Bankruptcy Prediction

Overview of Project

The objective of the project is to use the features (i.e., financial parameters) given in the dataset to understand their impact in identifying whether a company will face bankruptcy in the future or not.

Business Understanding

FIRM DESCRIPTION:

CTBC Bank

CTBC Bank, established in 1966 is one of the largest private banks in Taiwan, headquartered in Taipei.

Number of employees

- 11,000 employees

Geographic footprint of the firm

- 152 branches in Taiwan
- 116 overseas branches across 14 countries such as the US, Canada, Japan, Indonesia, the Philippines, India, Thailand, Vietnam, Malaysia, Hong Kong, Singapore, China, Myanmar, and Australia.

Major product or service lines

- Institutional banking, capital markets, and overseas business
- Retail banking

Business Understanding

Revenues tied to each product or service line

Revenue breakdown (Note)

Unit: NT$ million

Revenue source	Amount	Percentage
Institutional banking, capital markets, and overseas business	53,286	51%
Retail banking	46,245	45%
Other	4,178	4%
Total	103,709	100%

Note: For fiscal year 2019 on a consolidated basis.

Business Understanding

LINE OF BUSINESS THAT IS THE SUBJECT OF OUR ANALYSIS:

- **Retail Banking: Loan services**

Small and medium-sized enterprises are provided with diverse loan services including land loan, factory loan, loan for purchase of machinery and equipment, refinancing, installment loans, policy-based loans, financial planning mortgages, unsecured term loans, and revolving loans, export loan, purchase turnover financing.

- **Global Risk Management Group:**

Responsible for regulatory compliance such as Credit Risk Management.

This includes maintenance of minimum regulatory capital as per central bank regulations and submitting reports for the same.

Business Understanding

STRENGTHS:

1. Good financial and market position: Largest bank in Taiwan and leading net revenue of NT$103.7 billion
2. Overseas expansion
3. Diverse products

WEAKNESSES:

1. Lack of AI infrastructure
2. Government Regulations
3. Lack of targeted digital marketing

SWOT ANALYSIS

OPPORTUNITIES:

1. Invest in innovative AI Technology to expedite and accurately determine processes such as sanction of loan, maintenance of capital, setting interest rates, etc.
2. Expand R&D of digitalization to create a social media presence targeting specific businesses to products.

THREATS:

1. Competitor banks which have invested in AI technology to increase profits
2. Political and economic uncertainties, such as the U.S.–China trade war

Data Analysis and Understanding

DATA DESCRIPTION

Dataset is from UCI Machine Learning Repository: https://archive.ics.uci.edu/ml/datasets/Taiwanese+Bankruptcy+Prediction

Deron Liang and Chih-Fong Tsai, deronliang'@'gmail.com; cftsai'@'mgt.ncu.edu.tw, National Central University, Taiwan

Company bankruptcy was defined based on the business regulations of the Taiwan Stock Exchange.

The data is collected from the Taiwan Economic Journal for the years 1999 to 2009

Data Analysis and Understanding

Number of records: 6819
Number of features/ variables: 96
Target variable of interest: Bankrupt?

data	6819 obs. of 96 variables

	Bankrupt.	ROA.C..before.interest.and.depreciation.before.interest	ROA.A..before.interest.and...after.tax	ROA.B..before.interest.and.depreciation.after
1	1	0.37059426	0.42438945	
2	1	0.46429094	0.53821413	
3	1	0.42607127	0.49901875	
4	1	0.39984400	0.45126472	
5	1	0.46502218	0.53843218	
6	1	0.38868035	0.41517662	
7	0	0.39092283	0.44570432	
8	0	0.50836055	0.57092237	

Showing 1 to 8 of 6,819 entries, 96 total columns

Data Analysis and Understanding

Dataset Fields and Description

[1] "Bankrupt."	Target Variable to determine if a company is bankrupt or not
[2] ROA.C..before.interest.and.depreciation.before.interest	Return on Assets before interest and depreciation before interest
[3] ROA.A..before.interest.and...after.tax	Return on Assets before interest and after tax
[4] ROA.B..before.interest.and.depreciation.after.tax	Return on Assets before interest and depreciation after interest
[5] Operating.Gross.Margin	Metric used to measure company's profitability including operating expenses like overhead
[6] Realized.Sales.Gross.Margin	Actual gross profit margin you realize at the end from the product, after exposing it to different discounts and markdowns.
[7] Operating.Profit.Rate	Profitability or performance ratio that reflects the percentage of profit a company produces from its operations, prior to subtracting taxes and interest charges. It is calculated by dividing the operating profit by total revenue
[8] Pre.tax.net.Interest.Rate	Net interest rate before income tax
[9] After.tax.net.Interest.Rate	Interest you pay, minus the tax savings you get back.
[10] Non.industry.income.and.expenditure.revenue	Portion of an organization's income that is derived from activities not related to its core business operations
[11] Continuous.interest.rate..after.tax.	It is the continous interest rate after the tax deduction.
[12] Operating.Expense.Rate	Total operating expense (excluding interest), minus depreciation, divided by gross income.
[13] Research.and.development.expense.rate	Expense rate for research and development
[14] Cash.flow.rate	Rate of movement of money into and out of a business
[15] Interest.bearing.debt.interest.rate	Interest rate of financial liabilities that businesses commonly have, including bank loans and corporate bonds
[16] Tax.rate..A.	Percentage at which an individual or corporation is taxed.
[17] Net.Value.Per.Share..B.	Measurement of the net worth of the company for each share of stock that has been issued.
[18] Net.Value.Per.Share..A.	Measurement of the net worth of the company for each share of stock that has been issued.
[19] Net.Value.Per.Share..C.	Measurement of the net worth of the company for each share of stock that has been issued.
[20] Persistent.EPS.in.the.Last.Four.Seasons	Earnings per share in the last 4 seasons
[21] Cash.Flow.Per.Share	After-tax earnings plus depreciation on a per-share basis that functions as a measure of a firm's financial strength.
[22] Revenue.Per.Share..Yuan.Â..	Ratio that computes the total revenue earned per share over a designated period, whether quarterly, semi-annually, annually, or trailing twelve months (TTM)
[23] Operating.Profit.Per.Share..Yuan.Â..	Per share net earnings of the Company for each fiscal year in a Performance Period
[24] Per.Share.Net.profit.before.tax..Yuan.Â..	Net income (also known as profits or earnings) divided by the available shares.
[25] Realized.Sales.Gross.Profit.Growth.Rate	company's net sales revenue minus its cost of goods sold (COGS)
[26] Operating.Profit.Growth.Rate	amount of profit realized from a business's operation
[27] After.tax.Net.Profit.Growth.Rate	it shows how well a company controls its costs
[28] Regular.Net.Profit.Growth.Rate	how much net income is generated as a percentage of revenues received
[29] Continuous.Net.Profit.Growth.Rate	shows how rapidly a company has been able to boost its bottom line.
[30] Total.Asset.Growth.Rate	change in total assets over the most recently completed fiscal years
[31] Net.Value.Growth.Rate	percentage change of net value
[32] Total.Asset.Return.Growth.Rate.Ratio	percentage change of company using its assets to generate earnings
[33] Cash.Reinvestment..	estimate the amount of cash flow that management reinvests in a business
[34] Current.Ratio	measures a company's ability to pay short-term obligations
[35] Quick.Ratio	ratio used to gauge a company's liquidity
[36] Interest.Expense.Ratio	measure of a company's ability to meet its interest payments
[37] Total.debt.Total.net.worth	metric used in comparing the level of debt of a company with its net worth
[38] Debt.ratio..	measures the extent of a company's leverage
[39] Net.worth.Assets	Asset minus liability
[40] Long.term.fund.suitability.ratio..A.	a variation of the traditional debt-to-equity (D/E) ratio, shows the financial leverage of a firm
[41] Borrowing.dependency	dependency of borrowing funds
[42] Contingent.liabilities.Net.worth	Potential loss that may occcur in future
[43] Operating.profit.Paid.in.capital	total earnings from its core business functions , paid in capital
[44] Net.profit.before.tax.Paid.in.capital	profit before tax, paid in capital
[45] Inventory.and.accounts.receivable.Net.value	assets that can be converted to cash
[46] Total.Asset.Turnover	ratio compares the sales of a company to its asset base
[47] Accounts.Receivable.Turnover	number of times per year that a business collects its average accounts receivable
[48] Average.Collection.Days	the average number of days between the date a credit sale is made and the date the purchaser pays for that sale

Data Analysis and Understanding

Dataset Fields and Description

[49] Inventory.Turnover.Rate..times.	It's a financial ratio showing how many times a company has sold and replaced inventory during a given period.
[50] Fixed.Assets.Turnover.Frequency	It's the ratio of sales to the value of fixed assets.
[51] Net.Worth.Turnover.Rate..times.	It's a ratio that measures how efficiently a company is using its working capital to support sales and growth
[52] Revenue.per.person	It's the total revenue or sales a company makes divided by the full- time people working there.
[53] Operating.profit.per.person	It's a measure of Net Income for the past twelve months (LTM) divided by the current number of Full-Time Equivalent employees
[54] Allocation.rate.per.person	it refers to a percentage of income an investor chooses to allocate to specific investments in an automatic investment plan.
[55] Working.Capital.to.Total.Assets	It's the difference between a company's current assets, such as cash, accounts receivable (customers' unpaid bills) and inventories of raw materials and finished goods, and its current liabilities, such as accounts payable.
[56] Quick.Assets.Total.Assets	It include cash on hand or current assets
[57] Current.Assets.Total.Assets	It's the sum of cash, accounts receivable, inventory and supplies.
[58] Cash.Total.Assets	It measures the portion of a company's assets held in cash or marketable securities.
[59] Quick.Assets.Current.Liability	It's a more conservative measure of a company's liquidity than current assets since it excludes inventories.
[60] Cash.Current.Liability	It's the ability of a company to settle its current liabilities using only its cash and highly liquid investments.
[61] Current.Liability.to.Assets	It compares all of a company's current assets to its current liabilities
[62] Operating.Funds.to.Liability	It's non-interest bearing and comprise of accounts payable, accrued expenses, and income tax payable.
[63] Inventory.Working.Capital	It's a calculation that allows an investor-analyst to understand the ability of a company to raise additional cash from working capital.
[64] Inventory.Current.Liability	It's a company's short-term financial obligations that are due within one year or within a normal operating cycle.
[65] Current.Liabilities.Liability	It's all the all liabilities of the business that are to be settled in cash within the fiscal year or the operating cycle of a given firm, whichever period is longer.
[66] Working.Capital.Equity	It's the difference between assets and liabilities for the short-term flows of your business
[67] Current.Liabilities.Equity	It's the net difference between a company's total assets and its total liabilities.
[68] Long.term.Liability.to.Current.Assets	It's the financial obligations of a company that are due more than one year in the future.
[69] Retained.Earnings.to.Total.Assets	It's a ratio which helps in measuring the profitability of the assets of an entity.
[70] Total.income.Total.expense	It's total revenue for the month, quarter or year, is the total income before you start subtracting expenses.
[71] Total.expense.Assets	It's a measure of the total costs associated with managing and operating an investment fund
[72] Current.Asset.Turnover.Rate	It's an activity ratio measuring firm's ability of generating sales through its current assets

[72] Current.Asset.Turnover.Rate	It's an activity ratio measuring firm's ability of generating sales through its current assets
73] Quick.Asset.Turnover.Rate	measures the efficiency with which a company uses its assets to produce sales
[74] Working.capitcal.Turnover.Rate	It implies that funds are coming in and flowing out on a regular basis
[75] Cash.Turnover.Rate	efficiency ratio that shows the number of times cash is turned over in an accounting period
[76] Cash.Flow.to.Sales	reveals the ability of a business to generate cash flow in proportion to its sales volume
[77] Fixed.Assets.to.Assets	reveals how efficient a company is at generating sales from its existing fixed assets
[78] Current.Liability.to.Liability	a useful measurement when reviewing a company's debt structure.
[79] Current.Liability.to.Equity	The debt to equity ratio indicates how much debt and how much equity a business uses to finance its operations.
[80] Equity.to.Long.term.Liability	The ratio is calculated by taking the company's long-term debt and dividing it by the book value of common equity.
[81] Cash.Flow.to.Total.Assets	used by company management to estimate when cash will be available
[82] Cash.Flow.to.Liability	ratio of a company's cash flow from operations to its total debt
[83] CFO.to.Assets	an efficiency ratio that rates cash flows to the company assets without being affected by income recognition or income measurements.
[84] Cash.Flow.to.Equity	a measure of how much cash is available to the equity shareholders of a company after all expenses, reinvestment, and debt are paid.
[85] Current.Liability.to.Current.Assets	to measure a company's liquidity or ability to pay off short-term debts.
[86] Liability.Assets.Flag	Indicates if there is liabillity assets flag or not.
[87] Net.Income.to.Total.Assets	is a financial ratio that shows the percentage of profit a company earns in relation to its overall resources
[88] Total.assets.to.GNP.price	Its rhe ratio of total assets and gnp price.
[89] No.credit.Interval	is a financial metric that indicates the number of days that a company can operate without needing to access noncurrent assets
[90] Gross.Profit.to.Sales	an accurate indicator of how efficiently a company is selling its goods and services.
[91] Net.Income.to.Stockholder.s.Equity	is a profitability ratio that measures the ability of a firm to generate profits from its shareholders investments in the company
[92] Liability.to.Equity	The debt to equity ratio indicates how much debt and how much equity a business uses to finance its operations.
[93] Degree.of.Financial.Leverage..DFL.	measures the percentage change in EPS for a unit change in operating income
[94] Interest.Coverage.Ratio..Interest.expense.to.EBIT.	used to determine how easily a company can pay interest on its outstanding debt
[95] Net.Income.Flag	Indicates if there is net income flag or not.
[96] Equity.to.Liability	used to evaluate a company's financial leverage

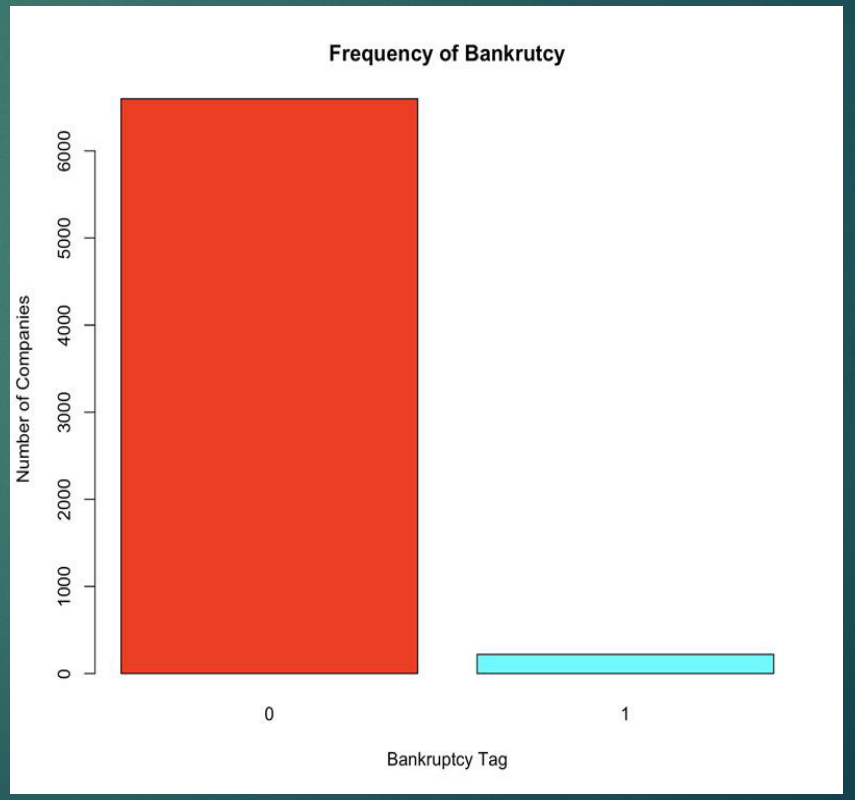
Data Analysis and Understanding

SUMMARIZE THE DATASET

Target Variable Distribution

- We can observe that our dataset is very imbalanced.
- The minority class which is the one we're most interested by predicting represents about 3% of total observations.

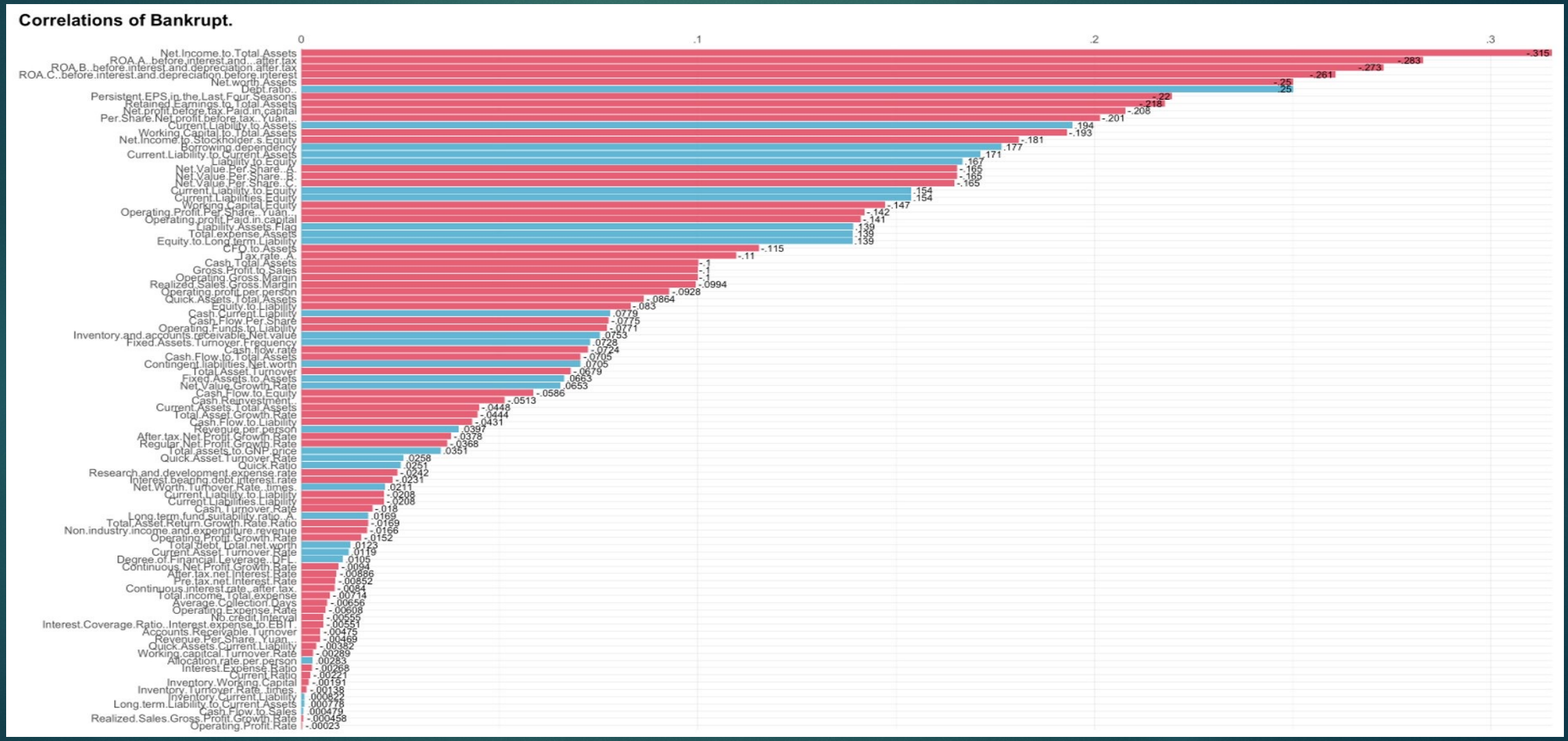
	Bankrupt_Companies	Safe_Companies
Percentage	3.22628	96.77372



Data Analysis and Understanding

SUMMARIZE THE DATASET

Target Variable Correlation



Data Analysis and Understanding

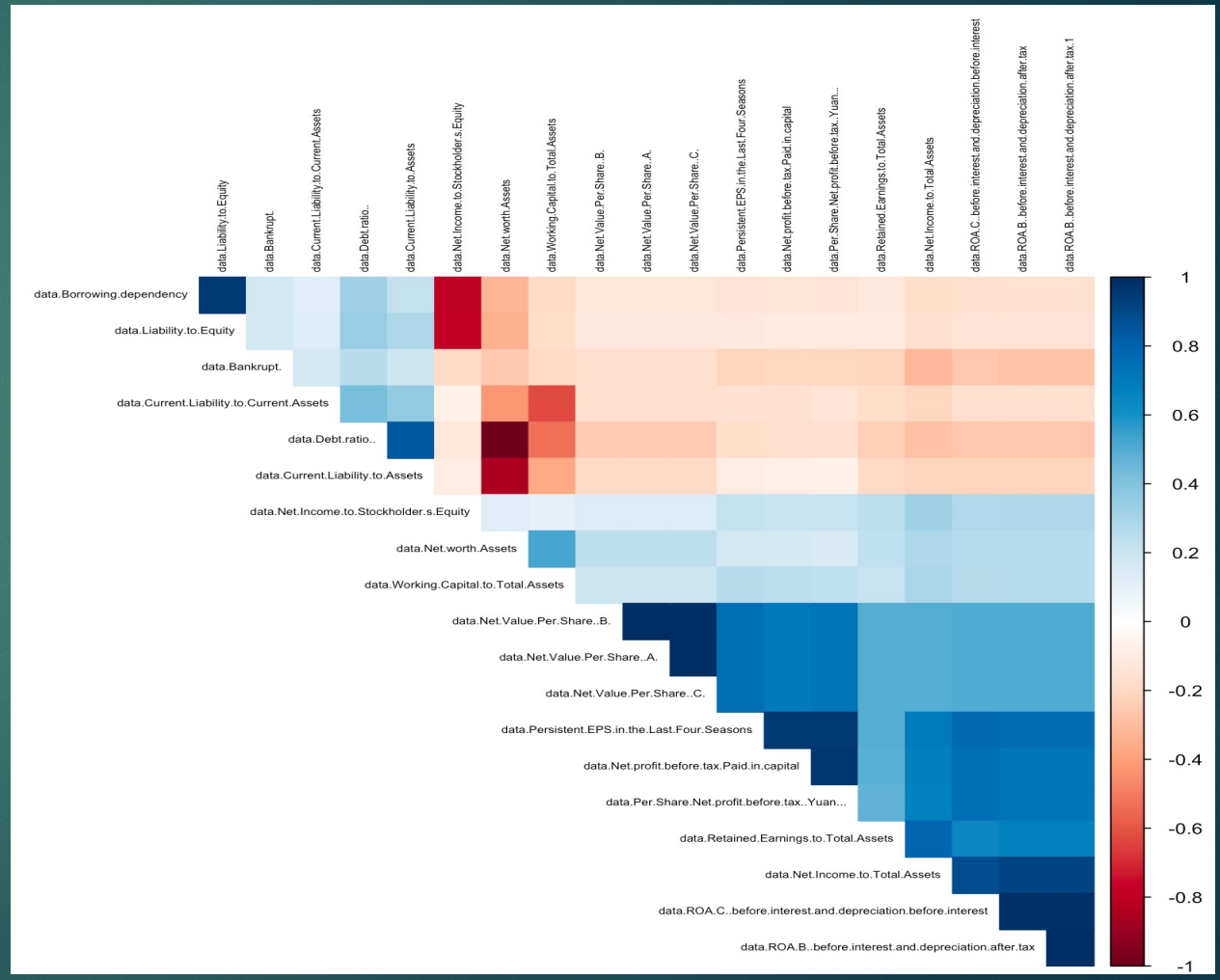
SUMMARIZE THE DATASET

- One thing to point out is that there are groups of features that appear highly correlated with each other as well as the label.

Data Statistics

	mean	median	sd	min	max	X25.	X50.	X75.	miss.val
data.Bankrupt.	0.03226280	0.00000000	0.17671018	0	1	0.00000000	0.00000000	0.00000000	0
data.Net.Income.to.Total.Assets	0.80776022	0.81061904	0.04033219	0	1	0.79674985	0.81061904	0.81061904	0
data.ROA.B..before.interest.and.depreciation.after.tax	0.55358871	0.55227796	0.06159481	0	1	0.52727662	0.55227796	0.55227796	0
data.ROA.B..before.interest.and.depreciation.after.tax.1	0.55358871	0.55227796	0.06159481	0	1	0.52727662	0.55227796	0.55227796	0
data.ROA.C..before.interest.and.depreciation.before.i...	0.50517963	0.50270560	0.06068564	0	1	0.47652708	0.50270560	0.50270560	0
data.Net.worth.Assets	0.88682292	0.88859328	0.05392031	0	1	0.85119569	0.88859328	0.88859328	0
data.Debt.ratio..	0.11317708	0.11140672	0.05392031	0	1	0.07289053	0.11140672	0.11140672	0
data.Persistent.EPS.in.the.Last.Four.Seasons	0.22881285	0.22454382	0.03326261	0	1	0.21471117	0.22454382	0.22454382	0
data.Retained.Earnings.to.Total.Assets	0.93473275	0.93767232	0.02556422	0	1	0.93109651	0.93767232	0.93767232	0
data.Net.profit.before.tax.Paid.in.capital	0.18271503	0.17845562	0.03078477	0	1	0.16937637	0.17845562	0.17845562	0
data.Per.Share.Net.profit.before.tax..Yuan...	0.18436058	0.17970927	0.03318021	0	1	0.17036981	0.17970927	0.17970927	0
data.Current.Liability.to.Assets	0.09067279	0.08270479	0.05028986	0	1	0.05330128	0.08270479	0.08270479	0
data.Working.Capital.to.Total.Assets	0.81412517	0.81027523	0.05905440	0	1	0.77430896	0.81027523	0.81027523	0
data.Net.Income.to.Stockholder.s.Equity	0.84040206	0.84117876	0.01452253	0	1	0.84011480	0.84117876	0.84117876	0
data.Borrowing.dependency	0.37465429	0.37262432	0.01628616	0	1	0.37016784	0.37262432	0.37262432	0
data.Current.Liability.to.Current.Assets	0.03150637	0.02759714	0.03084469	0	1	0.01803367	0.02759714	0.02759714	0
data.Liability.to.Equity	0.28036515	0.27877758	0.01446322	0	1	0.27694424	0.27877758	0.27877758	0
data.Net.Value.Per.Share..A.	0.19063318	0.18440015	0.03347351	0	1	0.17361257	0.18440015	0.18440015	0
data.Net.Value.Per.Share..B.	0.19066058	0.18440015	0.03338977	0	1	0.17361257	0.18440015	0.18440015	0
data.Net.Value.Per.Share..C.	0.19067237	0.18440015	0.03348014	0	1	0.17367578	0.18440015	0.18440015	0

Correlation Matrix



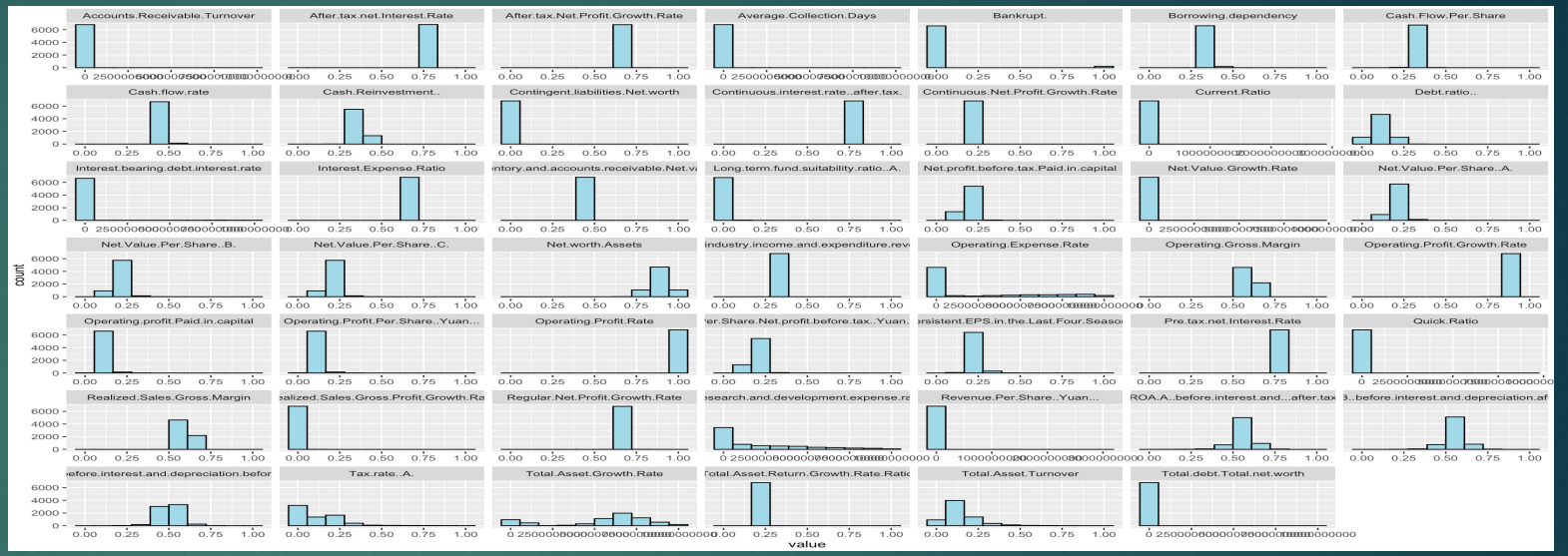
Data Analysis and Understanding

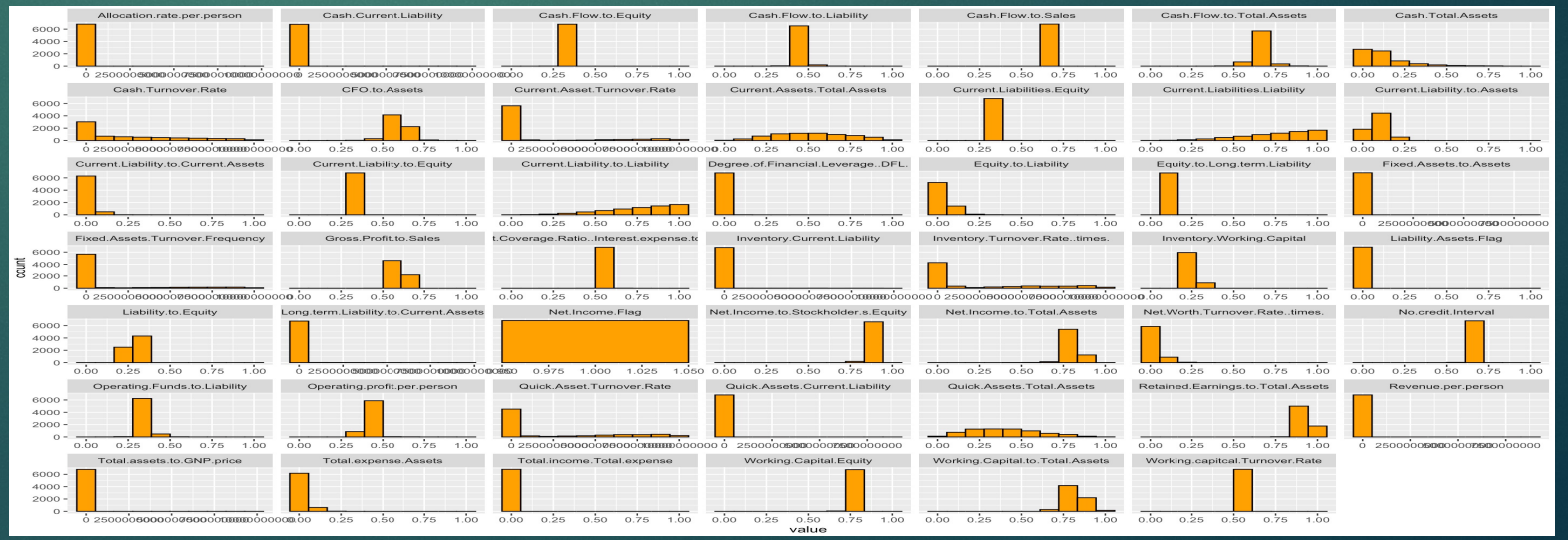
SUMMARIZE THE DATASET

Histograms

- It is apparent that our features come in groups of different distributions, some resembling exponential while some more like normal or skewed normal distributions.

- We also know that most features are numerical and are on different scales. Log transformation could not eliminate the skewness of most distributions.





Data Analysis and Understanding

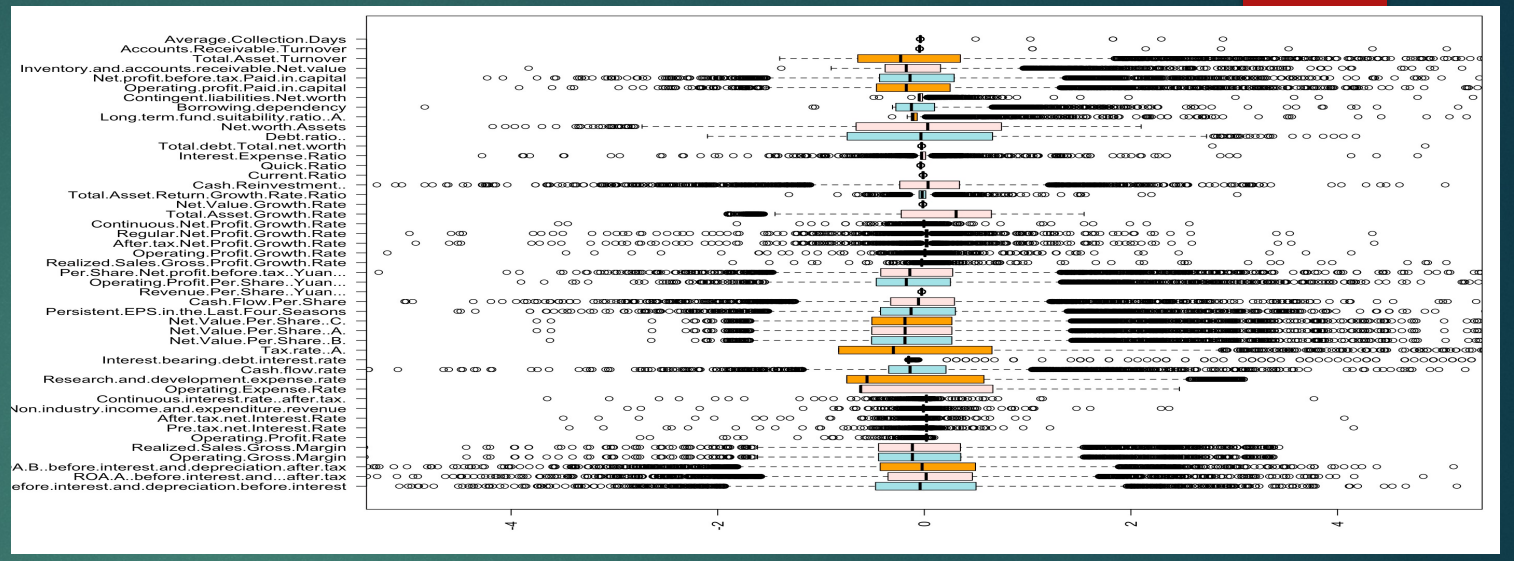
SUMMARIZE THE DATASET

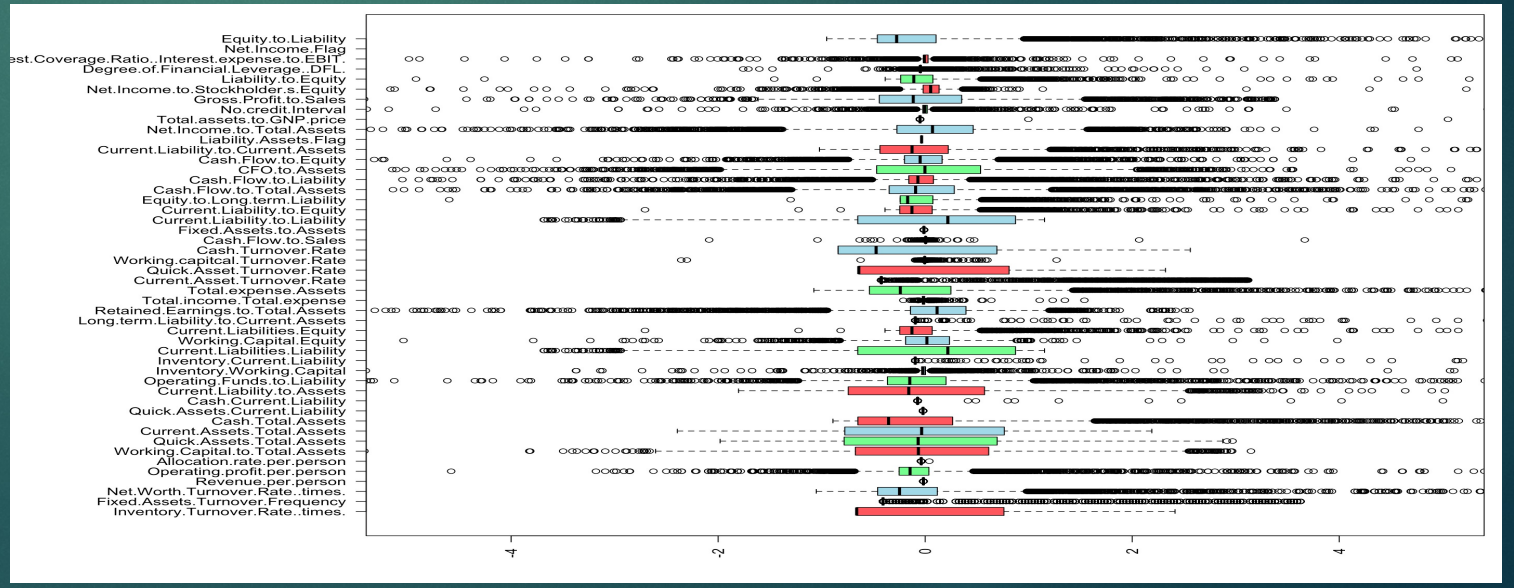
Boxplots

- Major values are concentrated around starting ranges yet there are very high valued records.

- Some features show outliers in top 1% values only. Few of such features are:
  - Total_debt/Total_net_worth
  - Revenue_per_person
  - Net_Value_Growth_Rate
  - Revenue_Per_Share etc

- There are some features that have significant number of higher values, like:
  - Current_Asset_Turnover_Rate
  - Cash_Turnover_Rate





Data Modeling

GOALS AND OBJECTIVES:

Prediction: To predict if a company will go bankrupt or not.

Hope to Accomplish: We hope to build a classification model that will predict the bankruptcy and help lenders, shareholders and investors to make informed decisions.

Target variable Description: Bankrupt?

Target variable determines if a company is bankrupt or not.

1 - bankrupt

0 - not bankrupt

Data Modeling

CLASSIFICATION MODELS:

- Decision Trees
- Random Forest Classifier
- Logistic Regression

Analysis of metrices such as accuracy, confusion matrix to determine the best model for the prediction.

test.df	1364 obs. of 96 variables
train.df	4091 obs. of 96 variables
valid.df	1364 obs. of 96 variables

NUMBER OF MISSING VALUES: 0

```
> #Calculating the total missing values in the data set
> miss.val=sum(sapply(data, function(x)
+   sum(length(which(is.na(x))))))
> print("Totlal Number of missing values:"); miss.val
[1] "Totlal Number of missing values:"
[1] 0
>
```

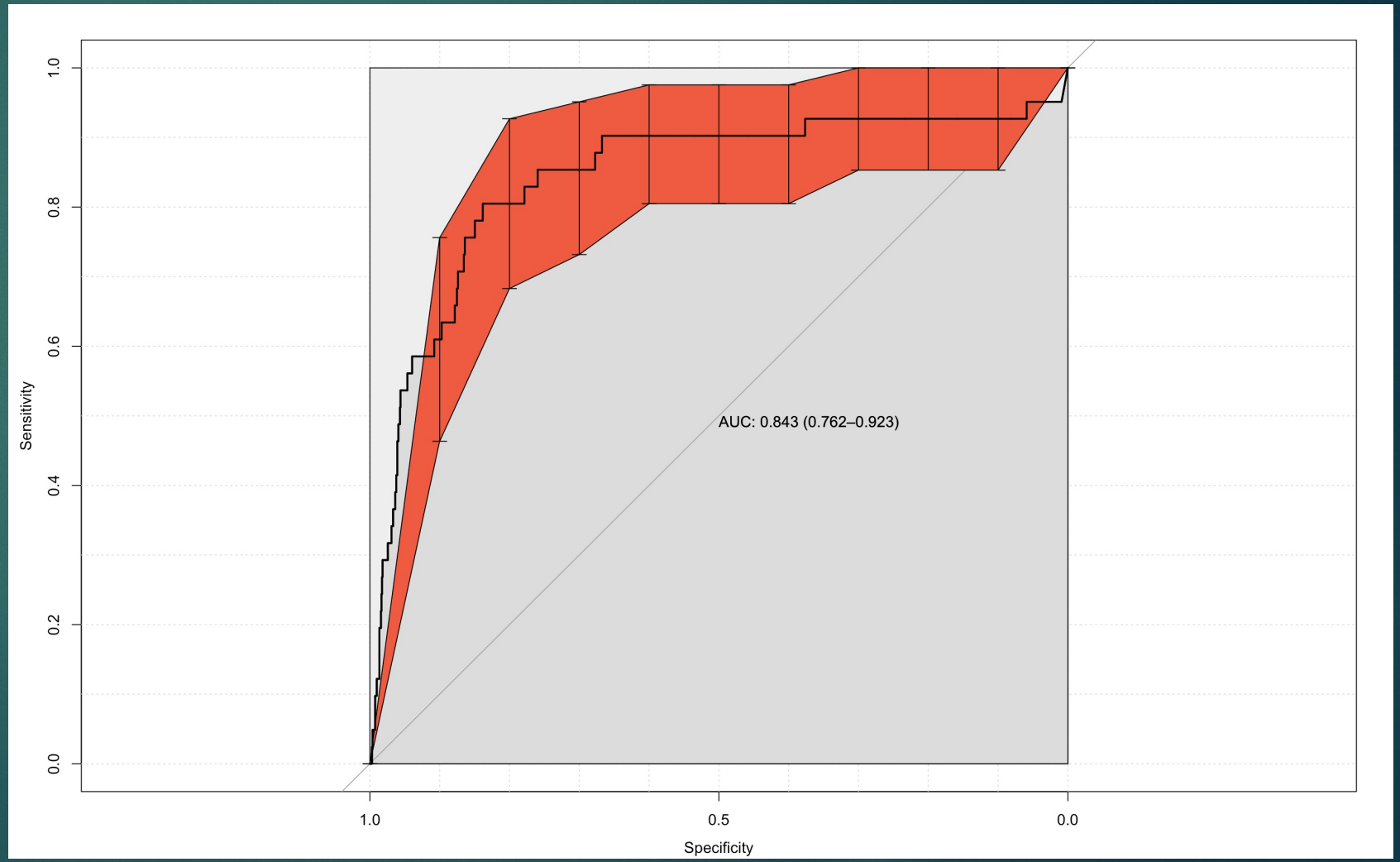
Data Modeling

LOGISTIC REGRESSION MODEL

Summary Statistics

```
Confusion Matrix and Statistics


       FALSE TRUE
  FALSE  1255   19
  TRUE     68   22

               Accuracy : 0.9362
                 95% CI : (0.9219, 0.9486)
    No Information Rate : 0.9699
    P-Value [Acc > NIR] : 1

                  Kappa : 0.3073

 Mcnemar's Test P-Value : 0.0000002659

            Sensitivity : 0.9486
            Specificity : 0.5366
         Pos Pred Value : 0.9851
         Neg Pred Value : 0.2444
             Prevalence : 0.9699
         Detection Rate : 0.9201
   Detection Prevalence : 0.9340
      Balanced Accuracy : 0.7426

       'Positive' Class : FALSE
```

ROC Curve



Data Modeling

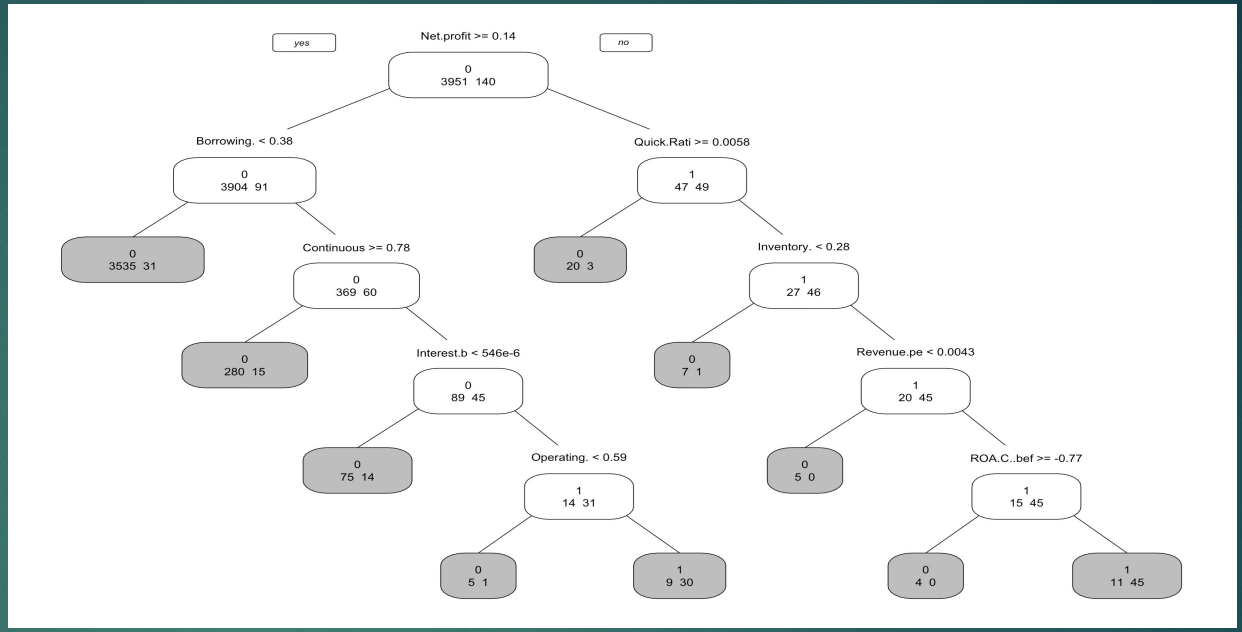
DECISION TREE MODEL (SCALED DATA)

- TRANSFORMATION: Scaling
- Max-depth: 30

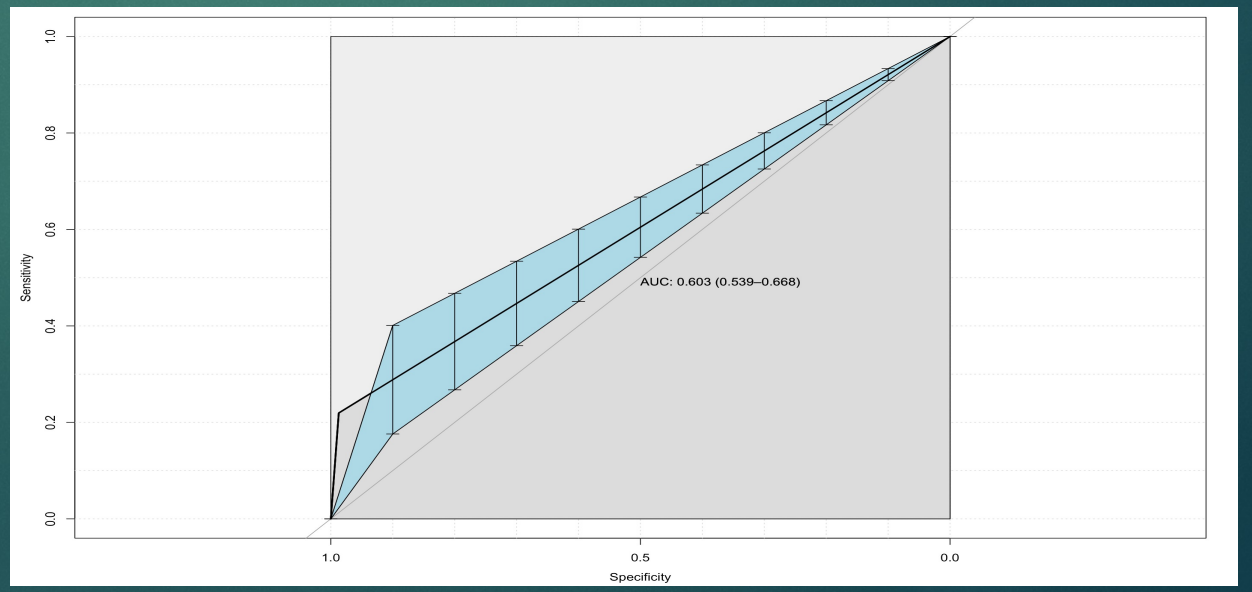
Summary Statistics

```
Confusion Matrix and Statistics

          Reference
Prediction    0    1
         0 1306   32
         1   17    9

               Accuracy : 0.9641
                 95% CI : (0.9528, 0.9733)
    No Information Rate : 0.9699
    P-Value [Acc > NIR] : 0.9083

                  Kappa : 0.2512

 Mcnemar's Test P-Value : 0.0455

            Sensitivity : 0.9872
            Specificity : 0.2195
         Pos Pred Value : 0.9761
         Neg Pred Value : 0.3462
             Prevalence : 0.9699
         Detection Rate : 0.9575
   Detection Prevalence : 0.9809
      Balanced Accuracy : 0.6033

       'Positive' Class : 0
```

Decision Tree



ROC Curve



Data Modeling

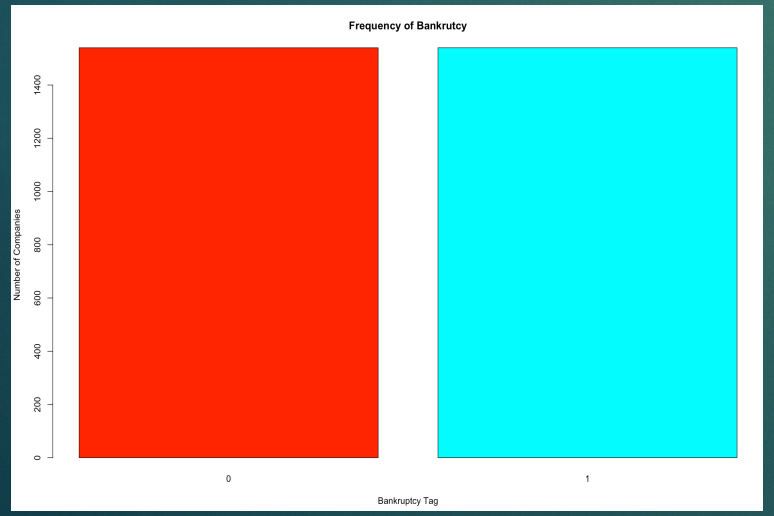
RANDOM FOREST MODEL (SMOTE)

- **Transformation:** SMOTE algorithm for unbalanced classification problems
- This function handles unbalanced classification problems using the SMOTE method.

SMOTE Dataset

balanced.data	3080 obs. of 96 variables

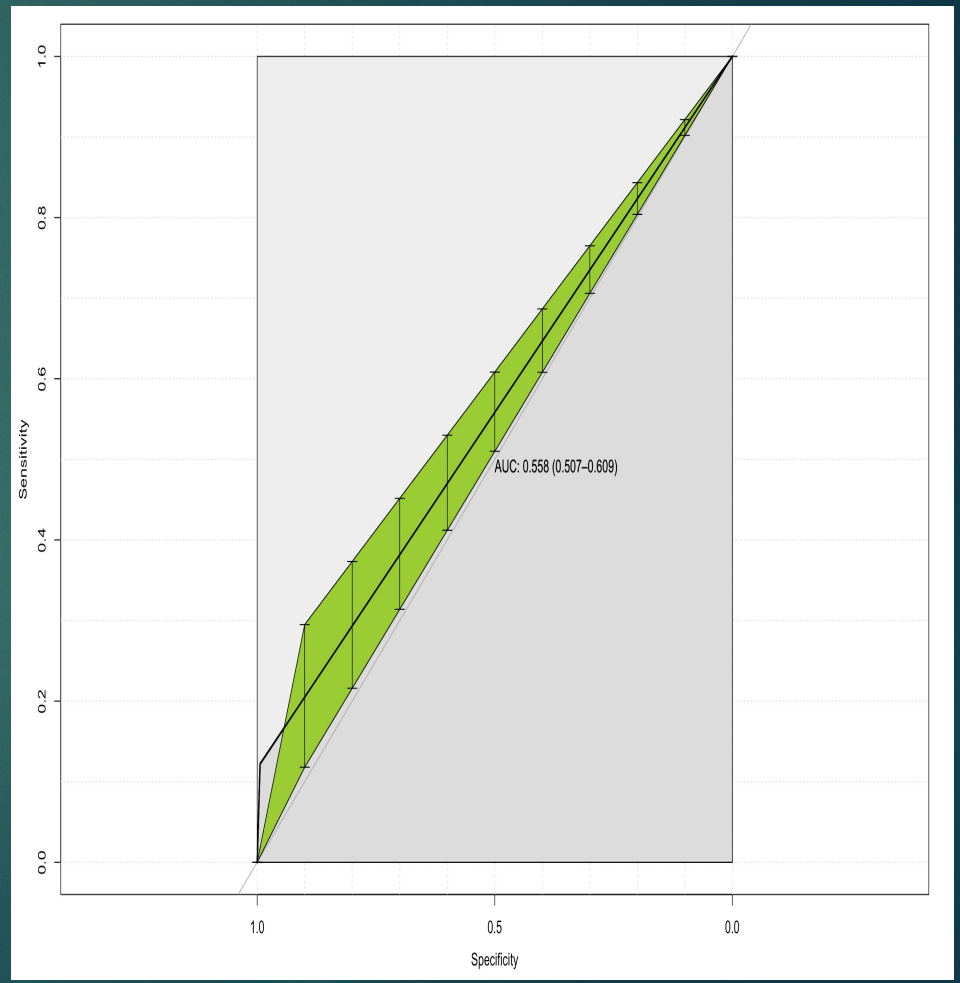
Target Variable Distribution (SMOTE Dataset)



Summary Statistics

```
          Reference
Prediction    0    1
         0 1253   19
         1   70   22

               Accuracy : 0.9348
                 95% CI : (0.9203, 0.9473)
    No Information Rate : 0.9699
    P-Value [Acc > NIR] : 1

                  Kappa : 0.3018

 Mcnemar's Test P-Value : 0.0000001158

            Sensitivity : 0.9471
            Specificity : 0.5366
         Pos Pred Value : 0.9851
         Neg Pred Value : 0.2391
             Prevalence : 0.9699
         Detection Rate : 0.9186
   Detection Prevalence : 0.9326
      Balanced Accuracy : 0.7418

       'Positive' Class : 0
```

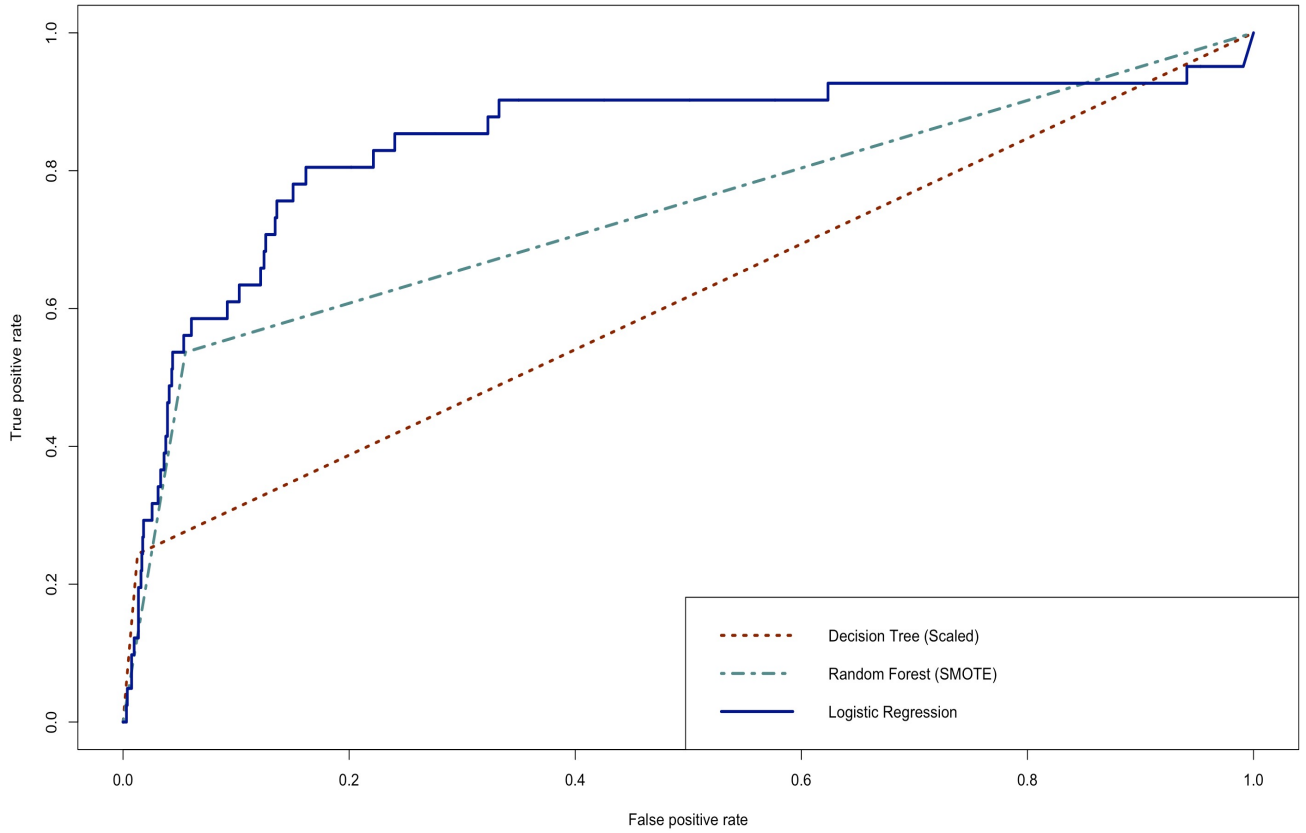
ROC Curve



Data Modeling

MODEL PERFORMANCE COMPARISION

ROC Curves



Model Performance Metrices

Model	Accuracy	Specificity	Sensitivity	Balanced Accuracy
Decision Tree (Scaled)	96.1%	21.95%	98.72%	60.33%
Random Forest(SMOTE)	93.48%	53.66%	94.71%	74.18%
Logistic Regression	93.62%	53.66%	94.86%	74.26%

FINAL MODEL: LOGISTIC REGRESSION

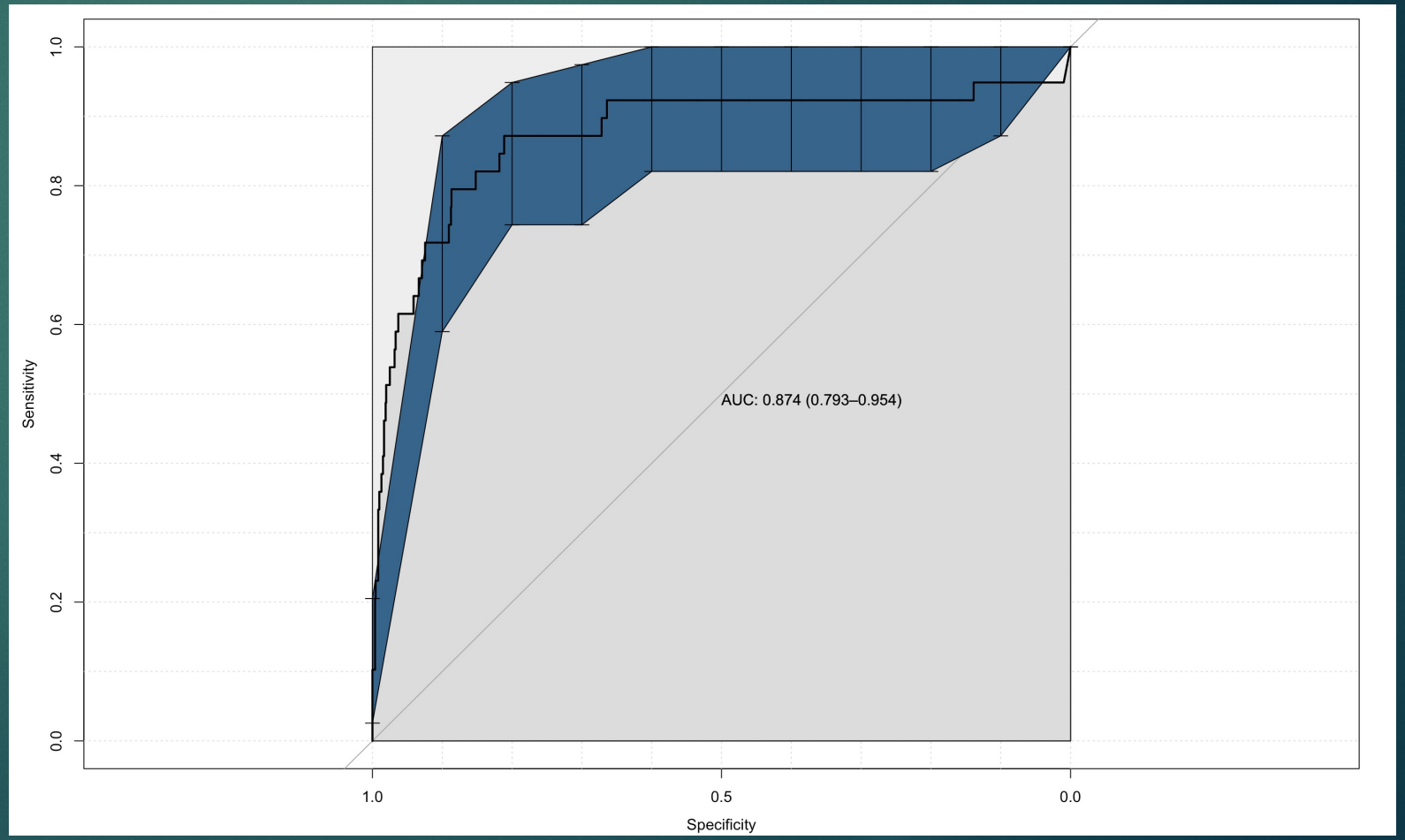
Data Modeling

PREDICTION WITH TEST DATA USING LOGISTIC REGRESSION (FINAL MODEL)

Summary Statistics

```
Confusion Matrix and Statistics


       FALSE TRUE
  FALSE  1255   15
  TRUE     70   24

               Accuracy : 0.9377
                 95% CI : (0.9235, 0.9499)
    No Information Rate : 0.9714
    P-Value [Acc > NIR] : 1

                  Kappa : 0.334

 Mcnemar's Test P-Value : 0.00000000471

            Sensitivity : 0.9472
            Specificity : 0.6154
         Pos Pred Value : 0.9882
         Neg Pred Value : 0.2553
             Prevalence : 0.9714
         Detection Rate : 0.9201
   Detection Prevalence : 0.9311
      Balanced Accuracy : 0.7813

       'Positive' Class : FALSE
```

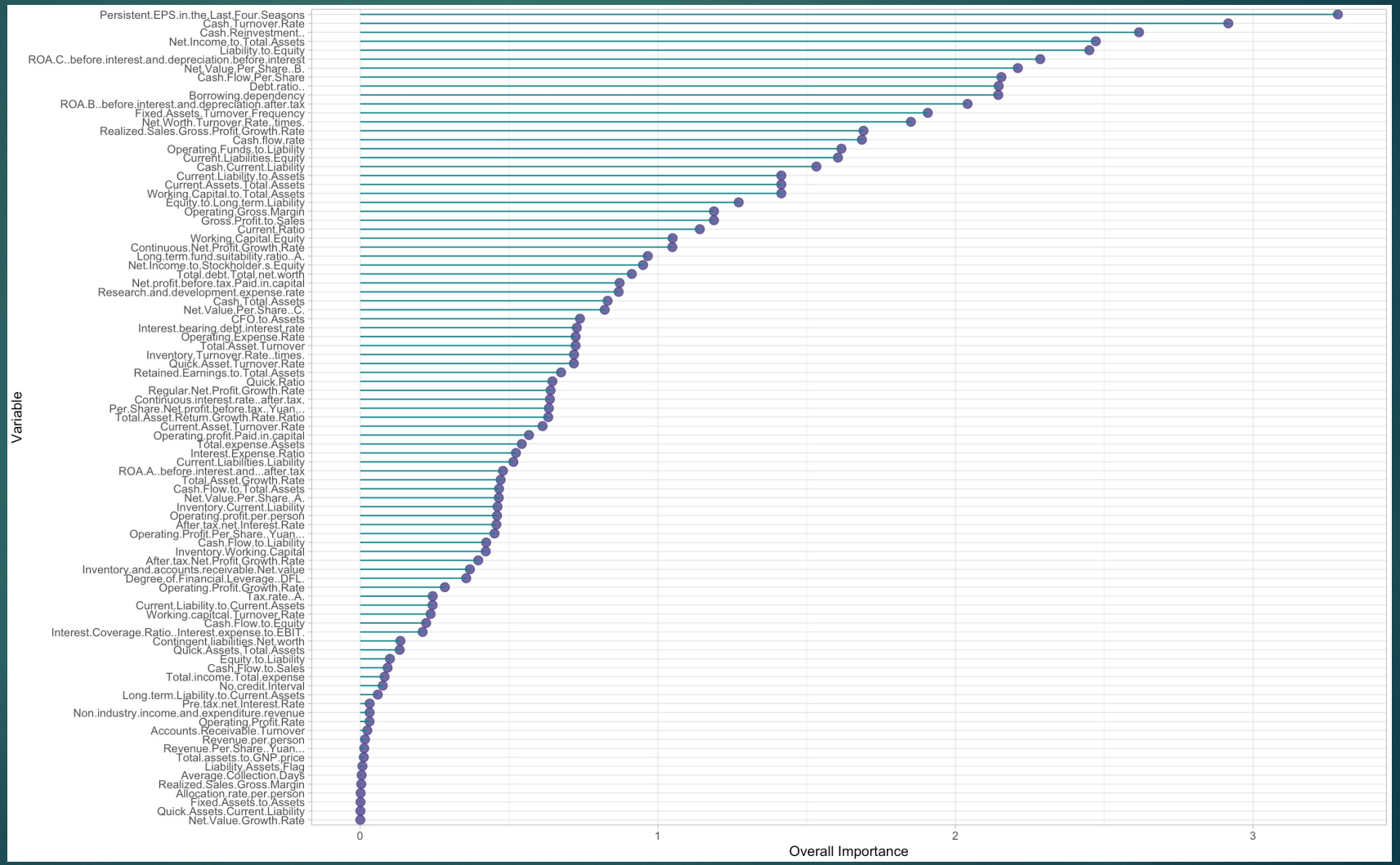
ROC Curve



Data Modeling

PREDICTION WITH TEST DATA USING LOGISTIC REGRESSION (FINAL MODEL)

Variable Importance Plot



Data Modeling

PREDICTION WITH TEST DATA USING

LOGISTIC REGRESSION (FINAL MODEL)

LIMITATIONS:

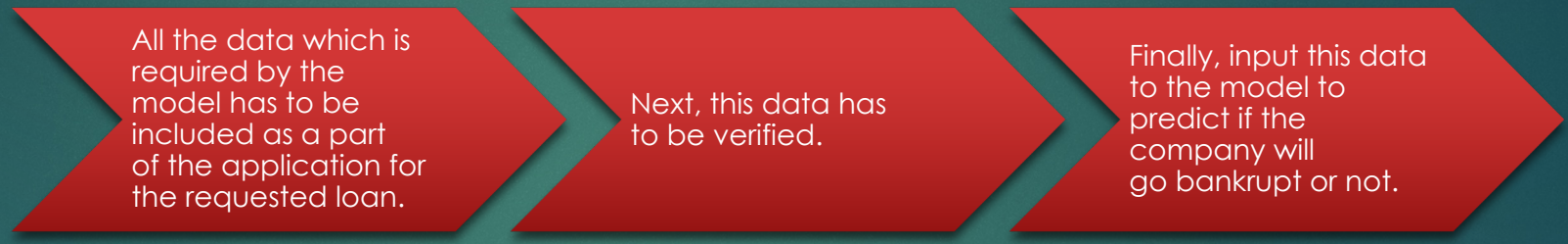
- Most companies tend to submit flawed statements or are limited by the availability
- Assumption that the models are stable across economic conditions that change over time, such as inflation, interest rates, and credit availability
- The companies which gets predicted as bankrupt but is not actually bankrupt loses potential business and thereby profits for the banks
- The companies which are classified as not bankrupt by the model but are bankrupt lead to risk of default for the bank

IMPROVEMENT SCOPE:

- The data contains outliers in almost all the variables. Corrective measures in each one of them can drive increased performance of the model.
- Other classification algorithms such as K-nearest neighbours, Naive Bayes, SVM etc
- More accurate predictions can be made from separate industry-based models
- Factor the current macroeconomic conditions like growth rates, inflation, and interest rates into the model

Recommendations

CTBC Bank can use this model to evaluate a company's financial stability before establishing new relationships or engagements with a company.



They can decide if the loan requested by a company should be sanctioned or not on the basis of if it classifies as bankrupt or not by the model.

Furthermore, this model can also be used to set interest rates for the loan issued.
For example, if a company gets classified as bankrupt by the model and CTBC still wants to sanction the loan, they can quote a higher interest rate to take into account the risk of being bankrupt and hence default of loan.

Recommendations

CTBC Bank can also use this model to assess the financial distress of companies that they have already lend to.

Data required by the model has to be collected and verified every quarter from all the companies.

Use this data in the model to predict if the company will go bankrupt or not.

The prediction of a company as bankrupt or not can be used to set aside exposure amounts which are subject to default.

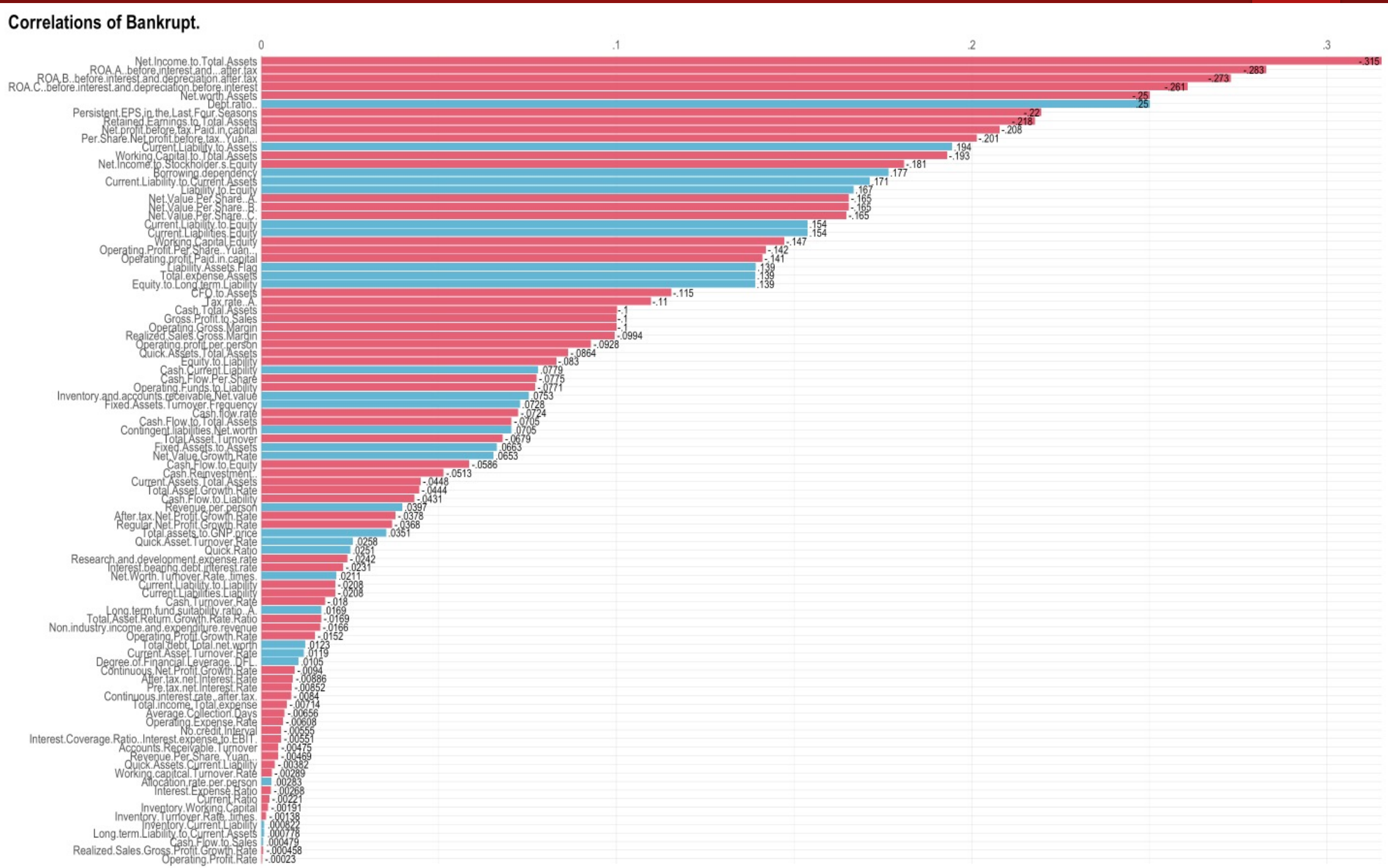
This model can also be used by CTBC Bank to determine the floating interest rate for the loan which can be increased or decreased based on bankruptcy prediction.

Recommendations

CTBC Bank can utilize this model to calculate the minimum regulatory capital required to be maintained by every bank as per Central Bank of Republic of China (Taiwan)

- Data required by the model has to be collected and verified every quarter from all the companies.
- Use this data in the model to predict if the company will go bankrupt or not.
- Calculate the percentage of companies that could go bankrupt for a given quarter
- Introduce this percentage as a coefficient in the calculation of minimum regulatory capital.
- This report can then be submitted to the central bank to validate the minimum capital maintained by the bank.

APPENDIX


Correlations of Bankrupt.
0
.1
.2
.3
Net.Income.to.Total.Assets -.315
ROA.A..before.interest.and...after.tax -.283
ROA.B..before.interest.and.depreciation.after.tax -.273
ROA.C..before.interest.and.depreciation.before.interest -.261
Net.worth.Assets -.25
Debt.ratio.. .25
Persistent.EPS.in.the.Last.Four.Seasons -.22
Retained.Earnings.to.Total.Assets -.218
Net.profit.before.tax.Paid.in.capital -.208
Per.Share.Net.profit.before.tax..Yuan... -.201
Current.Liability.to.Assets .194
Working.Capital.to.Total.Assets -.193
Net.Income.to.Stockholder.s.Equity -.181
Borrowing.dependency .177
Current.Liability.to.Current.Assets .171
Liability.to.Equity .167
Net.Value.Per.Share..A. -.165
Net.Value.Per.Share..B. -.165
Net.Value.Per.Share..C. -.165
Current.Liability.to.Equity .154
Current.Liabilities.Equity .154
Working.Capital.Equity -.147
Operating.Profit.Per.Share..Yuan.. -.142
Operating.profit.Paid.in.capital -.141
Liability.Assets.Flag .139
Total.expense.Assets .139
Equity.to.Long.term.Liability .139
CFO.to.Assets -.115
Tax.rate..A. -.11
Cash.Total.Assets -.1
Gross.Profit.to.Sales -.1
Operating.Gross.Margin -.1
Realized.Sales.Gross.Margin -.0994
Operating.profit.per.person -.0928
Quick.Assets.Total.Assets -.0864
Equity.to.Liability -.083
Cash.Current.Liability .0779
Cash.Flow.Per.Share -.0775
Operating.Funds.to.Liability -.0771
Inventory.and.accounts.receivable.Net.value .0753
Fixed.Assets.Turnover.Frequency .0728
Cash.flow.rate -.0724
Cash.Flow.to.Total.Assets -.0705
Contingent.liabilities.Net.worth .0705
Total.Asset.Turnover -.0679
Fixed.Assets.to.Assets .0663
Net.Value.Growth.Rate .0653
Cash.Flow.to.Equity -.0586
Cash.Reinvestment.. -.0513
Current.Assets.Total.Assets -.0448
Total.Asset.Growth.Rate -.0444
Cash.Flow.to.Liability -.0431
Revenue.per.person .0397
After.tax.Net.Profit.Growth.Rate -.0378
Regular.Net.Profit.Growth.Rate -.0368
Total.assets.to.GNP.price .0351
Quick.Asset.Turnover.Rate .0258
Quick.Ratio .0251
Research.and.development.expense.rate -.0242
Interest.bearing.debt.interest.rate -.0231
Net.Worth.Turnover.Rate..times. .0211
Current.Liability.to.Liability -.0208
Current.Liabilities.Liability -.0208
Cash.Turnover.Rate -.018
Long.term.fund.suitability.ratio..A. .0169
Total.Asset.Return.Growth.Rate.Ratio -.0169
Non.industry.income.and.expenditure.revenue -.0166
Operating.Profit.Growth.Rate -.0152
Total.Debt.Total.net.worth .0123
Current.Asset.Turnover.Rate .0119
Degree.of.Financial.Leverage..DFL. .0105
Continuous.Net.Profit.Growth.Rate -.0094
After.tax.net.Interest.Rate -.00886
Pre.tax.net.Interest.Rate -.00852
Continuous.interest.rate..after.tax. -.0084
Total.income..Total.expense -.00714
Average.Collection.Days -.00656
Operating.Expense.Rate -.00608
No.credit.Interval -.00555
Interest.Coverage.Ratio..Interest.expense.to.EBIT. -.00551
Accounts.Receivable.Turnover -.00475
Revenue.Per.Share..Yuan.. -.00469
Quick.Assets.Current.Liability -.00382
Working.capitcal.Turnover.Rate -.00289
Allocation.rate.per.person .00283
Interest.Expense.Ratio -.00268
Current.Ratio -.00221
Inventory.Working.Capital -.00191
Inventory.Turnover.Rate..times. -.00138
Inventory.Current.Liability .000822
Long.term.Liability.to.Current.Assets .000778
Cash.Flow.to.Sales .000479
Realized.Sales.Gross.Profit.Growth.Rate -.000458
Operating.Profit.Rate -.00023