RESEARCH ARTICLE

FORECASTING AND COMPARING THE RESULTS FROM ALTMAN Z-SCORE AND MERTON DISTANCE TO DEFAULT MODEL IN THE INDIAN SCENARIO.

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Manuscript Info	*Abstract*
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Bankruptcy is a state where the company is unable to pay back its debt. In order to avoid bankruptcy we executed two tests with the help of the models viz. Altman Z Score and KMV model for bankruptcy prediction prior to its occurrence. 40 Indian Companies from diverse sector were selected and were tested for the accuracy. It was found that KMV (derived from Merton distance to default model) is better in prediction of companies which have poor financial statement whereas Altman Z Score equally effective is overridden by KMV as it gives probability for only 1 year.

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Introduction:-
For an economy to be financially stable it has to look that the industry it comprises is stable and performing well. For India to be developing at a faster rate, its industries (primary, secondary and tertiary) should b (Sreedhar T. Bharath, 2008) (Yan chen, 2014) (Amit Kulkarni)e financially sound proof and work towards economic upliftment. No company ever wants to face its worst nightmare that is of bankruptcy. Bankruptcy is something which can be avoided if it can be predicted at an early stage and companies should take proper course of action to evade it.

In this research paper, keeping in mind the challenges faced by the Indian industry, the paper focuses on the prediction of corporate insolvency and how effectively the various models predict insolvency for Indian Co (Jacob Muvingi, 2015) (Apoorva D, 2019) (Mohammed Mushtaq Khan, 2018) (Sundaresan, 2013)mpanies.

Insolvency is a state of financial distress in which an individual or organization is unable to meet its future obligations to its lenders when the liability arises. It results to insolvency proceedings, in which legal action is taken against the insolvent entity followed by liquidation of the entity's assets in paying off the outstanding debts. There are numerous factors that can lead to insolvency- inadequate accounting and human resource management, rising vendor costs leading to customers shift to other businesses where they can pay less for a product or a service, lawsuits from consumers or business associates, unfit consumer products due to changing needs of the customers.

In India, there is an 'Insolvency Bankruptcy Code,2016', an act to amend the laws relating to reorganization and insolvency resolution of corporate persons, firms and individuals to balance the interests of all the stakeholders including change in order of making repayments. It provides a time bound process to resolve insolvency. The Code also consolidates provisions of the current legislative framework to form a common forum for debtors and creditors of all classes to resolve insolvency.

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Insolvency is nothing but the economic failure of a country, so it becomes very important for an economy to measure risk of insolvency, its impact and what are the factors that can lead to insolvency. This can be done through various "Insolvency Prediction Model." Insolvency

Prediction Models are the methods which help identify the firms that run a risk of going insolvent. It becomes very important that this method is simple, clear, applicable across all the firms in a particular industry and is consistent in predicting insolvency.

There many methods to assess the risk of insolvency- Altman's Z-score model, Taffler's Z-score model, Sandin & Porporato's model, Zmijewski's model and Kralicek DF ratio, KMV, Merton Distance To Default Model, Linear Regression, Neural Network and Discriminant Analysis. Each model has its own set of limitations and benefits.

For the purpose of our research we have taken Altman's Z-score model, KMV and Merton Distance To Default Model. The Altman Z-score is the output of a credit-strength test that gauges a publicly traded manufacturing company's likelihood of insolvency. The Altman Z-score is based on five financial ratios that can calculate from data found on a company's annual 10-K report. It uses profitability, leverage, liquidity, solvency and activity to predict whether a company has high probability of being insolvent. KMV compares the firm's net worth to its volatility and measures the ability to adjust to the credit cycle and ability to quickly reflect any deterioration in credit quality. It works best in highly efficient liquid market conditions. Merton Distance To Default Model is used by the analysts and investors to understand how capable a company is at meeting financial obligations, servicing its debt, and weighing the general possibility that it will go into credit default. The Merton (or Black-Scholes) model calculates theoretical pricing of European put and call options without considering dividends paid out during the life of the option.

The calculations from the above models will provide an early signal of a significant bankruptcy risk, and to indicate companies facing potential insolvency. Prediction of financial distress is a significant issue for managers, shareholders, creditors, government, auditors, suppliers, employees and other entities. The contents of this research paper are in consideration with the interests of various stakeholders such as the banks, the shareholders, customers and the investors since the paper will provide useful insights into the insolvency and the risks associated with it.

Therefore, it is necessary to develop a model which could be specifically applied to a prediction of bankruptcy for companies that are not working financially stable.

Problem Specification:-
To manage the credit risk, the lender needs to have a good idea about how likely the borrower will default. There are a number of different models available to estimate the likelihood of a borrower defaulting. We have used two models for predicting default of insolvency, namely Altman Z score developed in 1968, where database is collected from the balance sheets and profit and loss statements and secondly a modifies Merton Model.

Aims And Objectives:-
The objective of this research paper is to forecast and predict incolvency for the companies in the Indian economy, using two models, namely, Altman Z score and Merton Default to

Distance Model and KMV, compare the result derived from each model and suggest the best model to predict insolvency.

The aim of our research paper is to help stakeholders predict the financial performance of various companies and their probability of getting bankrupt using models like Altman Z Score and KMV Merton Distance Model. Insolvency means that a company has negative financial statements and is unable to payback its debt which means huge loss to the company and its stakeholders. Thus, using insolvency default model, the company can take due actions and prevent bankruptcy.

Altman Z Score uses 5 financial ratios and gives us probability about the company's tendency to default.

Merton DD model is used as a tool to produce the probability of default for each firm in the sample at any given point in time by estimating the market value of debt by applying the classic Merton (1974) bond pricing model.

Moody's KMV gives us the default point and helps to overcome the limitations of Merton Distance Model to calculate the default point.

To analyse Both models are studied for their effectiveness on the Indian companies in prediction of bankruptcy.

To compare both the models, i.e Altman Z score and KMV Merton Distance to Default Model as to how accurate they are in predicting insolvency of a firm

Literature Review:-
Rao et al studied the Indian companies to predict their bankruptcy before they are taken to NCLT (National Company Law Tribunal). Bankruptcy is a state of insolvency wherein the company fails to pay its debt amount back. Bankruptcy prediction helps take appropriate course of action. The collective purpose of their research is to study the suitability of prediction models by applying them to Indian Companies which have been declared sick. The two models used are Altman Z Score and KMV Merton Distance to Default Model.

Bapat & Nagale (2014) constructed bankruptcy prediction model with data of Indian listed companies using multiple discriminant analysis, logistic regression and neural network and compared the performance of the three models. Khan & Safiuddin (2018) studied the bankruptcy prediction capability of Altman Z-score and Zmijewski models in Indian context. They concluded that Altman Z score model and Zmijewski model of bankruptcy can be applied to Indian companies for the prediction of bankruptcy.

Prasad ET AL (2019)used Altman Z score to predict the bankruptcy of Indian Companies 3 years prior to the year in which bankruptcy case was filed and found that the model was 85% accurate and useful to protect stakeholders interest. Ramesh ET AL (2017) used Altman Z score to evaluate the financial health of power sector companies and concluded that specific financial ratios in Z score are efficient to judge the financial failure of companies. Altman (2014), founded that all the variables under research were well balanced except BV/Total Liabilities, Mohammed (2012), Narayanan (2018) used Altman Z score and concluded that the model is fairly reliable in bankruptcy prediction and is superior to market based models.

Shumway ET AL (2008) used Merton distance to default model and compared it to naïve alternatives which uses the functional form suggested by the Merton model but does not solve the model for an implied probability of default. It concluded that KMV probability is a useful variable for forecasting default but is not a sufficient statistic for default. Shumway ET AL (2008) used KMV and studied volatility of stock returns F and presented a number of empirical result, including correlations of probability estimates with those published by Moody's KMV. The findings of the research show that forecast default, the Merton DD model does not appear to produce a sufficient statistic for default. It appears to be possible to construct an accurate default forecasting model without considering the iterated Merton DD probability. The naive probability, which captures both the functional form and the same basic inputs of the Merton DD probability, performs surprisingly well.

Rao ET AL founded that overall the Altman Z-score model is able to predict bankruptcy filing efficiently for the Indian Companies as compared to the KMV Merton Distance to Default model. The study shows that Altman Z-score is able to predict that a firm might get into state of distress at least two years prior to the situation occurring. KMV Merton does not have a fixed period where in it can with certainty state that a firm will get into financial distress. This is due to its dependency on the volatility of equity which is not high for Indian firms as they are traded thinly. Companies which have Z-scores of 0.8 or less for two consecutive years have a high probability of filing for bankruptcy in the third or fourth year. 7 out of 9 companies (77.77%) in the study had Z-scores less than 0.8 for two years and filed for bankruptcy within the next two years

The value of equity volatility is expected to increase tremendously in the horizon in which a company defaults. This is primarily due to a panic in the market. However in the Indian context most of the companies which file for BIFR are thinly traded. Thus, the volatility of the stocks does not show a large shift in the event of filing. Since the KMV model is largely dependent on market parameters for its output, it is vulnerable to type I errors. An increased volatility due to an overall panic in the market and industry as a whole could produce misleading results.

From an industrial perspective the KMV Merton is quite cumbersome to apply and hold as a benchmark measure of a company's credit worthiness. This is due to the restriction of the model in its dependency on the equity volatility.

A financial institution is more likely to develop a logit model based on historical data and use it rather than apply a complex model such as the KMV. Thus, a Z-score developed on Indian data is more (Altman, 1968) (Dr.Rajesh. P. Ganatra, 2019) likely to be used by financial institutions to evaluate credit worthiness.

In its initial test, the Altman Z-Score was found to be 72% accurate in predicting bankruptcy two years prior to the event. In subsequent tests over 31 years up until 1999, the model was found to be 80-90% accurate in predicting bankruptcy one year prior to the event.

Background of the models:
Altman z -score
The Z score, developed by Prof. Edward I. Altman, is a widely applied model for predicting financial distress. It was developed when traditional ratios were losing favour with academics. It requires a firm to have a publicly traded equity. Altman evaluated 22 potentially significant variables of the 66 firms by using multiple discriminant analysis to build the discriminant function with five variables. This model was later modified to Altman model (1993) that uses the same variables multiplied by different factors. Individual financial ratio to predict the financial performance of an enterprise may only provide caution when it is too late to take a corrective action. Further, a single ratio does not convey much of the sense. There is no internationally accepted standard for financial ratios against which the result can be compared. Edwin Altman, therefore, combines a number of accounting ratios (liquidity, leverage, activity and profitability) to form an index of the probability, which was effective indicator of corporate performance in predicting bankruptcy. The Z score is a set of financial ratios in a multivariate context, based on a multiple discriminated model for the firms, where a single measure is unlikely to predict the complexity of their decision making.

Elements of the Altman Z Score model:

$$Z= 1.2X1 +1.4X2 + 3.3X3 + 0.6X4 + 1.0X5$$

A score of Z less than 2.675 indicates that a firm has a 95% chance of becoming bankrupt within one year. However, Altman result shows that in practice, scores between 1.81 to 2.99 should be thought of as a grey area. Firms, with Z scores within this range, are considered uncertain about credit risk and considered marginal cases to be watched with attention. Altman (1968) formerly described the grey area as the "zone of ignorance". This area is where firms share distress and non-distress financial characteristics and should be carefully observed before it is too late for any remedial or recovery action. Firms with Z scores below 1.81 indicate failed firm, Z score above 2.99 indicates non-bankruptcy. Altman shows that bankrupt firms have very peculiar financial profiles one year before bankruptcy. These different financial profits are the key intuition behind Z score model.

Merton Model:-
The Merton Model was developed in 1947, by economist Robert C. Merton. It is used as an analysis model to evaluate and assess the risk of the level of a firm's obligation and how a firm is satisfying its debts as well as the possibility that it will go into insolvency. It takes into account the market information of the sample, which makes it distinct from Altman Z score. It is based on the simple idea that if market value of assets is less than the market value of liabilities, then the firm has chances of going insolvent. If the value of assets is greater than the liabilities then the firm will be able to pay back it's debt and will reinvest it surplus earnings into it's business. The value of equity i.e $ET = max (AT - D, 0)$, where debt is matured, is considered the default point .

In this paper we have used the value of market equity and equity volatility and then by solving two simultaneous equations we have estimated the market value of asset and volatility of the asset. The Merton model has taken into account some assumptions such as (1) no transaction cost, (2)no taxes, (3)there are no opportunities for arbitrage on the market, (4)there are no bankruptcy costs involved, (5)the capital market is frictionless, (6) the firm had issued just one discount bond maturing in Time T, (7)The total value of the firm uses Geometric Brownian Motion(GBM).

For Merton model we have used:-

$$E=VtN(d1)−Ke−r\,TN(d2)$$

Moody's Kmv Model:-
Moody's KMV model is also based on the structural approach that if the value of assets of the firm is less then the value of liabilities, then the firm is likely to get make default. It distincts itself from Merton and improvises the disadvantage which is setting of default point. In KMV model, the default point is suggested as the short term debt + 0.5* long term liabilities. In Merton, the risk is can also be underestimated in normal distribution in Merton. Thus KMV has improvised this as well and hence the model becomes less dependent on underlying distributions. KMV uses three steps to calculate probability of default , (1) Estimate the market value of assets and asset volatility , (2) calculate distance to default , (3) Transform distance to default into probability of default. The KMV model needs six variables, which includes market value of equity, equity volatility, long term debt, short- term debt, risk free rate, and time horizon.

Hypothesis:-

Altman z – score :

HIT Ratio (p')	(TP+TN)/Total	0.771428571
Misclassification rate=	(FP+FN)/total	22.86%
		(The sample selected is
Sample size(n)=	35	35 companies out of 40)
Step 1: Formulating Hypothesis		
	H0	p≥0.8
Step 2: Selecting Test	H1	p<0.8
	i) Testing for Proportion	
	ii) Sample is large (since it is	Hence, Z test for
	greater than 30)	proportion
Step 3: Calculate Statistics		
	Z-cal=	-1.010152545
Step 4: Make decision	Z-Cri=	-1.644853627
Since, Z-Cal > Z-Cri for a left tailed		
test,we accept the null hypothesis		
i.e. The accurary rate of Altman Z-		
score is above 80%		
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Merton Default To Distance Model:-

TP	27	
TN	2	
HIT RATIO	0.828571429	
Misclassification rate=	(FP+FN)/total	0.171428571
	Sample selected is 35 out of 5	
Sample size(n)=	companies	
Step 1: Formulating Hypothesis	H0	p≥0.85
	H1	p<0.85
Step 2: Selecting Test	i) Testing for Proportion	
	ii) Sample is large (since it is	
	greater than 30)	
	Hence, Z test for proportion	

Step 3: Calculate Statistics	Z-cal=	-0.734993936
	Z-Cri=	-1.644853627
	Since, Z-Cal > Z-Cri for a left tailed test,we accept the null	
Step 4: Make decision	hypothesis i.e. The accurary rate of KMV is above 80%	

we have assumed the proportion to be 85% since the number of accurately predicted companies are more.

Research Methodology:-

Altman Z Score and KMV model were used to predict the financial health of the Indian companies and their probability of getting bankrupt. While the Altman Z Score provided us with a score which could be classified into three different categories, the KMV model provided us with a percentage which is the probability of the firm defaulting. The higher the Z-score, the better the health of the company whereas for the KMV Merton model, a smaller distance to default meant that a higher probability of the company going bankrupt.

For our research work we have selected 40 Indian companies (not any sector specific) and collected their financial statements for the year 2015-2016 from various sites like screener.com, moneycontrol.com etc. Financial ratios were calculated using the values from these financial statements. Apart from the financial data, the opening and closing prices of the stock prices were collected from Bombay Stock Exchange website. The market capitalization was calculated by taking the shareholding pattern from moneycontrol website and was multiplied by the closing price at year end which was again picked up from the Bombay Stock Exchange data. The extracted data was then put into the formula given by Edward Altman for the selected companies to arrive at the Altman Z-score. For the KMV Merton Distance to Default model, the values for market value of asset and asset volatility was generated simultaneously by running a macro on solver using excel. This gave a distance to default value which was then converted to a probability.

Altman Z Score model

Z-scores are used to predict corporate defaults and control measure for the financial distress status of companies. It is given by :-

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

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

The Zone of discrimination of the scores are as follows,
Z > 2.99 -"Safe" Zones
1.81 < Z < 2.99 -"Grey" Zones
Z < 1.81 -"Distress" Zones
If a company's Z score is less than 1.81, the chances of that company going bankrupt within two years is high.

Kmv Merton Model

The Merton distance model produces a probability of default for each firm in the sample at any given point in time. To calculate the probability the face value of the firm's debt from an estimate of the market value of the firm and then its divided by an estimate of the volatility of the firm.

The resulting 'Distance to Default', is then substituted into a cumulative density function to calculate the probability that the probability of the value of the firm will be less than the face value of debt. The Merton model makes two particularly important assumptions. The first Is that the value of a firm follows geometric Brownian motion,

$dV = \quad Vdt + vVdW$ (1)

where V is the total value of the firm, is the expected continuously compounded return on V, v is the volatility of firm value and dW is a standard Weiner process. The second critical assumption of Merton model is that the firm has issued just one bond maturing in T periods.

The Merton model stipulates that the equity value of a firm satisfies: $E = V\ (d\ ) - \quad e\text{-}r^*T\ N(D2)$ (2)

Where $d1 = (\ln(V/K) + (r + {}^2/2) * T)/(\ * T^{0.5})$ (3)

And $d2 = d1 - \quad * T^{0.5}$ (4)

E = Theoretical value of a company's equity
V = value of company's asset in period t
K = value of company's debt
T = future time period
r = risk-free interest rate
N = cumulative standard normal distribution, formula: NORMDIST(value)
e   = exponential term, formula: exp(-r*t)
= standard deviation of stock returns

Under Merton's assumptions the value of equity is a function of the value of the firm and time, so it follows directly from ITO's lemma that:

$e = (V/E)\ N(D1) * (\ )$

The first step in implementing the Merton DD model is to estimate e from either historical stock returns data or from option-implied volatility data. The second step is to choose a forecasting horizon and a measure of the face value of the firm's debt. For example, it is common to use historical returns data to estimate e, assume a forecasting horizon of 1 year (T = 1), and take the book value of the firm's total liabilities to be the face value of the firm's debt. The third step is to collect values of the risk-free rate and the market equity of the firm. After performing these three steps, we have values for each of the variables in Equations (2) and (5) except for Vf and y, the total value of the firm and the volatility of firm value, respectively. The fourth, and perhaps most significant, step in implementing the model is to solve Equation (2) numerically for values of Vf and y. Once this numerical solution is obtained, the distance to default can be calculate:

$DD = (\ln(Vf/K) + (- \quad {}^2) * T)/(\quad *T^{0.5})$

EDF(Estimated default frequency)=NORMDIST(-d1). (Alexandros Benos, 2007)

Data Analysis:-
Altman Z- Score:-

Name of companies	Working capital/Total assets(A)	Retained Earnings / Total assets (B)	EBIT/ assets (C)	Total
electrosteel steels	0.182583151	0.259758198	0.027220689	
jaypee infrastructure	0.020568704	0.251008566	0.03420551	
era infra	0.164542338	0.514426454	0.047611268	
amtek auto	0.214350253	0.202251304	0.180644328	
ABG shipyard	0.276546237	0.292691744	0.247879375	
jyoti structures	0.583979328	0.013854812	0.083762742	
Monnet ispat	-0.031186096	0.038765396	-0.16002033	
jet airways	-0.197665723	0.179682685	0.057131555	
lanco Infratech	-0.116893918	0.077816922	0.027801958	
alok industries	0.259640888	0.155144626	0.128652431	
amit spinning industry	-0.814189189	1.301801802	0.211570946	
ang industries	0.32417292	0.210971356	0.028502977	
jenson & nicholson	-17.08216561	25.91464968	0.657324841	

usher agro ltd	0.419739448	0.049136179		0.195119719
ub engineering	-1.61829653	1.553512349		0.647187813
unity infra projecys ltd	0.748256771	0.015537639		0.146552957
nagarjuna oil refinery ltd	-0.001430729	0.852581936		0.008769838
Vimal Oils and Foods Ltd.	0.640552172	0.159441872		0.369842003
castex technologies	0.096267864	0.295056709		0.049923015
Jayaswal Neco Industries	0.140969798	0.210833249		0.004872716
orchid pharma	0.312144009	0.020736752		0.060309953
SEL Manufacturing Company Ltd.	0.450406434	0.073225626		0.048275047
Uttam Galva Steel	-0.11269209	0.038482823		0.070372015
visa steel	-0.223736871	0.150675788		0.043681521
jai balaji	0.101693802	0.241970539		0.175062089
Jaiprakash Associates Ltd.	0.369563053	0.230532202		0.074262752
Ruchi Soya Industries	0.068512018	0.146370535		-0.07698082
Ushdev International Ltd	0.592054521	0.209286961		0.020241917

Name of companies			Market value of equity/Total liabilities (D)		Sales/Total Assets (E)		ALTMAN SCORE	Z-
Ashapura Intimates Fashion Ltd.			0.690513736		0.349157606		0.155033613	
Shilpi Cable Technologies			0.403273797		0.213534293		0.073740961	
Alan Scott Industries			0.931034483		4.775862069		-0.25862069	
Nicco Corporation			-0.450694008		1.288726604		0.234318325	
KSK Energy Ventures			-0.004861182		0.648840777		0.008673189	
Jindal Steel & Power Ltd.			-0.097986278		0.379132214		0.038452062	
Adhunik Metaliks			0.42296173		0.931817341		1.383250139	
MBL infrastructures			0.561943741		0.326168114		0.050855237	
Opto circuits			0.711107499		0.520454499		-0.00891424	
Madhucon Projects			-0.147583869		0.231246741		0.009378535	
Zee Entertainment Enterprises Ltd.			0.407678719		0.474271915		0.21524075	
Bharati Defence and Infrastructure			-0.561172905		0.453434339		0.073278024	
electrosteel steels			0.78131721		0.479623948		0.888884613	
jaypee infrastructure			0.063749169		0.152981221		0.678673532	
era infra			0.006462509		0.167282454		0.930017793	
amtek auto			0.042980362		0.001711949		-0.594574758	
ABG shipyard			0.023381016		0.003080529		-0.059299678	
jyoti structures			0.019969701		0.41342833		0.865030749	
Monnet ispat			0.442580943		0.200270873		-0.04740212	
jet airways			0.32428633		1.059988863		0.943740277	
lanco Infratech			0.071740325		0.140135458		0.058702825	
alok industries			0.019042657		0.364455573		0.476455132	
amit spinning industry			0.046941766		0.005067568		1.576861568	
ang industries			0.199828242		0.551174999		1.443987422	
jenson & nicholson			1.716333019		2.554140127		21.50948134	
usher agro ltd			0.081102127		1.029768013		2.284504671	
ub engineering			0.028362969		0.301454182		-1.587300908	
unity infra projecys ltd			0.042750221		0.06882824		1.497075669	
nagarjuna oil refinery ltd			0.419752732		0		1.414809009	
Vimal Oils and Foods Ltd.			1.090673537		2.566542076		2.520246154	
castex technologies			0.021729784		0.108480255		0.484288201	
Jayaswal Neco Industries			0.061786556		0.41689971		0.898052988	
orchid pharma			0.084080475		0.221237442		0.474054769	
SEL Manufacturing Company Ltd.			0.506490949		0.359119162		1.143118481	
Uttam Galva Steel			0.039021236		0.680766645		0.383789514	
visa steel			0.041180459		0.133904427		-0.46630571	
jai balaji			0.014370477		0.344820699		-0.444436307	
Jaiprakash Associates Ltd.			0.045156333		0.183256057		0.729670961	1303

Ruchi Soya Industries	0.066405264		1.664414681		1.720710157
Ushdev International Ltd	0.022517845		1.963195427		3.027339675
Ashapura Intimates Fashion Ltd.	40.55288406		1.543447589		27.6887916
Shilpi Cable Technologies	0.4904819		1.613756389		2.918129705
Alan Scott Industries	6.639941379		0.310344828		-2.131207586
Nicco Corporation	0.011421386		0.027615225		-3.084108623
KSK Energy Ventures	0.327695646		0.005080344		1.075569074
Jindal Steel & Power Ltd.	0.082134383		0.238721879		0.57192505
Adhunik Metaliks	0.192622731		1.881050102		-3.38390242
MBL infrastructures	0.300692889		1.095057844		2.563313129
Opto circuits	0.120251357		0.038943294		1.66325298
Madhucon Projects	0.122397952		0.212623825		0.461530318
Zee Entertainment Enterprises Ltd.	0.84677261		0.680939338		3.045683131
Bharati Defence and Infrastructure	0.014315354		0.007066326		-1.534448166
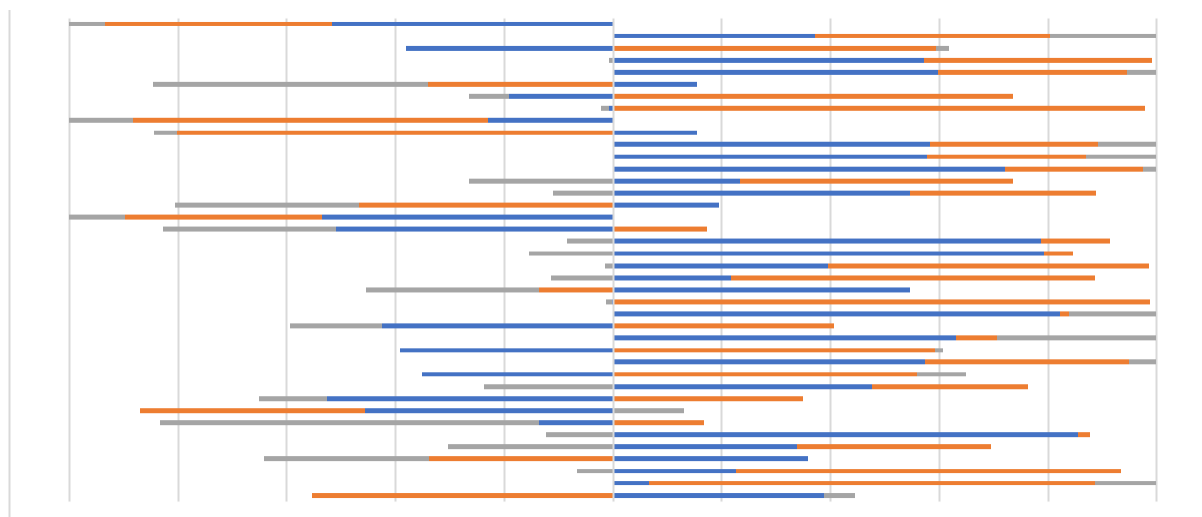
Ratios and Altman Z- Score
Bharati Defence and Infrastructure
Opto circuits
Jindal Steel & Power Ltd.
Alan Scott Industries
Ushdev International Ltd
jai balaji
SEL Manufacturing Company Ltd.
castex technologies

	unity infra projecys ltd
	jenson & nicholson
	alok industries
	Monnet ispat
	amtek auto
	electrosteel steels

-10	0	10	20	30	40

ALTMAN Z-SCORE   Sales/Total Assets (E)   Market value of equity/Total liabilities (D)

In Altman Z score column , safe zone is marked in Green, Grey Zone markings are intermediate.

The five financial ratios used to calculate Altman Z score for predicting insolvency have been utilized as yardsticks for evaluating the financial soundness of Indian public listed companies for the period 2015-2016.

The first ratio is the working capital divided by Total Assets as a measure is used to measure the operational efficiency of a company. A uniform working capital ensures better liquidity. It indicates the moderate use of current assets and current liabilities over the years. If a company has a very high net working capital ratio, it has more than enough current assets to meet all of its short-term obligations. From the sample size of 40 companies selected, companies such as, Monnet Ispat, Jet Airways, Lanco Infratech, Jenson Nicholson, Nagarjuna Oil Refinery ltd, Uttam Galva Steel, Visa Steel, Madhucon Projects, KSK Energy Ventures, Jindal Steel and Power Ltd have negative working capital to total assets ratio which means that the current liabilities exceed the current assets. It indicates that these companies may have incurred large outflow of cash or a very high increase in accounts payable because of large purchases from its vendors. It can be inferred that in the long term, these companies will have to struggle to make ends meet. This can be a warning signal of these companies. Whereas, the companies like Electro steel, Jaypee Infra, Era Infra have working capital ratio almost equal to zero which indicates that current assets will be almost equal to current liabilities. This indicates that the company's current assets might not be quickly converted into cash in the near future and this would decrease liquidity.

Secondly, to measure the profitability of assets of a company, Retained Earnings to Total assets ratio is computed. This ratio also tells that how much the company relies on debt for the funding of its total assets. A ratio of 1:1(100%) indicates the that long-term growth of a company is financed using more of debt and less of equity. A positive ratio indicates the company is more able to continually retain its earnings. Jenson Nicholson and UB Engineering has a Retained Earnings to Total assets ratio implying that the company was able to generate high profits and reinvested the surplus profits for future capital appreciation. Majority of the other companies have low Retained Earnings to Total assets ratio. A low ratio indicates that a company is using more leverage or debt to finance its assets which increases the risk of insolvency. Moreover, it indicates that the growth of a company may or may not be sustainable as it is financed using debt. Most of the companies in the sample have zero or negative.

EBIT to Total Assets Ratio indicates that how effectively a company is using its assets to generate earnings. EBIT is used instead of Net Profit to focus on operating earnings and keep aside the influence of tax and interest payments. This ratio is a pure measure of the efficiency of a company in generating returns from its assets without affecting the management's decisions. This ratio give a reliable picture of management's ability to pull profits from the assets and projects into which it has invested. A higher ratio indicates the efficient use of company's assets for generating income. In this study companies such as Visa Steel, Jai Balaji and Jai Prakash Associates Ltd have negative EBIT to Total Assets Ratio which shows that they are not efficient in generating income using their total assets.

Market Value Of Equity divided by Total Liabilities Ratio is a business ratio showing how business's assets can decline in value before the liabilities increase more in value than the assets and the firm ranges towards insolvency. The companies with Market Value Of Equity divided by Total Liabilities Ratio with more than 2 are the safest. The result shows that most ofthe companies in the Indian economy have negative or close to zero Market Value Of Equity divided by Total Liabilities Ratio like Amit Spinning Industry, Nicco Corporation and others. Decrease in the

value of this ratio means that the companies have kept their sales price very low and they are not reaping profits and their cost is relatively high. Ashapura Intimates Fashion Limited and Alan Scott Industries have their Market Value Of Equity divided by Total Liabilities with 40.55 and 6.63 respectively which is above 2 indicating that the companies are successful in maintaining a stable position.

Net Sales to Total Assets signifies how effectively a company is able to utilize its total assets to generate sales. A high ratio often reflects intensive use of assets which is ideally expected to 2:1. Companies like Vimal Oil and Foods limited and Jenson Nicholson have high sales to total ratio which means that the companies are intensively using their assets at disposal to enhance

their sales. Other companies have negative or almost zero which indicates that they have failed to utilize their assets and this has adversely impacted their financial health and soundness.

Present analysis reveals that the most companies out of the sample of 40 companies in the Indian scenario have been declared insolvent, which can be predicted using Altman Z Score. Most of the companies have a Z score less than 1.8 which means they are in the danger zone and have a high probability of getting bankrupt in the near future. Companies such as Jenson Nichol (Gupta, 2017) (Zielinski) (Daniel Miklos, 2015) (Ali Abusalah Elmabrok Mohammed, 2012) (Narendar V Rao, 2013) (Ray, 2011) (Miller, 2009) (Demirel, 2010) (Dr. SyedAzhar) (Adithya Narayanan R, 2018)son with a score 21.50, Ushdev international with a score of 3.02, Ashapuara Fashion ltd with a score of 27.68 and Zee Entertainment Enterprises with a core of 3.04 are in the safe zone and will not be in insolvent in the near future. But, due to the limitation of Altman Z Score which is that it is efficient in predicting insolvency for only one year, this result may or may not be true, since these companies are declared insolvent in the present. Companies such as Usher Agro Ltd with a score of 2.28, Vimal oil and Foods with a score of 2.52, Shilpi Cable Technologies with a score of 2.91 and MBL Infrastructures with a score of 2.56 are in the grey zone (between1.8 to 3.0), which means that they are intermediate and their insolvency cannot be predicted.

Z – Score Formula: - 1.2A + 1.4B + 3.3C +0.6D + 0.99E

Merton Default To Distance And Kmv Model:-

S.no	Companies		EDF(Expected Default)	S.no	Companies				EDF(Expected Default)
1	electrosteel steels		0.9622665	21	orchid pharma				1
2	jaypee inra		1	22	SEL Manufacturing Ltd.	Company			1
3	era infra		1	23	Uttam Galva Steel				1
4	amtek auto		1	24	visa steel				1
5	ABG shipyard		1	25	jai balaji				1
6	jyoti structures		1	26	Jaiprakash Associates Ltd.				1
7	Monnet ispat		0.9509607	27	Ruchi Soya Industries				1
8	jet airways		0.9757067	28	Ushdev International Ltd				0.99995003
9	lanco infratech		1	29	Ashapura Intimates Fashion Ltd.				1
10	alok industries		1	30	Shilpi Cable Technologies				0.00
11	amit spinning industry		1	31	Alan Scott Industries				0.94952834
12	ang industries		1	32	Nicco Corporation				1

13	jenson & nicholson		0.9429316	33	KSK Energy ventures			1
14	usher agro ltd		1	34	Jindal Power and steel			1
15	ub engineering		1	35	Adhunik Metalics			0.94820396
16	unity infra projecys ltd		1	36	MBL Infrastructures			0.81508119
	nagarjuna oil	refinery						
17	ltd		0.0	37	opto circuits			1
18	vimal oil & foods		0.4404349	38	madhucon projects			0.00019726
					zee entertainment enterprise			
19	castex technologies		1	39	ltd			0.00
	Jayaswal	Neco			Bharati	Defence	and	
20	Industries		1	40	Infrastructure Ltd.			0.00

In the Indian Scenario, the sample used for this research has varying means in distance to default for Merton Default to distance model and KMV Model. Studying each variable, insolvent companies have higher means in equity volatility, debt volatility and asset volatility.

Companies marked yellow in the following table, represent that there are 2 companies which actually have gone insolvent but, the calculation as per Merton Default Distance Model and KMV indicate that there is zero or less than 0.5 Expected Default Frequency (EDF) which implies that these companies will not default within one year.

Companies marked red in the following table, represent that there are 30 companies which actually have been declared insolvent and the calculation using the default model also indicates that there is EDF of 1 which implies the companies have defaulted within the period of one year that is in the year 2017.

And for the remaining 8 companies, the model fails to predict the correct the result.

In the end, it can be said that all models with result in lower means of distance to default (DD) for the companies that are actually defaulting and means that there is higher distance for the companies which are not defaulting.

Limitations to the study:
1. Our research has certain limitations which restrict our scope of study and for that some assumptions have been made to make data analysis better. Limitations are as follows:-
2. The companies selected are not sector specific. The selection was random and because of industry variation the predictions for some company were not accurate. For eg- Aviation industry is a sector where the debt level is usually high but it doesn't mean that the company is not profitable and is going to be bankrupt as in the case of Jet Airways and Zee Entertainment in the year 2015-16. Thus the model used do not consider the industry for its calculation.
3. Data for some companies specially private companies were not available thus making our sample size shorter.
4. The companies selected were for the ones which filed bankruptcy in the year 2015-2016 and didn't consider the companies which filed for bankruptcy before it and were still not cleared from NCLT by 2015-2016.
5. Altman Z Score doesn't use all the variables and gives the prediction for only 1 year thus restricting our long term analysis.

Conclusion:-
The prediction of financial distress becomes an important issue in developing countries like India. Although various studies have already been attempted to replicate and improve the initial insolvency model of Altman Z score in different industries worldwide. For the purpose of this research, three models are applied namely, Altman Z score, Merton Distance to Default Model and Moody's KMV Model. Merton Distance to Default and KMV are applied

together to calculate the Expected Default Probability (EDF). Altman Z score and KMV Model both are widely used to predict financial insolvency, but they largely differ in their prediction of insolvency, they both provide different accuracy levels depending on the different research situations.

The sample covers 40 companies of the Indian scenario out of which 35 were declared insolvent in the years 2017 and 2018; Jet Airways was declared in insolvent and remaining 4 companies were distressed as in 2019.

This paper assumes that corporate failure is a process commencing with poor top management decisions and can be tracked by the computation of various accounting ratios. The financial data for the period 2015-2016 was used for constructing the models and forecasting the default probability and compare the results from both the models.

Using Altman Z score, the study tries to examine the combined effect of financial ratios with the help of Multiple Discriminant Analysis (MDA). The study attempts to find whether Z score obtained using this model can predict insolvency or not. Computation of various financial ratio it is found that most of the companies are declared insolvent in the following year of 2017 and lie in the 'Danger or the Red Zone' (that is Z score <1.81).

Using Altman Z score, accurately predicted 27 companies as insolvent out of total sample of 40 companies selected for the research.

The second model used is KMV and Merton Default to Distance Model, using which it is possible to construct an accurate default forecasting model. Looking at the out of sample forecasting ability, it is comparatively easier to construct a model using Merton Default to Distance Model.

Merton Distance to default predicted 32 companies with a default probability of 1 hence, there are 32 companies that have shown the EDF as 1 and actually gone insolvent by 2017 (assuming the default period to be 1).

The study accepts the null hypothesis and henceforth, the accuracy for Altman Z score and Merton Distance to Default is 80 and 85% respectively.

In conclusion, during financial distress, it can be concluded that Merton Distance to Default Model is more accurate than Altman Z Score, since the default accuracy for Merton Default to Distance Model is higher than Altman Z score, moreover, Altman Z score. Hence, according to the empirical results, it can be recommended to use Merton Distance to Default Model and KMV Model to predict insolvency in the Indian companies. Both Merton Distance to Default Model and KMV Model are market-based models and they perform better because they gather more market information than any other model.

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