870000000	1,51	2 589 541 425	0,148	3 316 000 000	1,48
industries	**NST**	600141	0,867	2 221 809 885	1117703675	0,593	3301000000	1,12	1363094650	0,557	3536000000	1,10	1 608 485 625	0,525	3 770 000 000	1,09
Transportation	**ST**	000738	0,583	1 258 430 389	143752300	0,524	1399000000	1,71	143752300	0,524	1399000000	1,71	143 752 300	0,524	1 399 000 000	1,71
Facilities	**NST**	000913	0,614	1 007 841 663	1799602750	0,228	2763000000	1,53	1801638400	0,228	2765000000	1,53	1 803 674 050	0,228	2 767 000 000	1,53
Transportation	**ST**	600003	0,527	2 245 972 212	692294600	0,405	2923000000	1,88	829044600	0,388	3057000000	1,88	965 794 600	0,371	3 190 000 000	1,88
	NST	600269	0,458	7 502 037 754	2781565350	0,336	10220000000	2,17	3340630300	0,319	10770000000	2,16	3 899 695 250	0,304	11 310 000 000	2,16
Farming	**ST**	600506	0,860	983 934 444	102739500	0,781	1084000000	1,16	118256500	0,769	1099000000	1,16	133 773 500	0,759	1 115 000 000	1,16
	NST	600540	0,884	1 550 591 979	673911100	0,631	2202000000	1,10	703983800	0,623	2230000000	1,10	734 056 500	0,616	2 259 000 000	1,10
Utilities	**ST**	000692	0,525	654 120 472	1404373625	0,171	2026000000	1,79	1495648150	0,164	2115000000	1,79	1 586 922 675	0,158	2 204 000 000	1,77
(Electricity, Gas	**NST**	000426	0,777	958 004 436	532938500	0,51	1476000000	1,25	743346200	0,452	1679000000	1,23	953 753 900	0,406	1 881 000 000	1,21
Information	**ST**	000035	0,610	371 038 420	1598843400	0,122	1931000000	1,41	1654939300	0,118	1986000000	1,41	1 711 035 200	0,115	2 040 000 000	1,40
Technology	**NST**	000547	0,753	947 868 470	400448300	0,536	1338000000	1,31	417967100	0,53	1355000000	1,30	435 485 900	0,524	1 372 000 000	1,30
Retails	**ST**	600891	0,532	631 863 207	570374350	0,283	1189000000	1,84	588108200	0,279	1207000000	1,84	605 842 050	0,276	1 224 000 000	1,83
	NST	600859	0,513	1 999 097 590	1805124400	0,273	3763000000	1,91	1813342200	0,273	3772000000	1,90	1 821 560 000	0,272	3 780 000 000	1,90

APPENDIX III : CATTER PLOT OF REGRESSION RESULTS

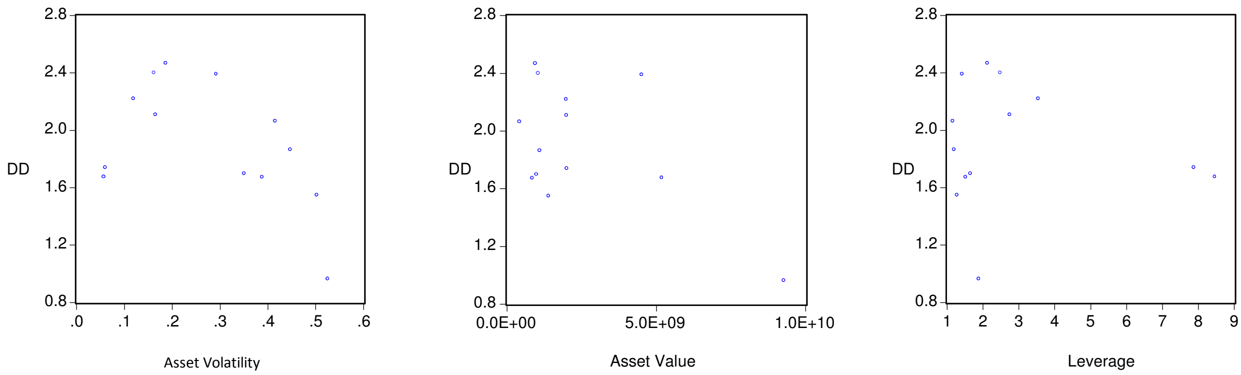
Year 2005_ST companies



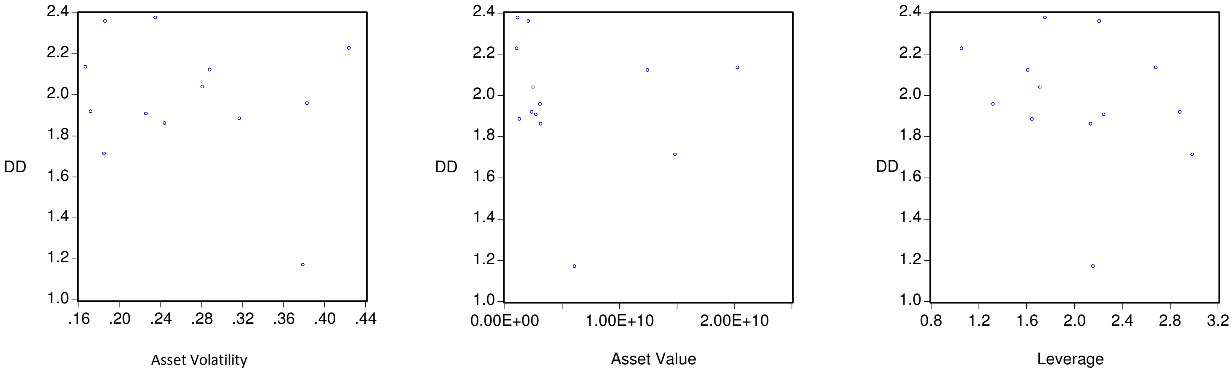
Year 2005_NST companies



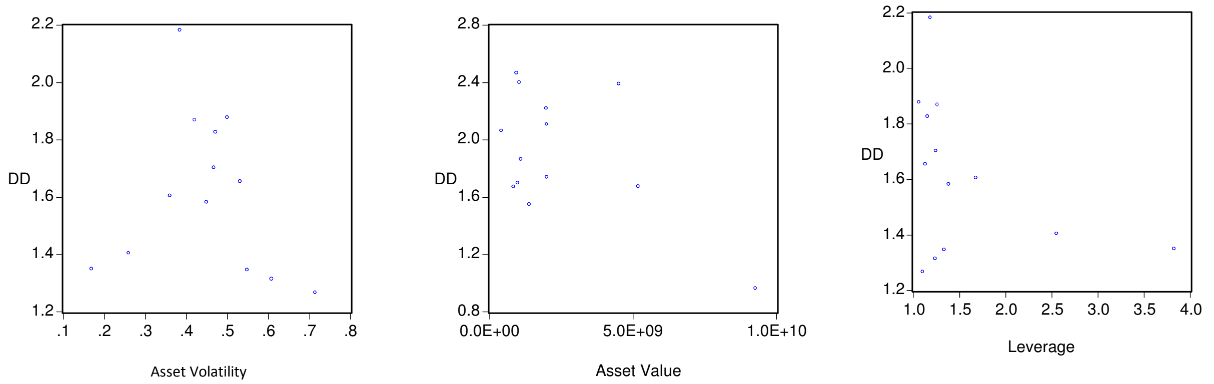
Year 2006_ST companies



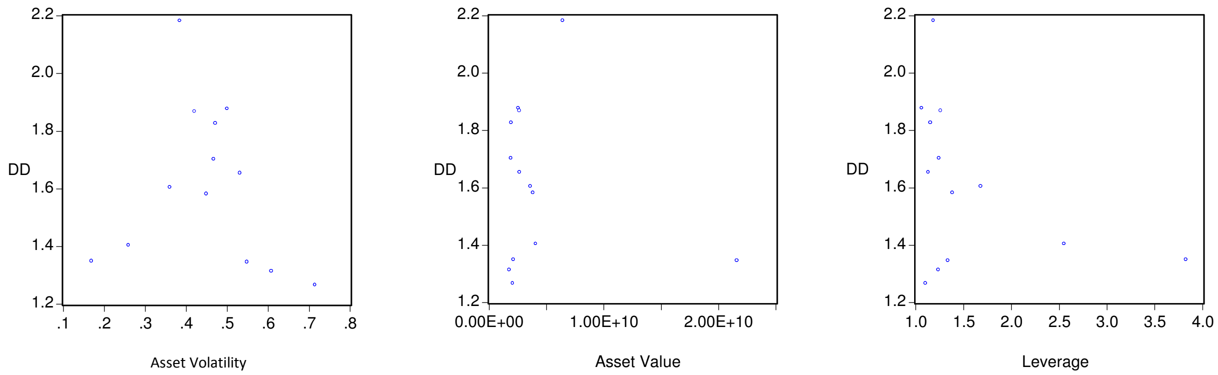
Year 2006_ST companies



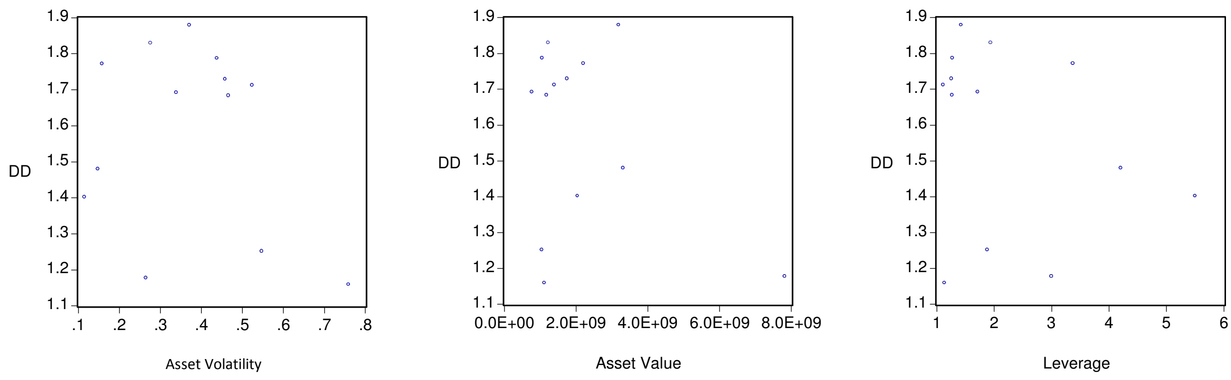
Year 2007_ST companies



Year 2007_non-ST companies



Year 2008_ST companies



Year 2008_non-ST companies