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A COMPARATIVE ANALYSIS OF CREDIT RISK IN INVESTMENT BANKS : A CASE STUDY OF JP MORGAN, MERRILL LYNCH AND BANK OF AMERICA

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Abstract: *Credit risk is the fundamentally significant for the sustainability of any investment bank. The recent studies show that credit risk was one of the determining factors behind the economic crisis that the world has suffered from. In this backdrop the present study analyses the credit risk os the three investment banks and tries to asses the severity of these banks in this context. We have employed Altaman's Z score model and KMV merton model for assessing the credit risk. The study found that These result implies that if the assets value drop or volatility increase over a period the Merrill Lynch had high chances to default then other two banks. Which actually realised in ex-post sense (i.e. on realization) ML Bank defaulted and merged to the Bank of America.*

Keywords: *Credit Risk, Altaman Z Score, Volatility, Distance to default, KMV Model.*

JEL Classification: *B26, G33, G21*

1. INTRODUCTION

The current scenario that is prevailing in the global banking industry is the danger of default risk. Risk is an inevitable element in all the areas of a business firm and the risk particularly credit risk, becomes more severe for the banks and financial institutions. Simply the credit risk is the inability of repayment of the credit by the customer, technically the credit risk can be defined "as the potential that a borrower or counter-party will fail to meet its obligations in accordance with agreed terms". Since a bank lends in many ways thereby exposes itself to the credit risk. Moreover there emerges other sources of credit risk for a bank or a financial institution, as it floats more financial product like futures, swaps, bonds, equities options etc or indulge itself into various other financial activities other then lending like accepting interbank transactions or trade financial or forex transactions etc. Credit risk has three elements exposure towards a party that may possibly default, the probability of default and lastly the recovery rate. While the higher recovery rate reduces credit risk, the first two elements increases in with every increment in them.

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Banks usually adopt a set of standard quantitative model proposed by the risk agencies to assess credit risk. While few other's bank have their own methodology or model for risk assessment like JP Morgan having their own Credit Metrics to asses credit risk. Important thing about the Credit Metrics model is that it allows to capture certain market risk components in risk estimation technique. These includes importantly the market-driven volatility of credit exposure like swaps, forwards, and to lesser extend, bonds. Typically market volatility are estimated over a dialy or monthly risk horizon. To analysis credit risk there are several approaches available with certain models which are applied for credit risk measurement.

Theses models have their own advantage and limitation for applying but he institutionals. The Chart below depicts the different type of model usually applied for credit risk measurement.

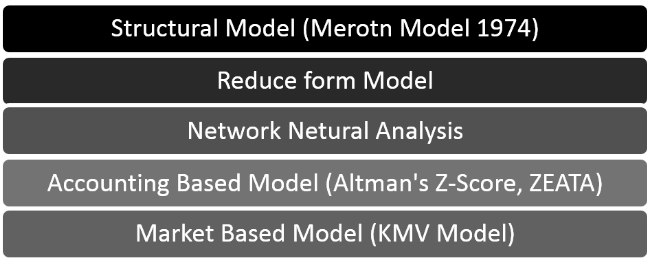

Figure 1: Various Models of credit risk measurement

Source: Author's *Own findings form different studies.*

2. REVIEW OF LITERATURE

Credit risk is sever risk for investment banks and particularly associated with on balance sheet side as well off balance side with derivative exposure explained by Hull (1989) and banks more aggressive in loan-making will pulled out a more aggressive credit posture with high level of both risk Alves, Dymski, and Paula (2007).

The financial approach of accounting data predominantly had important role in credit risk analysis and widely applied to assess credit risk in the industries firm's by Beaver(1966), Demirvic (2015) in different firm's either manufacturing industries or non-manufacturing entity. Particularly Altman's z-score models (1968) and ZETA Analysis: A new model to identify bankruptcy of risk in corporation. Demirovic, and Tucker (2015) observe that the accounting data based model have backward looking approach to assess credit risk. While Merton (1974) proposed a method of reassessing credit risk based on forward looking information of market securities, including debt and equity as derivative securities written on the value of a firm's assets, and employs option pricing theory to derive a measure of credit risk sensitivity. Moody's KMV Corporation (1995) provide an approach for estimating the default probability of a firms or financial institution based on extended model of Merton (1974), Vasicek (1997) and Kealhofer (1995). This market based model have more relevance and apply to assess the credibility of corporate big entity and limited in banking by international agencies providing credit ratings or rating migration.

3. METHODOLOGY AND ANALYSIS

Form the above mentioned models banks usually select the model based on their requirement and risk management strategy. However, JP Morgan's Credit Metrics approach combined with some of the model for their risk measurement methodology, *i.e*. market based approach, market volatility, rating migration based on accounting data etc. which overall improve the efficiency of model to capture credit risk.

In this backdrop, the present work concentrates on the method and methodology for measuring credit risk and the techniques with appropriate model adopted for identification of credit risk. The research approach is to asses the credit risk's within the three banks *i.e*. JP Morgan Chase, Merrill Lynch and Bank of America. We follow the accounting based approach and combined approach of market & accounting based approach to capture the credit risk within the three investment banks. It is also depicted as under.

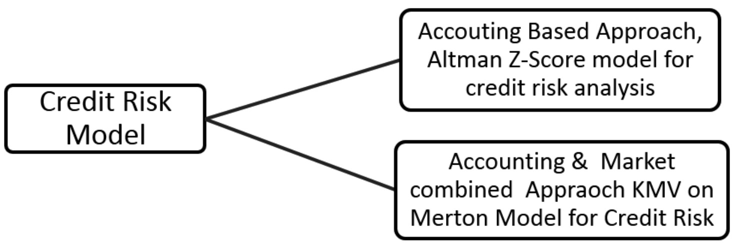

Figure 2: Credit Risk Model Approach

Sources: Authors own work.

Section two presents the review of literature, sections three shows methodology and analysis done and the fourth section concludes the present research work.

3.1. Accounting Based Approach for Credit Risk

The financial approach of accounting data predominantly had important role in credit isk analysis. Beaver (1966) had a number of studies attempting to extract sensitive information from financial accounting data. based on these Beaver examines 14 individual traditional accounting ratios to predict the firm default. Further, these ratios are significant predicators of a firm's failure to service its contractual obligation. Deakin (1972) employed the model with same ratios in a series of multiple discriminant models and concluded that they are able to predict firm failure. Demirovic (2015) found that accounting data contain information relevant to explaining change in the credit spread.

The multivariate accounting based credit-scoring model combined and weighted accounting variables to produce either a credit risk score or a probability of default measure. If the credit risk score (probability) attain a value above a critical benchmark then it found in distress zone. There were log it and discriminant analysis to predict the banking failure and by far the largest number of multivariate accounting based credit-scoring models have been based on discriminant analysis models. Particularly Altman et al. (1977) investigate the predictive performance of a Five variable discriminant analysis model.

3.2. Altman's Z-Score Model

Altman's Z-Score models (1968) is a outcome of multiple discriminant analysis approach to test for the difference between defaulted and non-defaulted firms are based on a multivariate approach built on the values for both ration-level and categorical univariate measures. These values are combined and weighted to produce a measure (a credit risk score) that best discriminates between firms that fail and those that do not.

The intuition behind applying the Z-score model is multiple linear discriminant analysis, based on a standard statistical approach to classify multivariate data into different groups according to their characteristics. Z-Credit Score model is a linear function of predictive variables that is employed to classify loan borrowers into different groups such as 'Bankruptcy', 'Undetermined' and 'Safe' zone. Such a measure is possible because failing firms exhibit ratios and financial trends very different from those of companies that are financially sound. In a bank utilizing such a model, loan applicants would either be rejected or subjected to increase scrutiny if their scores fell below a critical benchmark.

Altman in (1968) extended Beaver's unvaried analysis and developed a discriminant function which combines ratios in a multivariate analysis. The Z-score evaluated from accounting ratios including important information regarding firms profitability, liquidity and leverage capacity based on which the firms soundness are defined.

$$Z = 1.2X_1 + 1.4X_2 + 2.3X_3 + 0.6X_4 + 0.999X_5$$

Where,

X_1 = Working Capital/Total Assets

X_2 = Retained Earnings/Total Assets

X_3 = Earnings before Interest and Taxes/Total Assets

X_4 = Market Value of Equity/Book Value of Total Liabilities

X_5 = Sales/Total Assets

Z = Overall Index.

The Altman Z-score model has been widely applied to predict bankruptcies of firms in the banking and finance industries. The key idea of the model is to evaluate a Z-score based on a weighted linear combination of four or five common accounting ratios. The weights, or coefficients, of the Z-score formula are estimated using a sample of distressed firms and a matched sample of survived firms, where the matching is based on industrial sectors and market capitalization. The accounting ratios to be included in the Z-score formula may vary for different industrial sectors. The Z-score summarizes useful information from corporate balance sheets for assessing the financial health of a firm and predicting the likelihood of its bankruptcy.

To explaining the profile of each variable for computation of Z-score the following procedure were utilized:

1. **X_1, Working Capital/Total Assets (WC/TA**). The working capital/total assets ratio is to measure the firm's net liquid assets relative to its total capitalization. Working capital is defined as the difference between current assets and current liabilities. Liquidity and size characteristics are explicitly considered. If firm's experiencing consistent losses that it would mean that shrinking current assets in relation to total assets.
2. **X_2, Retained Earning/Total Assets (RE/TA).** The retain earning/total assets ratio represented as a earned surplus, reports the total amount of reinvested earning and or losses of a firm over its entire life. A new firms had reasonably higher incidence of failure then old firm's. So, new firm's usually have low retina earning as compared to old firms.
3. **X_3, Earnings before Interest and Taxes/Total Assets (EBIT/TA).** The purpose of this ratios is to measure the productivity of fim's assets, independent of any tax or leverage factors. As the firm's ultimate existence is based on the earning power of its assets, the ratios defined the firms failure if the firm's total labilities exceed a fair valuation of its assets, as determined by the earning power of those assets.
4. **X_4, Market Value of Equity/ Book of Total Liabilities (MVE/TL).** The ratios is the based on the assumption of that Equity measured by the combined market value of all shares of stock, preferred and common. While liabilities include both current and long-term items. The ratios measures the how much assets value (market value of equity plus debt) can decline before its liabilities exceed it s assets and it become insolvent.

The ratio adds market value dimension as other ration do not include such dimension including adding both operating and financial leases to the firm's total liabilities.

5. **X_5, Sales/Total Assets (S/TA).**Simply this ratios is defined as capital-turnover ratios, and proven the sales generating ability of the firm's assets. It is one measure of management's capacity to deal with competitive condition.

Form the above variable the first, observation of the statistical significance of various alternative functions, including determination of the relative contributions of each independent variable. Second, evaluation of correlations among the relevant variables. Third, observation of the predictive accuracy of the various profiles. Fourth, judgment of the analyst. The above Altman's original 22 variables, the final Z-Score model chosen was the above five-variable model under discriminate analysis.

Altman Z-Score has been classified in three different zone:

(i) 'Safe', if Zone: $Z > 2.99$.

(ii) 'Undetermined', if Zone: $1.80 < Z < 2.99$.

(iii)'Distress', if Zone: $Z < 1.80$.

Altman found that a lower bound value of 1.81 (failed), and an upper bound of 2.99 (non-failed) to be optimal. Any score in the 1.81-2.99 range was treated as being in the zone of ignorance.

3.2.1. Empirical Analysis using Z-Score

To predict the banks behaviour we have applied Altmn's Z-Score model in our selected banks for analysing the results for banks falling in defined zone *i.e.* 'Safe', or 'Distress', for the year of 2007 and 2008. The annual financial statement data have been collected for all three banks for the year 2007 and 2008. On the basis of data altman's Z-Score five variable model has been computed. While selecting the variable with define coefficient value in all five variable the first variable "working capital/total assets" has been dropped on the basis of the assumption of that bank's do not have working capital as corporate firm's and industry maintained.

On the basis of Z-Score the Table 1. Provide the z-value for all three banks for the year 2007 and 2008. The results concluded that Merrill Lynch fall on distress zone on 2007 as the index value is very low 3.3266 with the rejection area of Z-distribution table of normal curve found to be 0.999 on shaded left side of the normal curve, and for 2008 banks Z-index value become negative -22.67 implies that ML banks defaulted. While other two banks Z-Score found to be in the safe zone as per value in the table. Once we would assigned the rating of these value so the rating for ML Banks would be **[B–] Distress Zone**, as per rating score in the figure, while rating

Table 1
Predicting default based on Altman's Z-Score

Variable	*Ratios*	*M. Lynch 2007*	*M. Lynch 2008*	*BOA 2007*	*BOA 2008*	*JP Morgan 2007*	*JP Morgan 2008*
X_1	1. Working capital/Total Assets	-NA-	-NA-	-NA-	-NA-	-NA-	-NA-
X_2	2. Retained Earnings/Total Assets	2.3700000	–1.28880	4.74400	4.0608	3.50300	2.4833
X_3	3. Earnings Before Interest & Tax/ Total Assets	–1.2578795	–6.26640	1.21953	0.2699	1.45985	0.12759
X_4	4. Market Value of Equity/Total Liabilities	5.0980000	2.82470	11.67000	4.3053	10.21000	5.8608
X_5	5. Sales/Total Assets	1.1020000	–1.88650	3.89000	4.0035	4.56800	3.3489
	Z-Score = $1.2*X_1 + 1.4*X_2 + 3.3*X_3 + 0.6*X_4 + 0.99*X_5$.						
Z-Score		–3.326695598	–22.6732335	21.55415	13.1584665	20.36644	10.7596981
Area of Rejection as per Z-Table:		0.99956059	4.116	1	1	1	1
Results for Z-Score		Highe Probability of Default	Defaulted	Low Probability of default	Low Probability of default	Low Probability of default	Low Probability of default

Note 1: The X1 variable has been dropped based on assumption that banks do not have working capital as firm's and Industry.

Note 2: The Z-score provide overall index value which shows banks will be on safe zone or distress zone.

Note 3: The Z-distribution provides Area of rejection based on z-value of normal distribution.

Source: bloomberg database.

for the other two banks are higher JP Morgan 20.36 for the 2007 and 10.75 for 2008, while for BoA the index value is 21.55 for 2007 and 13.15 for the year 2008 implies they are still safe. So they would probably fall in the Safe Zone as per rating assigned in the Z-Score rating value.

	Z"-Score		Rating	Z"-Score		Rating	
Safe zone	8.15	>8.15	AAA	5.65	5.85	BBB–	Grey zone
	7.60	8.15	AA+	5.25	5.65	BB+	
	7.30	7.60	AA	4.95	5.25	BB	
	7.00	7.30	AA–	4.75	4.95	BB–	
	6.85	7.00	A+	4.50	4.75	B+	
	6.65	6.85	A	4.15	4.50	B	Distress zone
	6.40	6.65	A–	3.75	4.15	B–	
	6.25	6.40	BBB+	3.20	3.75	CCC+	
	5.85	6.25	BBB	2.50	3.20	CCC	
				1.75	2.50	CCC–	
				<1.75	1.75	D	

Z"-Score and Equivalent Bond Rating

Figure 3: Z"-Score credit rating

Source: In-Depth Data Corp. Average based on over 750 corporates with rated debt outstanding; 1995 data.

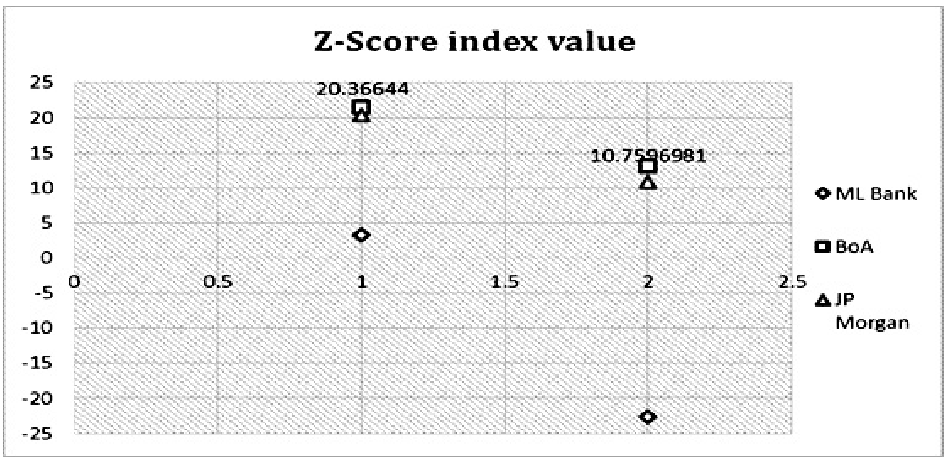

Figure 4: Z-score index value

Note: Depicted based on Z-Score index value.

Atman Z-score value could be depicted graphically in the figure:3. Shown that the Merrill Lynch banks are near to default *i.e.* on distress zone, while other banks JP Morgan & Chase, and Bank of America are found to be safe zone as the z-score value are positive and more stable in the graph conclude that ML is near to default.

Thus, the above results on the basis of Altman's model of accounting data concluded that Merrill Lych shows high probability of default since beginning of 2007 as credit risk spread, due to which financial strengthening becomes distress.

3.3. The KMV Approach of Distance of Default Model for Credit Risk

Moody's KMV Corporation (1995) provide an approach for estimating the default probability of a firms or financial institution based on extended model of Merton (1974). The purpose of applying market based model for explaining variation in credit spread with more accuracy. As it combines both types of variable with great expectation of outperformance that includes only market-based measure with relevance of accounting variables.

Hillegeist (2004) concluded that the distance-to-default variable outperforms the accounting based models particularly Altman's model in explaining bankruptcies. The Distance-to-Default (DD) model of Merton widely accepted model for credit risk measurement. It represented the difference between the market value of a firm's assets and the book value of debt. Which is very important as the market value of assets of a firm's differ then book value over a period. Therefore, DD combines information on both leverage and the volatility of assets. The purpose of scaling of leverage using assets volatility means in a given leverage ratios, more stable (*i.e.* less volatile) firms are less likely to be default on their obligations.

KMV model applies mostly publically traded companies and firm's where credit risk is essentially based on the dynamics of the asset value with capital structure of firms (*e.g.* equity, short-term and long-term debt, convertible bonds, etc.), with stochastic process for the assets value has been specified. Then the probability of default for any time horizon can be derived based on the market value of equity and debt. The process of derivation of the probabilities of default proceed in the two stage: first, estimation of the market value and volatility of the firm's assets; second, calculation of the distance-to-default.

Estimation of assets value, and volatility of assets return (V_A, σ_A): The first important assumption for the market value of the firm's assets is to be lognormally distributed (*i.e.* it will follow log-assets return which is normally distributed and remain stable over a time). The market volatility of asset return are computed annual basis. If firm's liability were traded on the daily basis of mark-to-market*, then value of the firm's assets and volatility would be parallel *i.e.* the value of assets would be the sum of market value of the firm's labilities, and volatility of the assets return computed simply form the historical time series of the reconstituted assets-value.

* Assets are valued on the basis of market-value and not on the basis of book value or accounting value, which only represent the historical cost of the physical assets, and good measure of the value of the firm's ongoing business and changes as per market views of firm's future prospects.

However, only the price of equity for most public firm's are directly observable for valuation, including some part of debt is traded. Merton suggested an alternative approach for assets valuation through applying option pricing model to the valuation of firm's liabilities. For the simplicity of model, KMV assume that the capital structure is only composed of equity, short-term debt consisting near cash equivalent, long-term debt for the analytical solution of value of equity.

σ_E the volatility of equity remain unstable and directly observable like the stock price, but sensitive to the change in assets value and computed from the historical data for the estivation of asset volatility reflected in the distance-to-default. Campbell and Taksler (2003) find that credit spread affected significantly from the equity volatility.

Estimation of Distant-to-Default (DD): Merton (1974) model of distant-to-default based on option pricing framework to predict the bankruptcy*, based on the assumption that DD occurred when assets value falls below the value of the firm's liabilities. The default is the basically an event when a firm's are unable to pay the principal at debt maturity and become or declare as a defaulted on all its obligations. The KMV observed point of DD form the empirical data of the hundred companies that firms assets value exceeds a value of total liabilities and the value of short-term debt. In which the tail of assets value distribution are below to the total value of debt, which may not be an accurate measure of the actual probability of default due to non-normality of asset return distribution or other factors.

KMV had come out with a index called distant-to-default "DD", is basically provide the number of standard deviations that the mean of distribution of assets value, with a critical point known the "default point", equate at the par value of current liabilities, including short-term debt plus half of the long-term debt.

So, DPT_T = default point = STD+1/2 LTD

Where,

STD short-term debt,

LTD long-term debt,

The Graph of distant-to-default has been shown in the figure below. Where DD is the difference of the V_1 in the expected value of value of assets after one year and DPT *i.e.* default point over a time horizon.

* However, in practice default is distinct form bankruptcy which corresponds to the situation where firms is liquidated, and the proceeds from the assets sale is distributed to the various claim holders according to pre-specified priority rules.

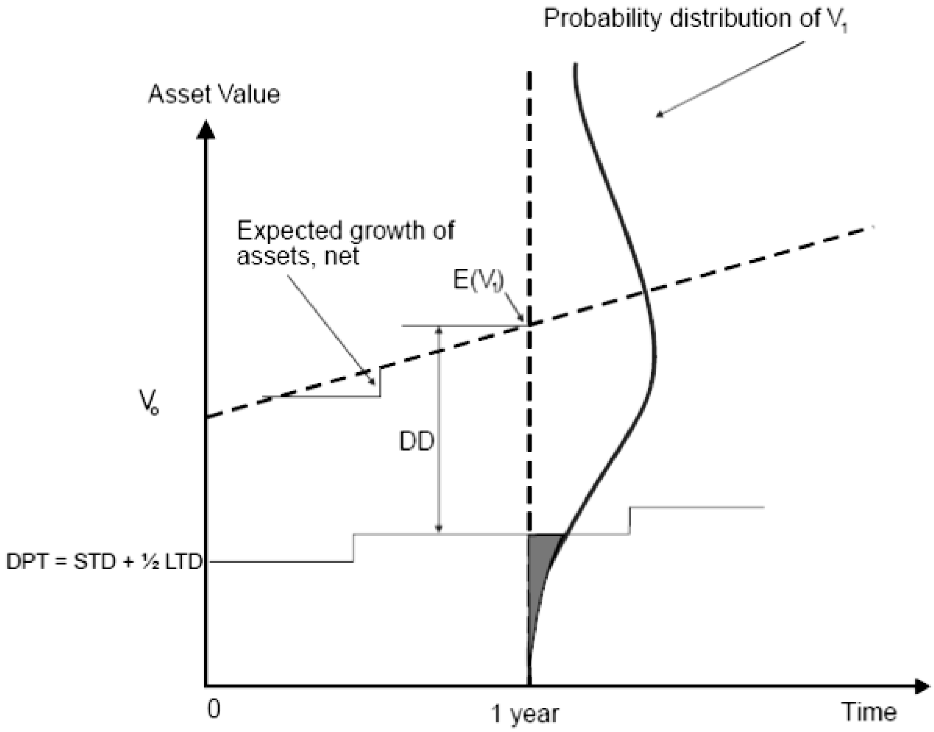

Figure 3: Distance-to-Default (DD)

Source: Crouhy et. al. (2000).

The important assumption of lognormality of asset values to be consider while expressing DD in a unit of asset return standard deviation at time horizon T, is

$$DD = \frac{\mathrm{In}\left(\frac{V_0}{DPT_T}\right) + \left(\mu - \left(\frac{1}{2}\right)\sigma^2\right)T}{\sigma\sqrt{T}}$$

Where,

V_0 is the current market value of assets, DPT_T the default point at time horizon T, μ is the expected net return on assets, σ the annualized assets volatility. The important is that it follows that the shaded area below the default point is equal to N(-DD).

Empirical Analysis of KMV Model: For the applicability of the standard model of KMV based merton model to predict the banks probability of defaults in all three banks *i.e.* JP Morgan Chase, Bank of America, and Merrill Lynch for the year of 2007, a period of sub-prime crises we have computed 'DD' on the basis of defined variable.

The Table 2 has been computed distant-to-default for the year 2007 to analyse the stability of all three banks JP Morgan & Chase, Bank of America and Merrill Lynch on the basis of merton model (1974) with both accounting data and mostly market data. Market based variable widely employed based on the model definition as this variable are assumed a good indicator of credit risk by Vassalou and Xing (2004).

Table 2
Computation of distant-to-default (DD) for the year of 2007.

	In USD $ Millions		
Variables	*Merrill Lynch*	*JP Morgan Cahse*	*Bank of America*
Total Liabilities	988118	1438926	1568943
Market Capitalization	62257.5	138727	183107.2
V0 (current market value of Assets)	1050375.4	1577653	1752050.2
Net Income Avail to Common	7187	15365	2556
Total Assets	494518	1157248	1817943
Expected return growth	0.01453334	4.5628994	0.001406
Average return from assets	0.0001396	0.00910509	0.01121154
Annualized volatility (%)	0.5066	0.2666	0.2189
DPT = STD+1/2 LTD	569646.5	442974.5	687374
ln(V0/DPT)	0.61188691	1.270181372	0.935663384
$(\mu - (l/2)^*\sigma_2)T$	–0.12818218	–0.02643269	-0.012747065
$DD = \dfrac{\text{In}\left(\dfrac{V_0}{DPT_T}\right)+\left(\mu-\left(\dfrac{1}{2}\right)\sigma^2\right)T}{\sqrt[\sigma]{T}}$	0.954806021	4.665223865	4.216154952
N(–DD)	0.830162099	0.999998459	0.999987575
Default Probability	16.98379011	0.000154141	0.001242515

Source: Own calculation based on market data form bloomberge.

The above data reveal monotonically consistent relationship between the credit spread and the market-based measures of the distance-to-default and equity volatility. And conclude that the relationship between the credit spread and the distance-to-default in highly significant, DD explaining the variation in credit spread which has been confirmed by estimating the model on the three investment banks. We also observe that equity volatility model significantly outperforms that distance-to-default in explaining changes in the credit risk.

4. CONCLUSION

On the basis of collected data and appropriate variable based on the model the value of variable calculated for all three banks including DPT *i.e.* default point time based on short-term debt plus half of long-term debt, and volatility, current market value of firm, and expected return form assets. Then applying the Merton model to calculated distant-to-default DD of three banks the results of all three banks reveal that distant-to-default is higher in the case of Merrill Lynch banks than other two banks *i.e*. JP Morgan & Chase, and Bank of America as the distant-to-default is **too high** *i.e***. 16.98%** while the other two banks are very low almost zero percent or 99 percent confidence level for the non-defaulting probability. These result implies that if the assets value drop or volatility increase over a period the Merrill Lynch had high chances to default then other two banks. Which actually realised in ex-post sense (*i.e*. on realization) ML Bank defaulted and merged to the Bank of America.

Thus the research provided the effectiveness and efficiency of credit risk model, if all the relevant information are collected to compute distant from default. Therefore, able to predict the banks default risk over the time horizon based on certain assumption. The KMV determines the percentage drop in the firm value that might bring it up to default point. A distant-to-default model is akin to bond rating and proceed to compute the expected frequency of default.

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