Financial Distress Prediction using Machine Learning

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Abstract—Financial distress prediction is a crucial area of research in the field of finance, and the use of machine learning techniques has gained considerable attention in recent years. In this study, the primary focus is to predict financial distress of Indian automobile sector using machine learning techniques. The study considers data from the companies that are performing well and the companies that has faced bankruptcy or insolvency. The study focuses on three types of machine learning models: random forest, decision tree and XGBoost. By using machine learning algorithms to predict financial distress, investors can make more informed investment decisions and policymakers can design better policies to mitigate the impacts of financial distress on the sector. Overall, this study demonstrates the potential of machine learning techniques in predicting financial distress in the automobile sector, and provides valuable insights for future research in this area.

Keywords—financial distress, financial distress prediction, bankruptcy prediction, insolvency, Indian automobile

I. INTRODUCTION

In the current scenario, financial management has much greater significance. The systematic financial management begins with proper collection of funds and ends with effective use of those funds by generating ROI with enhancing market value of the share. The proper financial management leads to longer survival of the entity. The longer survivals depend on year-on-year performance of the entity. If the entity's financial structure is not taken proper care, the unit grows weak leading toward the end of corporate failure. Bankruptcy is a legal status by which a person or an entity declares that it is unable to pay off its debts to creditors. Financial distress is a stage where the entity faces before declaring bankruptcy. Financial distress is the condition where the entity or the individual cannot be able to generate sufficient revenues or income, making it unable to meet the financial obligations. In India, Bankruptcy is governed by the Insolvency and Bankruptcy Code, 2016(IBC), which replaced the earlier laws on bankruptcy and insolvency in India. The IBC is a legal framework in India to insolve resolution of corporate entities, partnerships and individuals.

II. BACKGROUND

Machine learning (ML)

Machine learning is the process of using mathematical models of data to help a computer to learn without direct instruction. It's considered as a subset of Artificial Intelligence (AI). Machine Learning uses algorithms to identify patterns within data and those patterns are then used to create a model that can make predictions Machine learning algorithms are used in a wide variety of applications, such as in medicine, finance, speech recognition, and computer vision, where it is difficult or unfeasible to develop conventional algorithms to perform the needed tasks.

Bankruptcy

Bankruptcy is a legal process through which individuals or businesses can seek relief from their debts when they are unable to repay them. Bankruptcy is a serious financial condition that can have significant consequences for individuals, businesses, creditors, and the economy as a whole. Bankruptcy can occur for a variety of reasons, including a sudden loss of income, unexpected expenses, or poor financial management. It can also be the result of broader economic factors such as a recession or industry downturn. Bankruptcy prediction is the process of using financial and other relevant data to predict the likelihood of a company or individual filing for bankruptcy in the future. The prediction is usually based on various financial ratios, such as liquidity ratio, solvency ratio, profitability and activity ratios, as well as other factors such as industry trends and economic conditions. Financial Distress is a stage where the company experiences before declaring bankruptcy. Insolvency is a state of financial distress in which a company or person is unable to pay their bills. It can lead to insolvency proceedings, in which legal action will be taken against the insolvent person or entity assets may be liquidated to pay off outstanding debts.

Bankruptcy prediction models

The bankruptcy prediction models are statistical models that aim to predict the likelihood of a company or an individual to file for bankruptcy. These models use different kinds of financial and non-financial ratios to predict the probability of bankruptcy with a certain time frame. Some the prediction models are,

1. Altman Z-score method

In 1968, Professor Altman developed a bankruptcy prediction model. The Z-score is a formula which combines 5 financial ratios to predict the probability of a company going bankrupt within two years. The Z-score formula gives each of these ratios a important factor, which reflects the relative importance of each ratio in predicting bankruptcy. The formula is as

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

where,

A = Working Capital / Total Assets
B = Retained Earnings / Total Assets
C = EBIT / Total Assets
D = Market Value of Equity / Book Value of Total Liabilities
E = Sales / Total Assets

2. Springate Method
Developed by Gordon Springate in 1978, this model selects four out of nineteen common financial ratios to determine the likelihood of entity failing. At the calculation, if the companies with Springate score lower than 0.862 are classified as "failed companies" and if the companies scores more than 0.862 then the companies are classified as not distress (healthy). The formula to calculate Springate score is

$$S = 1{,}03X1 + 3{,}07X2 + 0{,}66X3 + 0{,}4X4$$

where,

X1 = Working Capital / Total Assets
X2 = Net Profit Before Interest and Taxes / Total Assets
X3 = Net Profit Before Taxes / Current Liability
X4 = Sales / Total Assets

3. Zmijewski Method
The Zmijewski score is another model for predicting bankruptcy of enterprises based on metrics like performance, leverage and financial liquidity. The ratios which are included are summarized in this model with the following formula

$$X = -4{,}3 - 4{,}5X1 + 5{,}7X2 - 0{,}004X3$$

where,

X1 = Earnings after Tax / Total Assets
X2 = Total Debt / Total Assets
X3 = Current Assets / Current Liabilities

III. METHODOLOGY

1. Sample Data
The objective of the research is to predict whether the entity will go bankrupt or not. TO proceed, collect the financial ratios and non-financial ratios of Automobile and automobile related companies from its balance sheet, income statement, cash flow statement market share and other relevant variables for the past 3 years.
The Financial ratios are
  i.   *Current Ratio=Current Assets/Current Liabilities*
  ii. *Debt-to-Equity Ratio = Total debt / Shareholder's equity*
  iii. *Return-on-Assets = Net Income / Total Assets*
  iv. *Return-on-Equity = Net Income / Shareholder's Equity*

2. Data Preprocessing

Preprocess the collected data by cleaning, formatting and transforming to suitable format for the machines to understand. This also includes removing missing values, punctuation, and handling outliers. Putting together all the collected data and randomize it. This helps to make sure the model is evenly distributed and the ordering does not affect the learning process.

Visualize the data to understand how it is structured and understand the relationship between various variables present in the dataset. Splitting the dataset into two set – a training set and a testing set. The training set is the set for the model to learn and the testing set is to check the accuracy of the model after training.

3. Choosing a model
A machine learning model determines the output you get after running a machine learning algorithm on the collected data. It is important to choose a model which is relevant to the task at hand. Since this is prediction-based research, use models such as Linear Regression, Decision Tree etc.

4.Train the Model
Predicting the financial distress comes under supervised algorithm. The main goal of a supervised algorithm is to take some data with known values and to create a model with those values. Since this is a financial related, the companies or entities which already faced bankruptcy or insolvency are considered as the training data (data with known values). The algorithm does the learning and the model contains the learned values. The learned values include

1. Distress value more than 2.9
No danger of bankruptcy and the company is financially safe.
2. Distress value from 2.77 to 2.90
The company is on alert to work for the betterment in terms of solvency of the company.
**3. Distress values from 1.8 to 2.77**
The values range depicts the signs of grey areas in the company. The company may go bankrupt within two years if no action is taken.
4. Distress value below 1.8
This value depicts the definite failure and closure of the company.

5. Evaluate the model
Evaluation is always good in any field. In the case of machine learning, it is considered as best practice. Evaluate the trained model by testing with previously unseen data using appropriate evaluation metrics such as accuracy, precision, recall and F1-score.
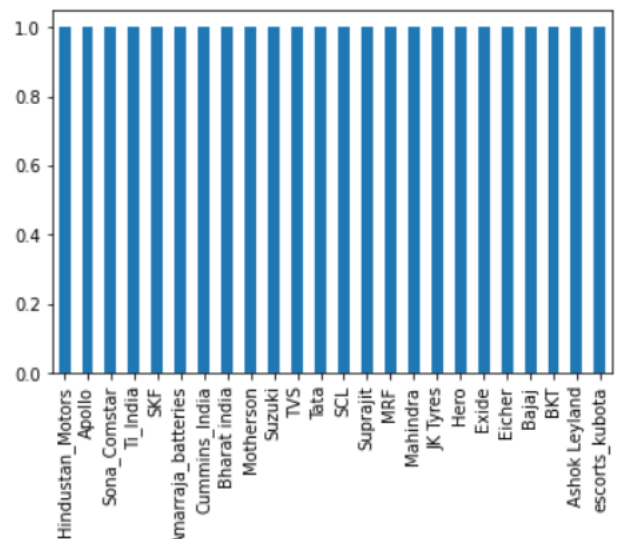
The list of bankrupted and non-bankrupted companies which collected for the study

IV. CONCLUSION

The purpose of this study is to predict the financial distress in automobile industries in India during 2020 – 2022 period. In predicting the distress values, three methods were considered as existed systems. Using machine learning algorithms such as random forest, decision tree and XGBooster to predict the financial distress using train data and test data. The accuracy of the study differentiates with each model and quality of the data used.

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