CORPORATE BOND DEFAULT PREDICTION USING Z SCORE AND SENTIMENT ANALYSIS

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Abstract

Purpose – The main purpose of the paper is to predict the default of corporate bonds in the ongoing Indian market. Concurrently, it also focuses to describe the procedure to determine the probability of default of corporate bonds using both financial and non-financial variables.

Design – Z score and Sentimental Score are used for predicting the default of corporate bonds. A combined weighted average of Z Score and Sentimental score brings the prime score to predict the default of corporate bonds.

Findings – The combined Z Score and Sentimental score in this paper portrays high forecasting ability to determine the default of corporate bonds and outperforms existing individual Z score and sentimental models. The model is a combination of existing two models comprising of Z score and Sentimental score which anticipate and analyses the default of corporate bonds in qualitative and as well as quantitative manner with respect to financial and non-financial ratios.

Originality/value – Using both Z score and sentimental score model in this paper, Investors and banks can get caution indication on the solvency status of various companies in the Indian market and assist to assess the enormity nature of the defaulted installment. The prediction of default of corporate bonds from the Z score and Sentimental score would elevate banks to evaluate the credit risk of the companies and position the creditworthiness of the firm.

Keywords - Bonds, Z score, Sentiment Score, Vector normalization.

I. Introduction

A bond default occurs when the bond issuer is unable to make either interest or principal payment within the stipulated time period. Defaults occur when the bond issuer is not in a position to pay its bondholders. The ability of a company to acquire financing in the future is highly dependent on defaulting of a bond, a default is mostly a last resort and hence it is a sign of extreme financial distress. The bondholders will not be going to lose all of his or her principal when a bond default occurs. Let us take the example of corporate bonds, once the bond issuer liquidates its assets, it makes sure that their bondholders receive a considerable portion of their original principal. Thus, predicting
default of Corporate bond plays a remarkable role in determining whether the Company is in Financial distress or not.

Based on the assessment done by the India ratings credit rating agency [XVIII], banks have slowed down or stopped lending to the stressed companies due to an elevated risk of refinancing. 240 companies are into stressed and ERR (elevated risk of refinancing) classification which proclaims to have a significant risk in refinancing during the financial year 2017. These 240 companies possess about 5.2 trillion in the stressed category and another 6.7 trillion in an elevated risk of refinancing category. The India ratings provide a warning signal that out of 6.7 trillion, around 4.6 trillion went neglectful. [V] developed a model to give an early caution to the investors that whether is it feasible or not to invest in a specific company. A Z score model has been developed in this research paper to predict the default of companies in the Indian market. The impact of Textual sentiment on various aspects of firm-level, market-level and individual performance and behavior. This research paper also demonstrates about what is agreed and what not to be agreed.

Prediction of the probability of default of Corporate bond using Z score and sentiment analysis is carried out in this research paper. Before understanding the two techniques mentioned above, let us have an overview of the performance of Corporate bonds and the various types of risks associated with it. Most of the investors are fond of investing in Corporate bonds rather than Treasuries because the former instrument offers higher yield when compared to the latter one. Hence, they invest directly in the Corporate bonds or in an indirect way in the form of exchange-traded funds or mutual funds. There is always an inverse relationship between the bond price and bond yield. Whenever there is an increase in the bond price, there will be a fall in bond yield. Most of the times there will be a decrease in the bond yield when the investors tend to do their investments in safer instruments. This decision of investment is carried out due to decelerating economic growth [X]. If the rate of unemployment increases in the country, it leads to the recession which also ultimately leads to a decrease in the bond yield. Similar to the bond yield, when the interest rates of bonds increase, the price of bonds inclines to fall. The underlying concept of providing high yield by Corporate bonds indicates that there is a high risk associated to these Corporate bonds. Therefore, it is important for the investors
to assess the different types of risks involved in these Corporate bonds before investing in them.

The possibility that the issuer of a Corporate bond may fail to pay its debt obligation is called as Credit risk. Many credit rating agencies are available in India to check the credit worthiness of the company [XII]. Capitalization ratios and Interest coverage ratios are the two significant metrics to assess and analyze credit risk. Each company used to take debt in order to raise capital. The company will be paying annual interest for the debt that it has taken. The quantity of money that the company produces in order to pay this annual interest is measured by Interest coverage ratio. The company should be in a position to produce a good amount of earnings so that it has adequate funds to pay out its annual interest levied on debt and hence this ratio should always exceed 1. If the interest coverage ratio is higher [XIII], then the company is performing well and on the other hand, if the company maintains a lower ratio, it is not performing well, and it denotes that the company doesn’t generate enough funds to pay out its annual debt. The quantity of interest-bearing debt that the company possesses in relation to the valuation of its assets is called Capitalization ratio. There is an inverse relationship between this ratio and a Company’s performance. If this ratio is 1[X], then the financial leverage of a company is highly affected and on the other hand, if the ratio is as low as possible, then the financial leverage of the company is in a better position.

II. Literature Review

Today’s world is fully based on capital markets revolution. One can become rich if he is a good investor and also one can become poor if his investments are in an amateurish way. Hence many agencies came in order to help the investors to decide and invest their valuable money in good companies. The agencies that help the investors to decide and invest their money are usually called credit rating agencies. And some of them are still without believing any agencies they decide themselves and based on their self-evaluation, they try to invest in the companies. And the bankers which are directly involved in investing public money in the market world by consulting public are termed as investment bankers. Investment bankers may consider many parameters in order to the
analysis of any bond of a company. If those analyses are not correctly evolved or derived, then the entire results go wrong and thus the investor loses his money if he decided to invest in that specific company. Thus, in predicting the default of bonds of a company is very much important for any customer in order to prevent any fallacious situation.

[V] demonstrated a model which is used for predicting corporate default. This model is much helpful in giving an alarming signal well ahead to predict the corporate default. It plays a significant role in developing countries like India. The significant outcome of this research is that the newly developed Z score model has high predictive power which gives us a good chance of predicting the default in each sample of bad firms. [XI] enumerated that financial ratios are one of the best ways to predict the default of corporate Bonds and it helps to forecasts the expected stock returns. This paper also estimated High Loadings of SMB and HML factors can define the high probability of corporate default. [VI] evaluated conditional probabilities of corporate default over some years with the help of time series dynamics of explanatory covariates. This research elucidates that the default rates of firms depend importantly on the current leverage of firm and present state of the economy. The method implemented in this research paper is applicable for forecasting of discontinuous events over many future periods. [II] studied the development of the bankruptcy process in the United States in comparison to different countries. The Z score approach has been used in this research paper to carry out the same. The significant finding of this research is to evaluate the probability of default in the United States of America. The loss given default has also been explored in depth in this research. [XIX] tested the nature of the two-bankruptcy model to predict the performance by using the Altman Z score (the accounting ratio method) and the structural Distance to default model. The paper portrayed and analyzed the various ordinal factors such as rating stability, rating durability and bankruptcy ability to predict using the Z score and Distance to default.

[XX] established a model to predict the financial distress of the automotive supplier industry. In this study used the methodology called Choice-Based Sample Bias Test in which opted for financial distress rather than bankruptcy distress. It matched distressed firms and date of distressed for healthy firms in order to data gathering purpose. The simulation result proved that the choice-based sample bias is getting
increased when the ratio of financial distressed to performing firms also increases among the data. [II] developed a bankruptcy classification model. This model plays a significant role in inspecting business failures. The Zeta model which has been used in this research shows more precision when compared to existing failure classification model. [XVI] studied the magnitude of yield spreads between Treasury bonds and Corporate bond. The two important contributions that have been contributed are; a contingent claim model has been built which conforms to default risk in coupons. Next, it gives us a confirmation that the models developed in this research are capable of generating yield spreads which are inharmonious with the observed levels of practice. [XXI] enumerated the present literature on FDP using Z score model by creating a full summary and analyzing the FDP of current literature. The paper resulted that training sampling and trading sampling are the following paired groups for reviewing the FDP classified with cross-industry, balanced and imbalanced sampling. FDP is divided and reviewed by combining both qualitative and quantitative selection. [II] evaluated whether Ratio analysis can be used as an Analytical technique. To elucidate this assessment, prediction of Corporate bankruptcy has been taken as an example. The final outcome of this research is that conventional ratio analysis cannot be used as an analytical technique. In this research, a conclusion has arrived that if the ratio analysis is carried out a framework which is multivariate, it will give a higher significance when compared to the ordinary technique of sequential ratio comparisons.

The performance of sovereign bonds using textual analysis. This process of textual analysis is carried out with help of information obtained from media. For example, let us consider a situation where there is a huge concentration of news about a company in a pessimistic manner and remaining parameters remain constant, then the yield spread of bond pertaining to that company will increase. This increase in yield spread causes the bond price to fall. On the contrary, if there is an increase in the optimistic view about a company in the media then automatically the bond price of the company will start to increase when all factors remain constant. This increase in the price of the bond will tend to decrease the yield. A constraint of this study is that this methodology is highly impossible during non-emergency situations. During these situations there are very less important news in the media and its count would be less than
10 in a given year. Hence this methodology is much suitable during exigency situations. Credit ratings play an important role in providing information about financial markets to different people like intermediaries, regulators, investors, and issuers. An automated text analysis system. This system analyses the news coverage pertaining to the financial industry. Based on this news coverage, credit ratings are received for each firm. Based on the findings of this research paper, they arrived at a conclusion that if there is a greater news coverage about a company then it has a greater possibility to receive a poor credit rating, which in turn decreases the bond price. On the other hand, if there is a less news coverage about a company, then it doesn’t affect the credit rating.

The key attributes of this paper consist of two parameters and they are Z-score analysis and sentiment analysis. Both the analysis plays a major role in analyzing any financial position of a company. Z scores are demonstrated in terms of standard deviations from their means. It can also be defined as a measure of how many standard deviations above or below mean a raw score is present in the given sample. This Z score is also termed as the Standard score. The two main uses of the Z score are; in a given normal distribution, it provides an opportunity to determine the probability of a score. The second use of this Z score is that in the given different normal distributions, it provides a comparison between two scores.

The process of deducing whether a given context of writing is positive, negative or neutral is called Sentiment analysis. It is also known as opinion mining. Sentiment analysis plays a significant role when there is a need to get a wider public opinion about a certain topic. Next biggest advantage of sentiment analytics is that it helps to increase the sales revenue of a product. When the discussions that are happening are positive then it automatically increases the revenue and on the other hand, if there are any negative discussions, it creates a room to work on the negative part of the product and to improve its performance. Speaking in financial perspective, it helps financial professionals and investors to exploit the market and to administer their risk exposure.

The combination of Z score and sentiment analysis gave us the quantitative and qualitative aspect of defaults which enables to predict the default of corporate bonds in a more precise manner and outperforms the previous models. The fact why these two
analyses have been involved here is that none of the previous papers has come up with the thought of involving two analysis that is both Z-score and Sentiment Analyses. Either they are using only the Z score analysis method or sentiment analysis method to find the answer but not both. This can be taken as a major problem or gap in previous papers. And thus, to fill that gap and to achieve the objective of this research paper both quantitative methodology (Z score) and qualitative methodology (sentiment score) have been used to predict the default of corporate bonds.

III. Methodology

The exploratory research design has been implemented in this research paper. This research methodology had been implemented whenever there are scarcely research studies or no research study to predict an outcome. This research paper belongs to the above-said type. There were few papers which focused on predicting the default of corporate bonds using different quantitative methods. It is a similar case on the qualitative side too. In this research paper, prediction of default of Corporate bonds using both quantitative (Z score) and qualitative (sentiment analysis) methods had been carried out to achieve an outcome with higher efficiency.

To start the research, 50 non-financial companies had been selected which are currently present in the Indian market. The companies have been selected based on their performance over the past 5 years i.e. from 2013 to 2017. Out of the selected 50 companies, 25 companies have defaulted and 25 companies are solvent. The decision of default and solvent companies are taken based on the rating given by ICRA Ltd (Investment Information and Credit Rating Agency of India Limited). The ratings provided by ICRA focusses only on the companies within India rather than various instruments across different countries. It assesses the credit risk of Indian companies in a relative manner. The ICRA provides three types of credit rating scale namely

1. Long-term rating scale
2. Medium-term rating scale
3. Short-term rating scale
This research paper concentrates only on Corporate bonds and hence only Long-term rating scale has been taken into consideration for the classification of the companies. According to the rating given by ICRA, any company is said to be solvent which possesses ratings of A, AA, and AAA. The companies having this type of rating is said to have a very low risk and they have adequate capability to service the financial obligations. On the other hand, any company is said to be in a high risk of default when they possess ratings of B, C and D. The companies having this type of rating is said to have a very high risk and they don’t have enough resources to service the financial obligations. In this research paper, 25 companies which have ratings in series of A and 25 companies which have D ratings have been selected.

The year on which the company is assessed is noted for all the 50 companies. Now to calculate the quantitative output, which is a Z score, the financial variables for all the companies of corresponding years on which it had been assessed by ICRA has been taken. The financial variables that have been taken are listed below:

- Total Assets
- Working Capital
- Cash profit
- Net profit
- Depreciation
- Total Liabilities
- Operating profit
- Sales.

Prowessiq is the software which has been used to collect the data of the above financial variables. The executive summary option available in Prowessiq software consists of the significant variables present in the Income statement and Balance sheet of a company. Working capital is calculated using the formula Current assets – Current liabilities. Cash profit is calculated using the formula Net profit + Depreciation. The remaining financial variables can be directly taken from the Executive summary option available for each company in Prowessiq software. By using the values of the above financial variables, the following ratios are calculated
• Working Capital to Total Assets (WK_TA)
• Cash profit to Total Assets (CASHPROF_TA)
• Solvency ratio (SOLVR)
• Operating profit to Total Assets (OPPROF_TA)
• Sales to Total Assets (SALES_TA)

Solvency ratio is calculated using the formula

\[ \text{SOLVR} = \frac{\text{Net Profit} + \text{Depreciation}}{\text{Total Liabilities}} \]

All the above mentioned 5 ratios are calculated for all the 50 companies. With the help of this calculated data, determination of the Z score using the formula mentioned below is done

\[ Z = -3.337 + 0.736 \times (WK_{TA}) + 6.95 \times (CASHPROF_{TA}) + 0.864 \times (SOLVR) + 7.554 \times (OPPROF_{TA}) + 1.544 \times (SALES_{TA}) \]

This Z score had been calculated for all the 50 companies.

The sentiment score can be determined using the reviews of stakeholders of a company. In this research paper, reviews of each company from their employees is taken. The sentiment score is calculated using three components namely

1. Positive score
2. Negative score
3. Neutral score

For each company, around 5 reviews are taken and based on the nature of sentences, they would be classified under either one of the above three mentioned scores. Therefore, each company would be having specific values for all the three scores. Now, the sentiment score is calculated by summing up the positive score, negative score and neutral score.

\[ Z \text{ score and sentiment score individually for all the 50 companies have been calculated. The ultimate step of the research is to determine the final score using the Z score and sentiment score. In order to obtain the final score, a method called “vector normalization” has been used. This method is generally used when there is a need to} \]
obtain a weighted value for numbers having both a positive and negative sign. In this research paper, both positive and negative numbers are present due to solvent and default firms respectively. It is used to calculate the weights of each score towards the final score. It is calculated using the excel function SQRT (SUMPRODUCT()). This value is obtained for both Z score and sentiment score. Let us assume that the value for Z score is “a” and for sentiment score is “b”. The weighted Z score is calculated using the formula \[\frac{a}{a+b}\] and weighted sentiment score is calculated using the formula \[\frac{b}{a+b}\]. The Final score is determined by summing up the weighted Z score and weighted sentiment score.

IV. Data Analysis and Interpretation

![Pie chart showing percentage of sentiment reviews](image)

**Figure 1** Percentage of sentiment reviews

The above pie chart shows the positive, negative and neutral reviews towards those 50 companies. The words namely good, nice, excellent are considered for positive review which overall counted to 48. The words namely bad, poor, low, less,
worst is considered for negative review which counted to 45. The words namely ok, fair enough are taken into consideration for the neutral review which counted to 5 only.

Table-1 Signs and decision patterns

<table>
<thead>
<tr>
<th>Z Score</th>
<th>Sentiment Score</th>
<th>Total Score</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Invest</td>
</tr>
<tr>
<td>+</td>
<td>-</td>
<td>+</td>
<td>Invest</td>
</tr>
<tr>
<td>+</td>
<td>-</td>
<td>-</td>
<td>Do not Invest</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Do not Invest</td>
</tr>
<tr>
<td>-</td>
<td>+</td>
<td>-</td>
<td>Do not Invest</td>
</tr>
<tr>
<td>-</td>
<td>+</td>
<td>+</td>
<td>Invest</td>
</tr>
</tbody>
</table>

The above table shows the possibility of the corporate bond default yes or no based on the different combinations of Z score and the sentiment score interpretation. The above table says that 1) If both Z score and the sentiment score is positive, then the result is positive, 2) & 3) if the Z score is positive and the sentiment score is negative there might be a possibility of the both positive as well as negative, 4) If both Z score and sentiment is negative then the result is negative 5) &6) If the Z score is negative and the sentiment score is positive, there can be chances of both positive as well as negative result.

Table-2 Companies and their scores

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Z value</th>
<th>Sentiment score</th>
<th>Total score (Z value<em>0.836) + (Sentiment Score</em>0.164)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abir Infrastructure Pvt. Ltd.</td>
<td>-2.6541</td>
<td>-0.6000</td>
<td>-2.3170</td>
</tr>
<tr>
<td>Company Name</td>
<td>Value 1</td>
<td>Value 2</td>
<td>Value 3</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Adishakti Alloys Private Limited</td>
<td>5.2114</td>
<td>-0.6667</td>
<td>-4.4655</td>
</tr>
<tr>
<td>Adlabs Entertainment Limited</td>
<td>3.0451</td>
<td>-0.3333</td>
<td>-2.6000</td>
</tr>
<tr>
<td>Aircel Cellular Limited</td>
<td>2.2603</td>
<td>-0.4167</td>
<td>-1.9577</td>
</tr>
<tr>
<td>Alumilite Architecturals Private Limited</td>
<td>1.5567</td>
<td>-0.3333</td>
<td>-1.3559</td>
</tr>
<tr>
<td>Balprada Hotels and Hospitality Services Pvt Ltd.</td>
<td>3.7734</td>
<td>-0.6667</td>
<td>-3.2635</td>
</tr>
<tr>
<td>Bhatia Coke &amp; Energy Limited</td>
<td>1.2478</td>
<td>-0.3333</td>
<td>-1.0977</td>
</tr>
<tr>
<td>Ciemme Jewels Limited</td>
<td>2.6147</td>
<td>-0.3333</td>
<td>-2.2402</td>
</tr>
<tr>
<td>Coastal Energy Private Limited</td>
<td>5.5000</td>
<td>-0.3333</td>
<td>-4.6520</td>
</tr>
<tr>
<td>Dishnet Wireless Limited</td>
<td>1.3605</td>
<td>0.0000</td>
<td>-1.1372</td>
</tr>
<tr>
<td>Facor Alloys Ltd.</td>
<td>1.4198</td>
<td>0.0000</td>
<td>-1.1867</td>
</tr>
<tr>
<td>Gayatri Hi-Tech Hotels Ltd.</td>
<td>3.0117</td>
<td>-1.0000</td>
<td>-2.6815</td>
</tr>
<tr>
<td>High Tech Fablon Pvt. Ltd.</td>
<td>1.4848</td>
<td>-0.3333</td>
<td>-1.2958</td>
</tr>
<tr>
<td>Icomm Tele Ltd.</td>
<td>2.6635</td>
<td>-0.3333</td>
<td>-2.2811</td>
</tr>
<tr>
<td>Indian Steel Corpn. Ltd.</td>
<td>2.1628</td>
<td>-0.3333</td>
<td>-1.8625</td>
</tr>
<tr>
<td>Jayaswal Neco Inds. Ltd.</td>
<td>2.5477</td>
<td>-0.3333</td>
<td>-2.1843</td>
</tr>
<tr>
<td>M S Ramaiah Developers</td>
<td></td>
<td>-0.3333</td>
<td>-2.9190</td>
</tr>
<tr>
<td>Company Name</td>
<td>Z Score</td>
<td>B Score</td>
<td>R Score</td>
</tr>
<tr>
<td>-----------------------------------------------------------------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Maa Mahamaya Industries Limited</td>
<td>3.427</td>
<td>-0.3333</td>
<td>-4.1649</td>
</tr>
<tr>
<td>R K M Powergen Private Limited</td>
<td>-4.917</td>
<td>-0.3333</td>
<td>-2.9728</td>
</tr>
<tr>
<td>Sai Regency Power Corporation Private Limited</td>
<td>-3.491</td>
<td>-0.2500</td>
<td>-0.1122</td>
</tr>
<tr>
<td>Saisudhir Infrastructures Limited</td>
<td>-0.0851</td>
<td>-0.2500</td>
<td>-1.1808</td>
</tr>
<tr>
<td>Samruddha Resources Limited</td>
<td>-1.486</td>
<td>-0.6667</td>
<td>-1.3519</td>
</tr>
<tr>
<td>Sankalp Engineering and Services Private Limited</td>
<td>-0.0393</td>
<td>0.0000</td>
<td>-0.0329</td>
</tr>
<tr>
<td>Saravana Buildwell Private Limited</td>
<td>-1.337</td>
<td>0.0000</td>
<td>-1.1182</td>
</tr>
<tr>
<td>V3S Infratech Limited</td>
<td>-4.569</td>
<td>-0.2500</td>
<td>-3.8601</td>
</tr>
<tr>
<td>Aarti International Limited</td>
<td>0.690</td>
<td>0.7500</td>
<td>0.6999</td>
</tr>
<tr>
<td>Aditya Birla Fashion and Retail Limited</td>
<td>2.552</td>
<td>0.7500</td>
<td>2.2569</td>
</tr>
<tr>
<td>Agrocel Industries Private Limited</td>
<td>2.5508</td>
<td>0.3333</td>
<td>2.1869</td>
</tr>
<tr>
<td>Anugraha Valve Castings Limited</td>
<td>3.4335</td>
<td>0.3333</td>
<td>2.9246</td>
</tr>
<tr>
<td>Barbeque Nation Hospitality Limited</td>
<td>2.5781</td>
<td>0.5000</td>
<td>2.2370</td>
</tr>
<tr>
<td>Bata India Limited</td>
<td>1.2746</td>
<td>0.5000</td>
<td>1.1474</td>
</tr>
<tr>
<td>Canon India Private Limited</td>
<td>1.3924</td>
<td>0.7500</td>
<td>1.2870</td>
</tr>
<tr>
<td>Cargill India Private Limited</td>
<td>0.3233</td>
<td>0.7500</td>
<td>0.3934</td>
</tr>
<tr>
<td>Daawat Foods Limited</td>
<td>0.1171</td>
<td>1.0000</td>
<td>0.2620</td>
</tr>
<tr>
<td>ECIL Rapiscan Limited</td>
<td>0.5775</td>
<td>0.5000</td>
<td>0.5648</td>
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<tr>
<td>I D F C Ltd.</td>
<td>1.6263</td>
<td>0.7500</td>
<td>1.4825</td>
</tr>
<tr>
<td>India Infoline Ltd.</td>
<td>1.9324</td>
<td>0.6667</td>
<td>1.7247</td>
</tr>
<tr>
<td>India Motor parts &amp;accessories</td>
<td>1.5011</td>
<td>0.6667</td>
<td>1.3641</td>
</tr>
<tr>
<td>Indian Express Newspapers</td>
<td>1.5291</td>
<td>0.3333</td>
<td>1.3328</td>
</tr>
</tbody>
</table>
The above table shows the list of 50 companies with the calculation of Z score and sentiment analysis and it also shows the result of the companies, which is used to predict the creditworthiness of the company. If the final score is positive, the company bonds can be bought and at the same time, if the final score is negative, the company bonds are not advisable to buy. The important step in this analysis part is that, though both Z score and sentiment score had been taken for obtaining the result, the weightage for Z score is given 83% and the weightage for the sentiment score is given 17%. The above values had been arrived using Vector normalization method.

V. DISCUSSION

By using the below formula,

\[
-(3.337 + (0.736 \times \frac{\text{Working Capital}}{\text{Total Assets}}) + (6.95 \times \frac{\text{Cash Profit}}{\text{Total Assets}}) + (0.864 \times \frac{\text{Operating Profit}}{\text{Total Assets}}) + (1.544 \times \frac{\text{Sales}}{\text{Total Assets}}))
\]

Z score is calculated. Sentiment score is calculated by giving +1 for the positive review, -1 for negative reviews and 0 for neutral reviews. So once both the Z score and the
sentiment score is calculated, the final part of the calculation is to be done by giving each score a weightage and combine them to obtain the final score. Since the score are in both positive and negative range, to find the total magnitude, weightage is calculated by taking the vector sum product of those 50 company’s Z scores and the sentiment score. The Z score weightage is obtained as 83 percent and the sentiment score is obtained as 17 percent. The sentiment score obtained for all companies must be multiplied by 17 percent and Z score must be multiplied by 83 percent. The result is a combination of both Z score and sentiment score. The final score depends on combined weightage of Z score and sentiment score and hence results may vary at any time. Some of the results may be in the positive and some be in the negative. If the result is in positive, it implies that the company has a good record and it is a wise decision to invest in this company and at the same time, if the result is in negative, then it is not advisable to invest in this company. The magnitude of the score directly implies the confidence level to invest in that specified company. For example, if the two companies MS Ramaiah Developers and Redington India Limited are taken for analysis for the investment purpose, then the investor should select the company MS Ramaiah which has the positive score (by combining both Z score and Sentiment score) in the positive range. And there is another case like if the company Nezone Strips Limited which has the score of 3.2836 and the company IDFC Ltd which has the score of 1.4825, it is judged that an investor can invest in the former company more confidently than the latter one, since the value of the former is greater than the latter one though both are in the positive range.

VI. Conclusion

With a sample of 50 listed non-financial institutions from ICRA, a Z-score & sentimental score model for firms has been formulated to predict the default of corporate bond. Z score provides result based on analyzing the financial ratios of the firms. The sentimental score provides result based on the reviews and degree of expression of the public towards the activities of the firm.

The combined value of Z score and sentimental score works as a quantitative and qualitative model to bring out the performing nature of the firms with respect to the
financial ratios and opinion of the firm by investors and employees. The final score (weighted Z score and weighted Sentimental score) exhibited a predictive power to determine the default nature of the firms (50 samples) in terms of its ability to payback its investors. Moreover, the model uses sentimental analysis to enumerate the qualitative aspect of repayment with the weight of 20 percent (50 samples). The Z score has about 80 percent (50 samples) of contribution in predicting the default. The Final score outcomes with an accuracy of 90 percent with a sample of 50 non-financial institutions. The incorporation of both financial and non-financial variables leads to the more precise accurate prediction of default of corporate bonds. This combined model of Z score and the sentimental score has outperformed the models which have been analyzed separately. This model helps the investors and banks to forecast the creditworthiness of the firm with the accuracy of 90 percent with 50 samples.

The constraint of this model is the high performing nature of the firm with respect to financial ratios, as Z score arrives through financial ratios which proportionally affect the predictive power. If the firm is strong financially, the contribution of Z score which is about 80 percent produces high Z score and affects the contribution of sentiment score towards the final score. On the other hand, if the firm is operating in very bad condition, automatically the Z score leads to high negative value. This high negative Z score value almost nullifies the effect of sentiment score towards the final score.

The future research would be to predict the default of corporate bonds with numerous financial variables of the firm. Z score must be developed for a period of financial crisis and recession by studying the effect of the crisis on the financial variables of a firm. The Z score can also be strengthened by adjoining with credit risk models and interpret with large samples to analyze the creditworthiness of the firm with respect to current market scenario and hierarchy of the firm for more accuracy. The Sentimental score of a firm with industry affiliation (ISO) provides us explicit score to enumerate the default nature of the firm. The further research to improve the accuracy of the prediction can be brought by adding new quantitative and qualitative techniques.
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