

Does Portfolio Comprising of Solvent Companies Consistently Provide Robust Performance? An Empirical Analysis

Authors: Yasmin Pardawala¹, Bhaskar Sinha²

ABSTRACT

This paper talks about identifying firms which are easily prone to bankruptcy and avoids including such stocks in the stock portfolio. The importance of risk, returns, profitability, value and growth strategies while creating a portfolio are highlighted in this paper. The univariate Z-Score and asset size are used for separating investible stocks from non-investible stocks. The performance of such a portfolio is tested over a time period for its robustness. The allocation of weights is done on the basis of market cap i.e. large cap is given a weight of 65 per cent to 97 per cent and the mid-cap is given a weight of 3 per cent to 35 per cent. This allocation is helpful for arriving at the number of shares to be purchased.

Keywords: Altman's Z-score, CAPM, Profitability, Risk-Reward Relationship

JEL Classifications: G11, G12, G15

¹ Yasmin Pardawala, MMS Finance Candidate, Rizvi Institute of Management Studies and Research, Mumbai (India), yasminpardawala@gmail.com

² Bhaskar Sinha, Assistant Professor, Finance, Rizvi Institute of Management Studies and Research, Mumbai (India), bhaskarsinha@rmi.rizvi.edu.in

INTRODUCTION

The alarming rise in the Non-Performing Assets (NPA) from 2015 onwards for the Indian banks is a result of the inability of businesses to repay the loan taken from these banks. This created a need to implement the Insolvency and Bankruptcy Code (IBC) 2016 in India wherein the defaulting companies would be referred to the National Company Law Tribunal (NCLT). The end result of this process would either be a restructuring of the stressed assets or liquidation of the company under trial.

Imagine, as an investor, holding shares in a company that is bound to undergo the IBC process. Thus, it has become extremely important to be wary while selecting a company for investment. Altman's Z-Score³ is one such indicator which can be used as a predictor of bankruptcy. It accurately predicts bankruptcy two years before the company becomes bankrupt.

This paper helps in forecasting the early bankruptcy of the firm and doesn't include such risky firms in its portfolio. The Z-Score is arrived at by using financial ratios calculated from data obtained from the Balance Sheet, Income Statement and Cash Flow Statement of companies listed on the Bombay Stock Exchange (BSE). The calculations and stock-portfolio creation are done using Microsoft Excel software.

INDIA: ECONOMY AND MARKETS

India is a country in the South East part of the Asian continent. It is a member of various organisations such as WTO, ASEAN, G-33, BRICS, IMF to name a few. It is one of the fastest growing economies and ranks sixth in the world on GDP (2018).

India's foreign exchange reserves stand at USD 399.22 billion as of 01.03.2019 while its gold reserves are at 598.60 tonnes as of January 2019 which is a strong indicator of its financial health in case a financial crisis has to strike an emerging economy like India.

As per the Financial Stability Report released by Reserve Bank of India (RBI) in December 2018, the Gross Non Performing Assets (GNPA) have fallen from 11.5 per cent in March 2018 to 10.8 per cent in September 2018 and are further projected to reduce to 10.3 per cent by March 2019.

³ Edward Altman in his paper on *Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy* published in 1968 in *The Journal of Finance* has briefly touched upon the use of z-score as an indicator of bankruptcy.

This quick recovery can be sighted as a result of the Prompt Corrective Action (PCA) framework executed by the RBI which ensures that the financial health of the banks can be restored. When the PCA framework was rolled out in April 2017, it looked at three parameters, namely, asset quality (NNPA), profitability (ROA) and Capital Adequacy Ratio (CAR) of the banks. If the Net Non-Performing Assets of a bank crossed 6 per cent, if a bank registered negative Return on Assets for previous two consecutive years and if the CAR fell 250 bps below RBI's prescribed rate then such a bank would be subject to PCA.

As of November 2018, RBI relaxed the ROA parameter. When a bank falls under PCA, depending on its risk threshold certain mandatory and discretionary actions would be imposed on it. A few of such restrictions would be on distribution of dividend, branch expansion, payment of director's fees and actions related to market risk, capital related, credit risk to name a few.

There were a total of 11 Public Sector Banks (PSBs) which were under the PCA quarantine and with help from Government's recapitalisation and RBI's ROA relaxation, 6 of these PSBs have managed to be out of PCA. The Government has so far transferred ₹1.9 trillion of the ₹2.11 trillion announced by it under the recapitalisation plan.

The Twin Balance Sheet (TBS) problem which is a result of the inability of the borrowers to repay the banks in time which in turn results in the standard assets (loan) of the banks to turn sub-standard and ultimately into NPA. The banks thus face a liquidity crunch and are unable to offer fresh loans. Such NPAs are then referred to the NCLT to be recovered through the IBC process.

Till date, 1322 cases have been referred to the NCLT which have either seen liquidation or restructuring. The stressed assets under IBC since 2016 are worth ₹3 trillion and the amount received by the creditors under IBC till date has been around ₹800 billion and a further of ₹700 billion is expected to be recovered in 2019. Some of the cases resolved under IBC and restructured are Bhushan Steel by Tata Steel (₹352 billion), Binani Cement by Ultratech Cement (₹7.9 billion) and Electrosteel Steels Ltd by Vedanta Ltd (₹5.3 billion).

India is part of the emerging economies and has seen tremendous growth in its stock markets over the past decade. India's Bombay Stock Exchange (BSE) is Asia's oldest and the world's fastest stock exchange established in 1875 as "Native Share and Stock Brokers". Its On-Line Trading System (BOLT) is highly applauded for its speed and

efficiency. It makes transacting on the BSE faster with an average rate of the transaction as six microseconds. The top three sectors on S&P BSE as of 01.03.2019 comprise of Finance Sector 42.28 per cent, IT sector 15.01 per cent and Oil and Gas sector 11.97 per cent in terms of market cap. BSE's index SENSEX is almost synonymous with India's stock market and is widely recognised by foreign participants.

KEY EVENTS ON BSE

The Indian stock market which today stands at 34000 plus SENSEX points has witnessed the following events since its inception:

- BSE was started in 1875 as Native Share and Stock Brokers Association.
- The present-day building of BSE was acquired in 1928 and became fully operational in 1930.
- The first ever IPO for the general public was announced by Reliance chief Dhirubhai Ambani in 1980.
- The most widely recognised index in India, the SENSEX, an index comprising of 30 stocks, was introduced in 1986.
- In 1991, under the new economic policy (NEP) a number of reforms were introduced to increase retail participation.
- In 1992, the Harshad Mehta scam was widely criticised and people lost confidence in the stock market.
- This scam led to the formation of the market regulator SEBI in 1992.
- BOLT was introduced in 1997 on BSE.
- In 1999 the Central Depository Services (India) Ltd (CDSL) was formed to enable book-entry transfer of securities.
- In 2003, T+2 settlement was introduced.
- In 2014, the market cap of BSE listed companies crossed ₹100 trillion.
- In 2015, BSE completed 140 years of existence.

There are five sections to this paper: 1. Introduction to Altman z-score 2. Ratios used from the literature cited 3. Calculation Methodology 4. Performance Evaluation 5. Limitations, Future Scope and Conclusion.

LITERATURE REVIEW

This paper emphasises on the use of Z-Score while selecting stocks of a company for investment. The Z-Score is a univariate score determined from multiple discriminant analysis. The Z-Score is based on five ratios which are most crucial in determining the solvency position of the firm. The weight assigned to each of these ratios further justifies the aggregate univariate Z-Score in terms of its importance in the determination of the solvency position of the firm. This paper further tests the performance of the stocks selected using a high Z-Score for the returns it generates. The Z-Score is of higher importance in this day and age because of the rise in non-performing assets in India due to which the defaulters are referred to insolvency courts for restructuring or liquidation. In this case, an investor is bound to lose if a firm undergoes liquidation. Thus, to safeguard the investment against such systemic risks, the Z-Score which acts as a predictor of bankruptcy protects the investor from the risk of firm failure.

Altman considered the following five ratios and gave them a weighted score which are as follows:

$$\text{Profitability (A)} = \frac{\text{Working Capital}}{\text{Total Assets}}$$

$$\text{Leverage (B)} = \frac{\text{Retained Earnings}}{\text{Total Assets}}$$

$$\text{Liquidity (C)} = \frac{\text{Earnings Before Interest and Tax (EBIT)}}{\text{Total Assets}}$$

$$\text{Solvency (D)} = \frac{\text{Market Value of Equity}}{\text{Total Liabilities}}$$

$$\text{Activity (E)} = \frac{\text{Sales}}{\text{Total Assets}}$$

$$\mathbf{Z = 1.2A + 1.4B + 3.3C + 0.6D + 1.0E}$$

A: A negative working capital is indicative that the firm is unable to meet its short term liabilities. Thus, this indicator will be negative which is a sign of worry.

B: This indicates the age of the firm as a younger firm will have low or no retained earnings as its cumulative profits will be low or zero. Also, the younger the firm, the higher is its chances of failure or shutdown.

C: EBIT indicates the amount of liquidity with the firm to repay its debts and other liabilities.

D: Indicates the market value of the firm as well as the sentiments of the market towards the firm.

E: Indicates the capability of the management in generating sales utilising the total assets of the firm.

Altman has drawn his work from Beaver⁴ to use ratios for predicting bankruptcy of a firm. Beaver carried out his study using six ratios from a list of thirty ratios which were shortlisted on the basis of predictive ability and frequency of them getting cited in other works. These ratios were able to predict bankruptcy at least five years before the bankruptcy would occur. Beaver used a sample of seventy-nine failed and non-failed firms each and classified them based on industry and asset size. The mean asset size of failed firms was \$6.3 million while that of non-failed firms was \$8.5 million. Beaver's study stated that a firm with a higher asset size had lower chances of failure as against the one with smaller asset size. This is because these assets could work as a shield if a firm was unable to repay its debt by liquidating these assets.

Beaver used the following six ratios from a set of thirty ratios for his study:

- $Cash\ Flow / Total\ Assets$
- $Net\ Income / Total\ Assets$
- $Total\ Debt / Total\ Assets$
- $Working\ Capital / Total\ Assets$
- $Current\ Assets / Current\ Liabilities$
- $No-Credit\ Interval$

These ratios were picked up from the set of ratios on the basis of their popularity and previous performance.

⁴ William H. Beaver published his paper on *Financial Ratios as Predictors of Failure* in 1966 in the *Journal of Accounting Research* which talks about using ratios to predict the failure of firms.

There is also a theory by Harry Markowitz (Markowitz, 1952) that states that an investor is often risk-averse. Thus, the investor would often look at earning the maximum expected return (mean return) at minimum risk (variance). This theory is also known as mean-variance theory. This theory popularly known as the *modern portfolio theory (MPT)* was published in 1952 by Harry Markowitz in *The Journal of Finance*.

Markowitz states that the risk gets minimized when the portfolio is diversified as compared to a non-diversified portfolio. Also, the diversification should be for the right kind and for the right reason. This means that the company-stocks that form a part of the portfolio should be from different sectors to further diversify the risk of the portfolio. In cases where one sector performs poorly, the other sector that performs well will help to achieve maximum expected returns.

A set of efficient portfolios can be plotted on the graph where x-axis plots the risk of the portfolio and y-axis plots the expected return of the portfolio. Any portfolio that does not appear on this curve is deemed to be undesirable for investment.

A risk-reward relationship can be determined as follows:

$$\frac{E}{R} = \frac{\text{Expected Return of Portfolio}}{\text{Risk}}$$

An investor would expect a higher return at the given level of risk or a lower risk at the given level of return. Investment decisions are often made based on this risk-reward relationship.

There is yet another theory by Robert Novy-Marx that states that profitable firms are less likely to have stressed assets and will have cash flow from operating activities which is higher than its net income. This paper was published in 2012 known as *The Other Side of Value: The Gross Profitability Premium* in the *Journal of Financial Economics*.

Profitability is measured as:

$$\text{Profitability} = \frac{\text{Revenue} - \text{Cost of Goods Sold}}{\text{Assets}}$$

Marx states that gross profitability helps in predicting the cross-section of returns. It refers to the comparison of one stock-return with the other stock-return or one portfolio-return with another portfolio-return.

In this paper, Marx also compares the performance of value-based strategies with growth based strategies. In value-strategy, the investor would sell an expensive stock

to purchase an inexpensive stock i.e. when the market value of the stock is lower than its intrinsic value. In growth-strategy, the investor would purchase a productive asset by selling an unproductive asset i.e. sell an unproductive stock to purchase a productive stock. It should be noted that firms with high book-to-market ratio are priced low and have high average returns. Also, value-firms generate higher average returns as compared to growth-firms.

The book-to-market ratio is as given below:

$$\text{Book to Market Ratio} = \frac{\text{Book Value}}{\text{Market Capitalization}}$$

The paper talks about profitability being a growth strategy. It further states that when both growth and value strategies are used together, the volatility of the portfolio reduces. Also, if the portfolio holds on to unprofitable but cheap stocks (growth-strategy) and profitable and less expensive stocks (value-strategy) is bound to outperform the conventionally created portfolio.

Marx had created a strategy wherein he ranked the non-financial stocks on the basis of value and profitability⁵. A higher of both the ranks are purchased and held year-on-year.

Returns are closely related to profitability and risk. Risk can be further measured using the CAPM (Sharpe, 1964) and the Fama French CAPM. While CAPM measures systematic risk using only one factor, Fama French (Eugene F. Fama, A Five-Factor Asset Pricing Model, 2014) have further extended the CAPM model using three and five factors for measuring risk.

A portfolio's performance may be measured using any of the stated models.

$$\text{CAPM} = R_f + \beta * (R_m - R_f)$$

CAPM = Capital Asset Pricing Model

R_f = Risk Free Rate of Return

β = Measure of Systematic Risk

R_m = Market Return

$(R_m - R_f)$ = Market Risk Premium

Fama French Five Factor Model is as stated below:

$$R_{it} - R_{Ft} = \alpha_i + \beta_i(R_{Mt} - R_{Ft}) + s_i\text{SMB}_t + h_i\text{HML}_t + r_i\text{RMW}_t + c_i\text{CMA}_t + e_{it}$$

⁵ Value is defined as book-to-market while profitability is defined as gross profits-to-assets.

R_{it} = Return on Security

R_{Ft} = Risk Free Rate of Return

R_{Mt} = Market Rate of Return

SMB = Return on a diversified portfolio of small stocks MINUS big stocks

HML = Return on diversified portfolios of high MINUS low book to market stocks

RMW = Return on diversified portfolios of stocks with robust MINUS weak profitability

CMA = Return on diversified portfolios of low MINUS high investment stocks

This model is an extension of CAPM and is more robust in measuring the risk-return relationship of the portfolio as it considers more than one factor that can affect a portfolio in any given situation.

Table 1: Summary of Literature Review

Author	Year	Inference	Relevance/Gaps in Literature
Edward Altman	1968	Helps in predicting bankruptcy of a firm/s at least two years before the occurrence of bankruptcy.	Cannot be applied to banking and financial services firm which have a complex nature as the z-score is arrived at on the assumption of normality of data.
William Beaver	1966	Helps in predicting the failure of a firm/s at least five years before the occurrence of a failure. Considers Cash flow-to-Debt relationship single best predictor of failure of a firm using the univariate statistical method.	A model which gives higher supremacy to a single basis of prediction may not work in the complex financial setup as the combined effect of a set of variables would be lost.
Novy Marx	2012	Uses both value and profitability for determining the return on investment i.e. return on asset or stock.	Though the value and growth strategies are both closely related and yet dissimilar in certain characteristics, these can be effectively used in determining profitability.
William Sharpe	1960	CAPM is a single-measure factor of systematic risk.	It is not the most robust asset pricing model as it considers only one factor for risk.
Eugene Fama and Kenneth French (Five Factor Model)	2014	This is an extension of CAPM and is based on five factors such as risk, size, value,	As compared to CAPM, this model is more robust as it considers several other factors

		profitability and investment.	apart from risk in identifying the stocks that should be picked for investment.
Harry Markowitz	1952	Formulated a set of efficient portfolios based on risk-reward relationship.	Markowitz stated that this could be made further robust by using probability and thus determining its results with higher accuracy.
Chung, Tan, and Holdsworth	2008	Stated that Altman's Z-score is an efficient predictor of failure of firms one year prior to the failure in New Zealand as compared to other models. Derived that ANN ⁶ based algorithmic analysis for arriving at the weights for each of Altman's five parameters is more robust than Altman's MDA. ⁷	Highly dependent on publicly available data on balance sheets and income statements. Thus, the risk of distorted data for firms nearing failure may be a possibility which can affect the results of the test conducted.
Bright Kpodoh	2009	Established that a correlation exists between corporate governance and corporate failure. Tested Altman's model in the telecommunication industry in Ghana.	While Altman applied this model only to manufacturing firms, Kpodoh extended the model's application to the telecom industry in Ghana. The model's predictability worked

⁶ Artificial Neural Network (ANN) system as stated by Hertz et al 1991 is an algorithm trained to collect large data and process it based on how the data units react with each other. By a genetic algorithm optimizer the model's predictive power is simulated and accordingly weights are assigned to each input.

⁷ Multivariate Discriminant Analysis(MDA) as stated by Edward Altman 1968 using five financial ratios for predicting failure of firm.

		Altman's Z-Score is widely used in predicting failure of firms, as high as 30% of the research carried out uses MDA (Z-Score) for prediction.	for this industry as well.
Pitrova	2011	<p>Stated that Altman's model could predict the failure of firms four years before the actual failure. However, when this model was applied to Czech firms it could predict failure accurately from one year prior to the actual failure.</p> <p>It also recognised healthy firms with 84% accuracy.</p>	This paper states that Altman's score predicts failure just one year prior to the failure. Thus, it can be concluded that the predictability of the Altman's model can vary across geographies and industries.
Onofrei and Lupu	2012	<p>Stated that each country needs to have its own model for predicting the failure of firms.</p> <p>The research stated that Altman's model worked only for stable economies, unlike Romania which was facing economic instability.</p>	<p>Failure to predict as per this research may be due to the shorter time period of the data as compared to the original Altman model.</p> <p>Failure in Romania was not always due to economic conditions. Firms closed business also due to political influence.</p>

METHODOLOGY

The stock-portfolio consists of only those company-stocks that have a Z-Score of three and above. The companies that fall under the BSE 500 index form the universe of stocks for the purpose of this research. Banking and financial companies are excluded from the scope of this study⁸. From this extensive list of companies (Z-Score three and above), only thirty companies are selected for the portfolio. The companies are further shortlisted based on their asset size rank and the top thirty ranks are picked up for the portfolio. Each of the thirty stocks is given a weight based on whether the company is a large cap or a mid-cap⁹. The exposure to each company is restricted to a maximum of five per cent of the total exposure. This portfolio is held for a year and its price performance is tested. The yearly return of the portfolio is compared with that of the index. At the end of every financial year, the existing portfolio is liquefied and a new portfolio is created using the same method.

⁸ The Z-Score works best for non-banking and non-financial companies. That is why such companies do not form part of this research paper.

⁹ For the purpose of this study the companies are only classified into large cap and mid cap. The companies with a rank of 1 to 100 on the market cap are treated as large caps while the companies with a rank of 100 and above on the market cap are treated as mid-caps.

Table 2: FY 2013

Large Cap = 65% Mid-Cap = 35%

Company Name	CD_Sector	Market Cap	Z Score	Asset Size	Asset Size Rank	Asset Size Cap	Equal Weights	No.of Shares
Bharat Petroleum Corporation Ltd.	Crude Oil	27343.2702	4.25	66971.53	13	Large	4.33%	1722
Tata Consultancy Services Ltd.	IT	307632.696	7.34	42685.81	23	Large	4.33%	278
Infosys Ltd.	IT	165880.26	5.10	42650	24	Large	4.33%	294
Wipro Ltd.	IT	107670.045	3.52	40591.5	26	Large	4.33%	1127
PTC India Ltd.	Power	1762.73955	3.24	3787.06	183	Mid	2.33%	1947
Coal India Ltd.	Mining	195270.2694	4.99	34037.12	35	Large	4.33%	785
ITC Ltd.	FMCG	244244.638	6.98	34017.43	36	Large	4.33%	1060
Mahindra & Mahindra Ltd.	Automobile & Ancillaries	50835.4068	3.41	27453.59	39	Large	4.33%	507
HCL Technologies Ltd.	IT	54082.5285	3.86	17780.07	55	Large	4.33%	548
Bajaj Auto Ltd.	Automobile & Ancillaries	51939.0213	5.71	12478.62	78	Large	4.33%	121

Cipla Ltd.	Healthcare	30490.1275	3.34	12156.71	80	Large	4.33%	563
Hindustan Unilever Ltd.	FMCG	100794.125	9.18	11307.69	83	Large	4.33%	459
Petronet LNG Ltd.	Inds. Gases & Fuels	10155	4.12	11082.82	86	Large	4.33%	3124
Bosch Ltd.	Automobile & Ancillaries	31673.023	3.64	10465.2	89	Large	4.33%	24
Hero MotoCorp Ltd.	Automobile & Ancillaries	30791.743	5.69	9641.65	93	Large	4.33%	141
Oracle Financial Services Software Ltd.	IT	21474.23937	3.02	9532.037	94	Large	4.33%	96
MRF Ltd.	Automobile & Ancillaries	5658.492	3.08	8257.34	106	Mid	2.33%	9
Lupin Ltd.	Healthcare	28153.13275	4.78	7045.73	116	Mid	2.33%	184
MMTC Ltd.	Trading	19925	6.35	6552.649	126	Mid	2.33%	836
Nestle India Ltd.	FMCG	51076.0845	7.57	6314.27	132	Mid	2.33%	25
Shree Cement Ltd.	Construction Materials	16262.9636	3.74	6066.35	135	Mid	2.33%	27
Titan Company Ltd.	Diamond & Jewels	22771.7109	5.06	5867.5183	136	Mid	2.33%	456

Asian Paints Ltd.	Chemicals	47138.9248	8.06	5646.17	139	Mid	2.33%	235
CG Power & Industrial Solutions Ltd.	Capital Goods	6010.855	3.02	5269.62	144	Mid	2.33%	4392
Godrej Consumer Products Ltd.	FMCG	26517.8775	4.81	4677.73	151	Mid	2.33%	300
Exide Industries Ltd.	Automobile & Ancillaries	10982	3.88	4548.35	155	Mid	2.33%	897
State Trading Corporation Of India Ltd.	Trading	815.7	4.63	4406.6	161	Mid	2.33%	715
Apollo Hospitals Enterprise Ltd.	Healthcare	11597.54336	3.06	4354.389	162	Mid	2.33%	139
Zee Entertainment Enterprises Ltd.	Media & Entertainment	20105.55	5.24	3995.7	174	Mid	2.33%	543
Motherson Sumi Systems Ltd.	Automobile & Ancillaries	11357.22	3.64	3981.9	177	Mid	2.33%	2120

Table 3: FY 2014

Large Cap = 65% Mid Cap = 35%

Company Name	CD_Sector	Market Cap	Z Score	Asset Size	Asset Size Rank	Asset Size Cap	Equal Weights	No.of Shares
Hindustan Petroleum Corporation Ltd.	Crude Oil	10489.06425	3.34	77993.17	13	Large	3.25%	2967
Bharat Petroleum Corporation Ltd.	Crude Oil	33283.3724	4.44	72127.29	15	Large	3.25%	1341
Tata Consultancy Services Ltd.	IT	416860.3275	7.62	57330.61	17	Large	3.25%	183
Infosys Ltd.	IT	187550.22	4.74	52170	20	Large	3.25%	241
Wipro Ltd.	IT	133805.16	3.97	45588.2	26	Large	3.25%	713
ITC Ltd.	FMCG	280708.194	6.99	39229.39	33	Large	3.25%	850
Mahindra & Mahindra Ltd.	Automobile & Ancillaries	57889.7308	3.20	31288.65	39	Large	3.25%	400
HCL Technologies Ltd.	IT	104758.5	4.85	25099.6	44	Large	3.25%	281
Coal India Ltd.	Mining	181848.0044	6.70	25041.59	45	Large	3.25%	689
Dr Reddys Laboratories Ltd.	Healthcare	43584.816	3.13	16722.7	57	Large	3.25%	76

Bajaj Auto Ltd.	Automobile & Ancillaries	60139.7671	5.16	14747.6	66	Large	3.25%	96
Sun Pharmaceutical Industries Ltd.	Healthcare	118752.252	4.26	14624.47	67	Large	3.25%	348
Tech Mahindra Ltd.	IT	41902.7425	4.15	14428.3	68	Large	3.25%	439
Chennai Petroleum Corporation Ltd.	Crude Oil	1020.04309	3.92	13942.2574	74	Large	3.25%	2960
Ambuja Cements Ltd.	Construction Materials	35442.7825	3.10	13900.85	75	Large	3.25%	987
Hindustan Unilever Ltd.	FMCG	130551.3855	9.85	12836.67	80	Large	3.25%	332
Petronet LNG Ltd.	Inds. Gases & Fuels	10275	4.20	11912.67	86	Large	3.25%	2880
Hero MotoCorp Ltd.	Automobile & Ancillaries	45388.8145	6.64	9991.32	94	Large	3.25%	88
MRF Ltd.	Automobile & Ancillaries	13834.8656	3.33	9796.96	95	Large	3.25%	9
Lupin Ltd.	Healthcare	41965.756	5.89	8798.96	100	Large	3.25%	211
ABB India Ltd.	Capital Goods	27254.578	3.20	8594.67	103	Mid	3.50%	254

Aurobindo Pharma Ltd.	Healthcare	14891.2775	3.01	8575.53	104	Mid	3.50%	804
Container Corporation Of India Ltd.	Logistics	18990.078	3.08	8049.88	107	Mid	3.50%	568
Shree Cement Ltd.	Construction Materials	25246.6318	3.74	7185.85	114	Mid	3.50%	37
Asian Paints Ltd.	Chemicals	52420.28	7.66	6719.87	122	Mid	3.50%	400
Cadila Healthcare Ltd.	Healthcare	21020.672	3.41	6332.6	129	Mid	3.50%	1048
Titan Company Ltd.	Diamond & Jewellery	23300.311	5.15	6097.59	131	Mid	3.50%	812
Nestle India Ltd.	FMCG	61514.0316	9.37	5819.5	135	Mid	3.50%	44
CG Power & Industrial Solutions Ltd.	Capital Goods	10009.1975	3.45	5586.76	139	Mid	3.50%	4833
Godrej Consumer Products Ltd.	FMCG	28991.868	4.64	5227.5	143	Mid	3.50%	479

Table 4: FY 2015

Large Cap = 65% Mid Cap = 35%

Company Name	CD_Sector	Market Cap	Z Score	Asset Size	Asset Rank	Asset Cap	Equal Weights	No. of Shares
Bharat Petroleum Corporation Ltd.	Crude Oil	58565.8646	4.54	69744.51	14	Large	2.60%	863
Hindustan Petroleum Corporation Ltd.	Crude Oil	22014.3363	3.78	67550.64	15	Large	2.60%	1596
Tata Consultancy Services Ltd.	IT	498890.6835	7.78	62761.83	16	Large	2.60%	182
Infosys Ltd.	IT	254465.68	4.89	61380	17	Large	2.60%	213
Wipro Ltd.	IT	154972.43	3.84	53242.6	23	Large	2.60%	733
ITC Ltd.	FMCG	260864.4475	6.21	44195.66	29	Large	2.60%	1044
Maruti Suzuki India Ltd.	Automobile & Ancillaries	111717.35	3.34	42567.2	30	Large	2.60%	63
Sun Pharmaceutical Industries Ltd.	Healthcare	211728.42	3.17	38535	32	Large	2.60%	214
Mahindra & Mahindra Ltd.	Automobile & Ancillaries	70208.051	3.10	32944.87	40	Large	2.60%	385

HCL Technologies Ltd.	IT	129499.63	4.65	29994.64	42	Large	2.60%	246
Coal India Ltd.	Mining	228904.8864	8.13	23501.45	45	Large	2.60%	638
Dr Reddys Laboratories Ltd.	Healthcare	59426.148	3.22	19111.7	52	Large	2.60%	65
Cipla Ltd.	Healthcare	57105.804	3.28	16802.16	56	Large	2.60%	326
Tech Mahindra Ltd.	IT	60477.556	4.33	16728.5	57	Large	2.60%	365
Bajaj Auto Ltd.	Automobile & Ancillaries	58376.05695	5.08	15562.32	63	Large	2.60%	114
Rajesh Exports Ltd.	Diamond & Jewellery	5795.952995	3.05	15526.5543	64	Large	2.60%	1129
Siemens Ltd.	Capital Goods	47109.48	3.51	13995.6	73	Large	2.60%	163
Hindustan Unilever Ltd.	FMCG	188851.915	12.55	13438.1	74	Large	2.60%	262
Bosch Ltd.	Automobile & Ancillaries	79704.19	6.11	11920.9	82	Large	2.60%	9
Petronet LNG Ltd.	Inds. Gases & Fuels	12858.75	4.85	11123.57	83	Large	2.60%	2633
Lupin Ltd.	Healthcare	90216.8975	7.56	11007.71	84	Large	2.60%	113
Hero MotoCorp Ltd.	Automobile & Ancillaries	52772.722	7.21	10448.16	85	Large	2.60%	87

Aurobindo Pharma Ltd.	Healthcare	35629.84	4.04	10225.88	86	Large	2.60%	371
United Spirits Ltd.	Alcohol	53200.9476	4.97	8930.631	95	Large	2.60%	318
Container Corporation Of India Ltd.	Logistics	30829.63125	3.67	8689.91	97	Large	2.60%	365
Shree Cement Ltd.	Construction Materials	39454.3838	4.38	7802.66	103	Mid	7.00%	57
Cadila Healthcare Ltd.	Healthcare	35620.864	4.44	7646.1	105	Mid	7.00%	1741
Asian Paints Ltd.	Chemicals	77575.3	9.54	7273.88	109	Mid	7.00%	759
Torrent Pharmaceuticals Ltd.	Healthcare	19646.2254	3.20	6496.91	117	Mid	7.00%	520
Bharat Forge Ltd.	Automobile & Ancillaries	29706.96995	4.68	6375.774	119	Mid	7.00%	943

Table 5: FY 2016

Large Cap = 97% Mid Cap = 3%

Company Name	CD_Sector	Market Cap	Z Score	Asset Size	Asset Rank	Asset Cap	Equal Weights	No.of Shares
Bharat Petroleum Corporation Ltd.	Crude Oil	59110.6992	3.91	75357.35	13	Large	3.34%	1016
Tata Consultancy Services Ltd.	IT	495661.85	7.34	75117	14	Large	3.34%	245
Infosys Ltd.	IT	279641.32	4.58	72327	17	Large	3.34%	249
Hindustan Petroleum Corporation Ltd.	Crude Oil	26601.07965	3.45	69579.29	18	Large	3.34%	1708
Wipro Ltd.	IT	139175.6175	3.56	58499.5	22	Large	3.34%	1071
ITC Ltd.	FMCG	263988.396	5.66	50031.28	27	Large	3.34%	1342
Maruti Suzuki India Ltd.	Automobile & Ancillaries	112316.82	3.84	41940	31	Large	3.34%	80
Mahindra & Mahindra Ltd.	Automobile & Ancillaries	71688.6976	3.01	35499.57	36	Large	3.34%	503
Sun Pharmaceutical Industries Ltd.	Healthcare	197208.837	3.44	34604.21	38	Large	3.34%	368

HCL Technologies Ltd.	IT	114827.716	4.75	25408.32	43	Large	3.34%	366
Coal India Ltd.	Mining	184437.712	7.99	21378.76	46	Large	3.34%	1045
Tech Mahindra Ltd.	IT	45976.015	3.66	20508.8	48	Large	3.34%	650
Dr Reddys Laboratories Ltd.	Healthcare	51775.394	3.16	17521.7	55	Large	3.34%	100
Bajaj Auto Ltd.	Automobile & Ancillaries	69625.3157	5.32	16486.5	58	Large	3.34%	124
Siemens Ltd.	Capital Goods	44163.58	3.63	16069.3	61	Large	3.34%	267
Cipla Ltd.	Healthcare	41150.148	3.22	15239.05	62	Large	3.34%	586
Petronet LNG Ltd.	Inds. Gases & Fuels	18806.25	3.27	14311.87	66	Large	3.34%	2433
Lupin Ltd.	Healthcare	66700.065	5.20	14236.14	67	Large	3.34%	205
Interglobe Aviation Ltd.	Aviation	31459.1661	3.47	14116.429	69	Large	3.34%	331
Hindustan Unilever Ltd.	FMCG	187812	12.38	13752	72	Large	3.34%	347
Hero MotoCorp Ltd.	Automobile & Ancillaries	58779.698	6.44	13533.74	73	Large	3.34%	101
MRF Ltd.	Automobile & Ancillaries	16268.244	3.88	13169.75	75	Large	3.34%	8

Ashok Leyland Ltd.	Automobile & Ancillaries	30891.98398	3.38	12773.7538	77	Large	3.34%	2730
Bosch Ltd.	Automobile & Ancillaries	65271.494	5.07	12581.6	78	Large	3.34%	15
Aurobindo Pharma Ltd.	Healthcare	43597.4	3.85	12558.7	79	Large	3.34%	411
Chennai Petroleum Corporation Ltd.	Crude Oil	2966.315088	3.83	10349.2281	87	Large	3.34%	1484
Cadila Healthcare Ltd.	Healthcare	32455.68	3.96	9654.3	90	Large	3.34%	938
Shree Cement Ltd.	Construction Materials	43274.4156	4.25	9091.49	94	Large	3.34%	24
Asian Paints Ltd.	Chemicals	83325.704	8.81	8724.95	98	Large	3.34%	345
United Spirits Ltd.	Alcohol	36317.735	5.87	8038.6	102	Mid	3.00%	540

Table 6: FY 2017

Large Cap = 97% Mid Cap = 3%

Company Name	CD_Sector	Market Cap	Z Score	Asset Size	Asset Rank	Asset Cap	Equal Weights	No. of Shares
Bharat Petroleum Corporation Ltd.	Crude Oil	85093.56875	3.53	91989.63	12	Large	3.34%	832
Tata Consultancy Services Ltd.	IT	478926.7	6.52	87311	13	Large	3.34%	293
Infosys Ltd.	IT	234375.68	3.96	79539	16	Large	3.34%	351
Wipro Ltd.	IT	125255.8175	3.34	62921.7	17	Large	3.34%	1398
ITC Ltd.	FMCG	340673.833	6.22	54215.95	23	Large	3.34%	1258
Maruti Suzuki India Ltd.	Automobile & Ancillaries	181933.86	4.40	50993.3	24	Large	3.34%	58
Mahindra & Mahindra Ltd.	Automobile & Ancillaries	76262.3614	3.01	39338.31	29	Large	3.34%	551
HCL Technologies Ltd.	IT	124566.774	4.50	31160.84	35	Large	3.34%	409
Mangalore Refinery & Petrochemicals Ltd.	Crude Oil	18691.46834	3.55	26404.621	40	Large	3.34%	3289

Tech Mahindra Ltd.	IT	44746.656	3.18	23707.9	41	Large	3.34%	782
Bajaj Auto Ltd.	Automobile & Ancillaries	81240.6275	4.90	20814.89	45	Large	3.34%	127
Coal India Ltd.	Mining	181752.9648	8.66	18885.4	48	Large	3.34%	1201
Lupin Ltd.	Healthcare	65247.168	4.36	17848.24	49	Large	3.34%	247
Interglobe Aviation Ltd.	Aviation	37977.63542	3.37	17140.763	51	Large	3.34%	339
Petronet LNG Ltd.	Inds. Gases & Fuels	30217.5	3.52	16179.46	56	Large	3.34%	1712
Hero MotoCorp Ltd.	Automobile & Ancillaries	64380.2845	5.84	15776.34	58	Large	3.34%	110
Cipla Ltd.	Healthcare	47650.535	3.17	15547.68	59	Large	3.34%	599
Hindustan Unilever Ltd.	FMCG	196506	12.16	14591	62	Large	3.34%	385
Ashok Leyland Ltd.	Automobile & Ancillaries	24061.88158	3.04	13799.5561	68	Large	3.34%	4214
Aurobindo Pharma Ltd.	Healthcare	39557.0385	3.53	13022.84	71	Large	3.34%	520
Bosch Ltd.	Automobile & Ancillaries	69474.73	5.61	12056.8	74	Large	3.34%	15
Chennai Petroleum Corporation	Crude Oil	5401.761035	4.19	11808.1125	76	Large	3.34%	946

Shree Cement Ltd.	Construction Materials	59297.68	5.02	10658.42	81	Large	3.34%	20
Titan Company Ltd.	Diamond & Jewellery	40954.214	4.36	10374.18	83	Large	3.34%	769
Asian Paints Ltd.	Chemicals	102749.504	8.81	10358.03	84	Large	3.34%	324
United Spirits Ltd.	Alcohol	31580.2285	5.34	8672.4	94	Large	3.34%	865
Motherson Sumi Systems Ltd.	Automobile & Ancillaries	52341.12	5.43	8225.2	96	Large	3.34%	1413
Torrent Pharmaceuticals Ltd.	Healthcare	26219.507	3.47	8080.51	97	Large	3.34%	235
Bharat Forge Ltd.	Automobile & Ancillaries	24231.63155	3.10	7677.025	100	Large	3.34%	658
Godrej Consumer Products Ltd.	FMCG	56880.2	5.88	7483.61	102	Mid	3.00%	375

PERFORMANCE EVALUATION

The performance of this portfolio is compared with the benchmark index. It can be seen from Table 7 that in all years except for FY 2016, the portfolio has outperformed the benchmark. The reason why the portfolio has earned lower returns as compared to the benchmark in FY 2016 is that the IT sector and the pharmaceutical sector gave negative returns from April 2016 to March 2017. The results are arrived as per the below calculations.

Table 7: Portfolio and Benchmark Returns

Particulars	2013	2014	2015	2016	2017
Portfolio Return	23.54%	45.33%	1.21%	18.17%	14.03%
BSE 500 Return	16.44%	32.97%	-8.93%	24.09%	11.00%

As observed in Table 7, the results obtained by creating a portfolio using stocks selected by Altman's Z-Score have proven to give better results than the market index. This shows that this strategy of selecting stocks can be practised for portfolio composition.

LIMITATIONS OF THE STUDY

The Z-Score by Altman can be used only for non-financial and manufacturing firms. The Z-Score does not work for the financial and banking firms as their business model differs from that of the other business models. Also, the Z-Score is highly dependent on the historical data and will not give robust predictions in case the financial statements of a company have been tampered with.

FUTURE SCOPE

While this research is limited to the study of manufacturing and non-financial firms, the study can be carried out for financial and banking companies by framing parameters relevant to their business model. This is because the prediction of failure or bankruptcy of any business is a helpful tool for the investors.

A bankruptcy predicting model can also be developed in lines with a particular sector, how the sector operates and based on its business model the parameters for Altman's Z-Score can be developed and the weights can be adjusted for each of the stated variables.

CONCLUSION

This paper helps in identifying firms which are nearing insolvency and thus selecting stocks of only those companies which are financially sound so that the return on investment can be higher as compared to the market benchmark. Hence, investments made using the Altman Z-Score can be a sound investing strategy.

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