A NEURAL NETWORK MODEL TO PREDICT BUSINESS FAILURE IN CONSTRUCTION COMPANIES IN THE UNITED STATES OF AMERICA

By

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A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
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To my parents, my family, Gina, Those on the other side, and Chester!

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The construction industry has one of the highest rates of bankruptcy in the United States of America. Although there are many generic prediction models developed to help company managers to predict whether their companies are still healthy or will fail, there was not a specific model trained and tested just using data from construction companies (heavy, utility and commercial construction). The purpose of this dissertation was to create a model using neural networks that was able to predict business failure in construction companies one, two and up to three years before it happened.

Data from sixty-seven healthy and bankrupt companies were collected. Although twenty-six financial ratios were first calculated, seven ratios were found to be the most significant indicators and were used to train and test the neural networks. Three neural networks (one, two and three years prior to business failure) were trained and tested. In order to understand the importance of the results, data from randomly chosen construction companies were entered into Altman's model, which is a generic predictor

of business health. The results obtained using the neural network models were more accurate than those obtained using Altman's model. Afterwards, a numerical analysis was performed to identify which of the financial ratios were the most important. The results showed that the debt-to-equity ratio, debt-to-assets ratio and the gross profit margin ratio could generate higher changes to the financial condition of a construction company.

It was hoped that the results obtained in this dissertation showed that future development of this models could become an important tool for construction companies.

CHAPTER 1
INTRODUCTION

1.1 Problem Statement

The construction industry has one of the highest rates of bankruptcy. As shown in Figure 1-1,[1] the number of U.S. businesses that declare bankruptcy are considerable. In 2001, 40,099 cases of bankruptcy were filed, with some seeking protection under Chapter Eleven, but most of them filing under Chapter Seven.

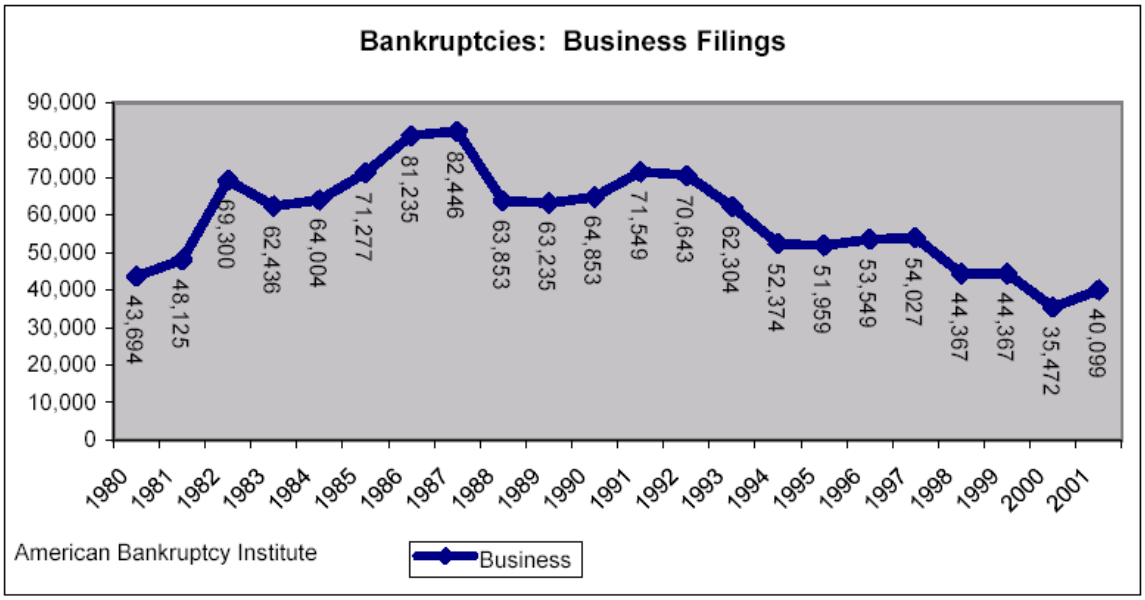


Figure 1-1 U.S. Bankruptcy: Business Filings (1980 – 2001)

In its annual report, the American Bankruptcy Institute stated that 38,540 businesses declared bankruptcy in 2002, and in the first months of 2003, 18,145 businesses did the same.[2] These numbers are among the lowest in the last twenty years, and they are impressive considering that the United States had been under a prolonged economic recession for most of those years.

The PricewaterhouseCoopers 2002 report,[3] stated that just 189 public trade companies fell into bankruptcy; approximately 50% of the companies were in the manufacturing sector, and 20% in the service sector.[3] The communications industry had the highest number of bankruptcy assets. The Phoenix Report (2003)[4] shows that 8 of the 30 companies with the highest percentages of bankruptcy assets were related to the construction industry. Consider also that this small number refers just to public trade companies, and that construction companies are normally private. In 2001, the construction industry reported 1.20% of the total number of bankruptcies (Table 1-1).[5] Though this number is not as high as the one reported by the manufacturing industry (32%) or the service industry (25%), it represents 481 cases. This number includes private and public trade companies.

Table 1-1. Number of Filings per Industry, 2001

Industry	Percent of All Filings
Manufacturing	32%
Services	25%
Communications	13%
Retail Trade	10%
Wholesale Trade	7%
Finance, Insurance, Real Estate	6%
Transportation	4%
Construction	1.20%
Energy	0.80%
Agriculture, Forestry, Fishing	0.40%
Mining	0.40%
Others	0.20%
Total	100%

Bankruptcy affects construction companies worldwide. In Japan, the construction industry has one of the highest instances of bankruptcies with 565 cases (2001-2002).[6] In Canada, the number of bankruptcies (8 cases in 2002)[7] were not as high as in the United States or in Japan. This number however, weighs heavily in a country where the industry with the highest number of bankruptcies reported only 14 cases (retail trade Industries).

While the U.S. economy was vibrant and strong in the late 1990s, a sharp decline in economic strength resulted after the terrorist attack of September 11, 2001. During the first nine months of 2002, nonresidential spending was 8.1% less than during the same period in 2001. Spending dropped 18.3% through the same period of time in the construction of offices, hotels, and retail establishments. Investments in industrial construction (warehouses and manufacturing plants) in the first nine months of 2002 were 45.1% lower than in the same period in 2001.[8] In 2002, investment for private non-residential construction dropped by 15.9%. Other sectors that have been affected are institutional buildings with a 1% fall in 2002, and construction of educational buildings with a reduction of 1%. On the other hand, for highways and bridges construction grew 3%, environmental public works rose 9%, and construction of health facilities grew 11%.[6]

1.2 Bankruptcy

Bankruptcy is a business failure that can be defined as "the condition in which a business cannot meet its debt obligations and petitions a federal district court for either reorganization of its debts or liquidation of its assets.[9]" When the debtor is not able to pay the creditors, it can file bankruptcy under Chapter Seven, Chapter Eleven, Chapter Twelve, or Chapter Thirteen. Depending on the characteristics of the business failure, the failed company can be liquidated (Chapter Seven), or rehabilitated (Chapters Eleven,

Twelve, and Thirteen). After bankruptcy is filed, a trustee is selected to supervise the possessions of the debtor. These possessions are divided with equality among the creditors when Chapter Seven is filed. On the other hand, when Chapter Eleven, Twelve, or Thirteen is filed, bankruptcy courts allow debtors to stay in business and use the revenues generated by the companies to pay their creditors.

Chapter Seven is better known as liquidation. Filing Chapter Seven requires debtors to give up properties to a bankruptcy court. After properties are sold, the amount of money received is used to pay the debts. Chapter Eleven is better known as reorganization. When a company files Chapter Eleven, the company can stay in business, paying its debtors by using part of its revenues. Family farmers typically file Chapter Twelve, and Chapter Thirteen, normally called Debt Adjustment, requires debtors to file a plan to pay their debts.[10] In this dissertation, the focus is on construction companies that filed bankruptcy under Chapter Seven or Chapter Eleven.

1.3 Hypothesis

It is possible to reduce the rate of bankruptcy in construction companies through the use of a neural network model that identifies and controls the variables that induce financial failure. There are five objectives of this dissertation:

1. Gather financial information from public trade construction companies that either had fallen into bankruptcy in the United States or are actually in business Classify the variables that lead construction companies to bankruptcy.
2. Quantify the impact that those financial variables had on the failure of the business.
3. Identify a neural network algorithm and train the algorithm.
4. Create a theoretical model based on the information gathered.
5. Create a neural network model to predict bankruptcy.

The results of this dissertation can be of great importance to:

- Construction companies
- Sureties
- Insurance companies
- Owners (Public and Private)
- Suppliers
- Bankruptcy Courts
- General contractors
- Construction companies that want to merge or buy other companies
- Construction institutes
- Banks and other financial institutions
- Public accounting firms
- Bond rating agencies

CHAPTER 2
LITERATURE REVIEW

As mentioned before, bankruptcy affects more than 30,000 companies in the United States every year. Many studies about bankruptcy prediction have been made in different areas such as finance, accounting, management, and computer science engineering since the late 1960's. Artificial intelligence systems that include expert systems and neural networks have proved to be superior to the traditional mathematical and statistical systems. This literature review summarizes some of the results that have been published in recent years on this field.

2.1 Statistical Prediction Models

The statistical models of bankruptcy prediction started in the late 1960's. One of the first models was a univariate analysis of a number of financial ratios to discriminate between failed and non-failed firms. The statistical method developed by Beaver in 1967[11] tried to predict bankruptcy five years before the business failure. During his research, Beaver realized that the most important factor in bankruptcy prediction was cash flow/total debt ratio.

One of the most famous bankruptcy prediction models is the one developed by Altman in 1968. This statistical model also called the Altman's Z-Score model, uses a multiple discriminate analysis using a discriminant function:

$$Z=0.012\ X_1 + 0.014\ X_2 + 0.033\ X_3 + 0.006\ X_4 + 0.999\ X_5^{11} \quad (1)$$

The variables X_1, X_2, X_3, X_4, X_5 represent the working capital/total assets, retained earnings/total assets, earnings before interest and taxes/total assets, market value of

equity/book value of total liabilities, and sales/total assets respectively. Later in 1977, Altman and Zeta Services, Inc. developed a model called the ZETA model[11] that used seven variables. The variables used were:

- Capitalization
- Size
- Return on assets
- Debt service
- Stability of earning
- Liquidity/current ratio
- Cumulative profitability

Altman used a sample size of sixty-six companies. In his model, 50% of the information came from healthy companies, and 50% from companies that had filed bankruptcy. During the development of the ZETA model, 113 companies were surveyed. The companies surveyed for these two studies were in the manufacturing and retail industry.

Serrano and Molinero used a linear discriminant analysis (LDA) in 2000[12] to find differences between healthy companies and those that had filed bankruptcy. This technique is based on a multivariate normal distribution, used the same ratios that Altman used[13] in the development of the Altman's Z-Score model. Serrano and Molinero applied a self-organizing neural network to the data provided by 129 companies in the United States. The results are illustrated in Figure 2-1.

Serrano and Molinero found that healthy companies were concentrated on the right side of the figure, and failed firms on the left side of the figure.[12] They concluded that by

using the combination of a linear discriminant analysis and neural networks they could predict the two areas shown in Figure 2-1.[12]

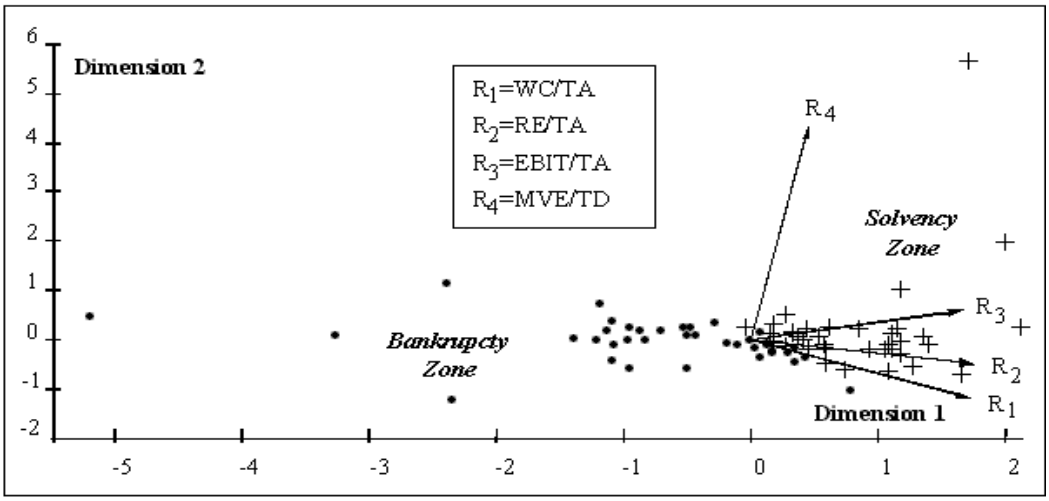


Figure 2-1 Multidimensional Scaling Representation of Company Data

More studies have been made to improve the use of statistical models in the prediction of bankruptcy, such as the ones made by Deakin (1972), Taffler (1982), and Ohlson (1980) [as cited by Serrano and Molinero[12]]. These studies have improved the growth of multivariate statistical models.

2.2 Mathematical Models

Mathematical models use the "gambler's ruin" approach to predict bankruptcy.[12] The gambler's ruin approach was developed by Feller in 1968. This approach states that a company will fall into bankruptcy when its net liquidation value becomes negative. The net liquidation value can be defined as

Net Liquidation Value= (Total Asset Liquidation – Total Liabilities)[12] (2)

Wilcox used the net liquidation value equation (Equation 2) to demonstrate that the risk of filing bankruptcy depends on the size of the adjusted cash flow and the net

liquidation value. Vinso, who improved Wilcox's theory, developed a safety index that can be used to predict the time when bankruptcy is more likely to occur.

In conclusion, there are no mathematical models completely accepted to predict bankruptcy. Presently, with the application of artificial intelligence, mathematical models have become part of more sophisticated models.

2.3 Neural Networks Models

Neural networks have been used to predict bankruptcy since 1990. Their main advantage is that neural networks impose less restrictive data requirements. In contrast, it is not possible to measure the importance of each variable because the element of the neural network that processes the input data is considered a "black box.[12]"

2.3.1 Neural Networks

Neural networks are algorithms that emulate the way human brains learn. These algorithms learn, and can be trained through trial and error procedures. As shown in Figure 2-2,[14] neural network consist of three parts:

1. Inputs
2. Processing element
3. Outputs

The design of a neural network to predict bankruptcy is a difficult task that is usually performed by systems developers. Even though there are many commercially available topologies of neural networks, not all of them can be used in bankruptcy prediction.[15] As part of the research process, the following steps are required:

- Identify the existing topologies
- Choose a topology that fits the research needs
- Train the neural network with the data to be collected

- Re-train the model. Neural network models should be re-trained in order to improve their accuracy

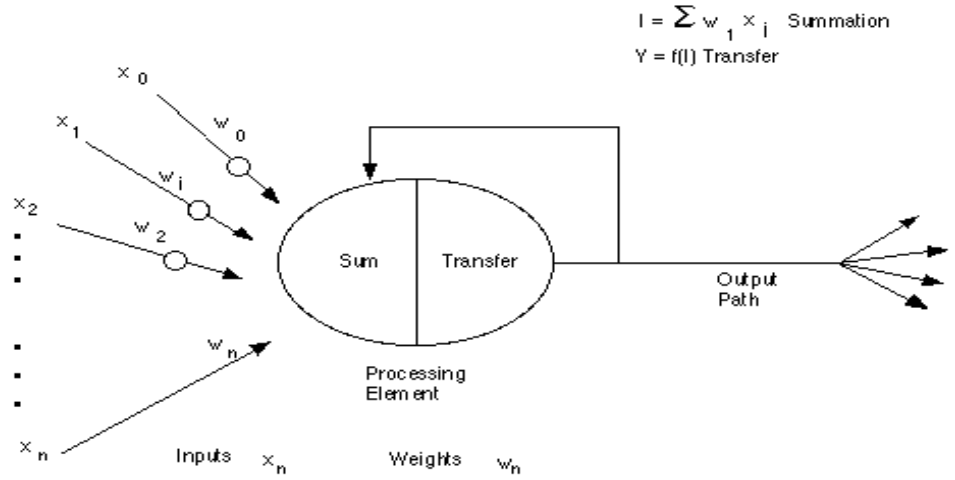


Figure 2-2 Basic Units of Neural Networks

Finally, when an acceptable level of accuracy is reached in the model outputs, a decision tree will be extracted from the neural network model. The reason for developing these models is because they are easier to understand by non-scientific users.

Training the model consists of six steps:[16]

- Choose the neural network with the best fits for the problem
- Provide the neural network with a set of statistical input data and output data variables
- The neural network user might provide to the system the initial weights
- The output values are generated by the neural network
- The error between the calculated outputs and the desired values is calculated using Equation 3

$$\delta^{(k)} = Z - y^{(k)} \qquad (3)$$

Where:

$\delta^{(k)}$= Vector of errors

$y^{(k)}$= Vector of calculated outputs

Z= Vector of expected outputs

- The weight matrix might be modified before the next iteration starts

In order to train the model, steps 4 to 6 might be repeated until the model provides acceptable results.

2.3.2 Bayesian Networks

Bayesian theory is based on subjective probability. Bayes' Theorem tries to identify an indicator of failure. The main idea is to examine post-failure investigations to see how often the indicator of failure appears when failure has occurred.[17] Bayes' Theorem is used by Bayesian Networks to predict the occurrence of a single event. This theorem can be expressed as

$$P [f/I]=P [I/F] xP [F]/((P [I/F] xP [F])+(P [I/N] xP [N])) \quad (4)$$

Where:

P= probability

F= failure

I= indicator

N= no failure

Bayesian Networks are a type of probabilistic graphical model that allow the user to manage uncertainty probabilistically. These networks are helpful in finding unknown variables through the use of structural relationships and data.[18] Bayesian Networks are based on three principles:

1. Inferences will be made based on previously collected data
2. Based on Bayes' theorem, the best way to make predictions is using probabilities
3. Some of the problems studied have levels of uncertainty.

In this research, Bayesian Networks such as neural networks will help to predict bankruptcy based on information gathered from filed cases. This will facilitate the analysis of variables that cause bankruptcy, and predict the business failures using probabilistic analysis.

The neural networks model to be developed cannot be proven true or false; these models can only be confirmed or rejected by the data collected.[17]

2.3.3 Prediction Models

Statistical and mathematical models have been unable to predict bankruptcy when companies' financial ratios are not linear. Neural network models provide an alternative to predict bankruptcy whether companies' financial ratios are linear or not. The following models are some of the most important neural networks prediction models.

2.3.3.1 Back propagation algorithm

Dorota Witkowska performed this research in 1999.[16] The main purpose of this research was to provide an artificial neural network model for financial institutions. These artificial neural network models would help banks to identify possible business failures.

Dorota Witkowska used information from 75 companies. Thirteen companies' data were used as a testing sample, and sixty-two companies' data was used as training data. In order to predict bankruptcy, information about financial conditions, and the functioning environment should be collected. The neural networks used are shown in Figures 2-3, 2-4, and 2-5.[16]

These neural networks (Fig. 2-3, 2-4, and 2-5) are denoted as: 4-2-1, 4-6-1, and 4-2-2-1 depending of the number on nodes in each layer. Furthermore, these neural

networks have one or two hidden layers. The number of iterations performed on each one of these neural networks was 5,000, 10,000, 20,000, 40,000 and 50,000.

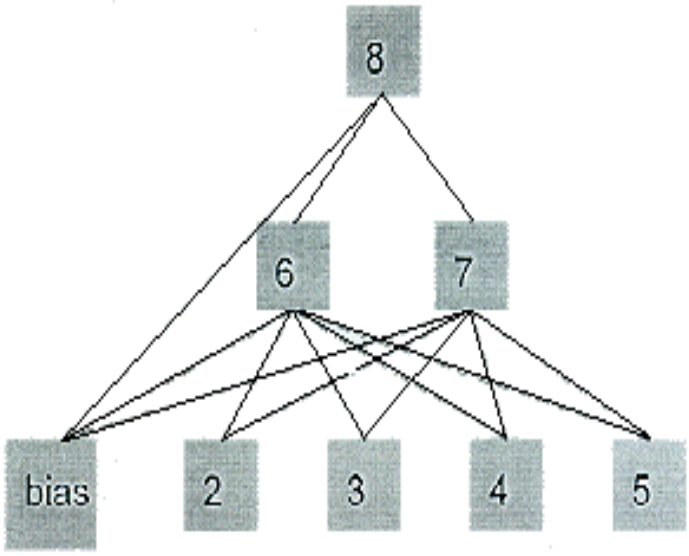


Figure 2-3 Neural Network with Two Elements in the Hidden Layer (4-2-1)

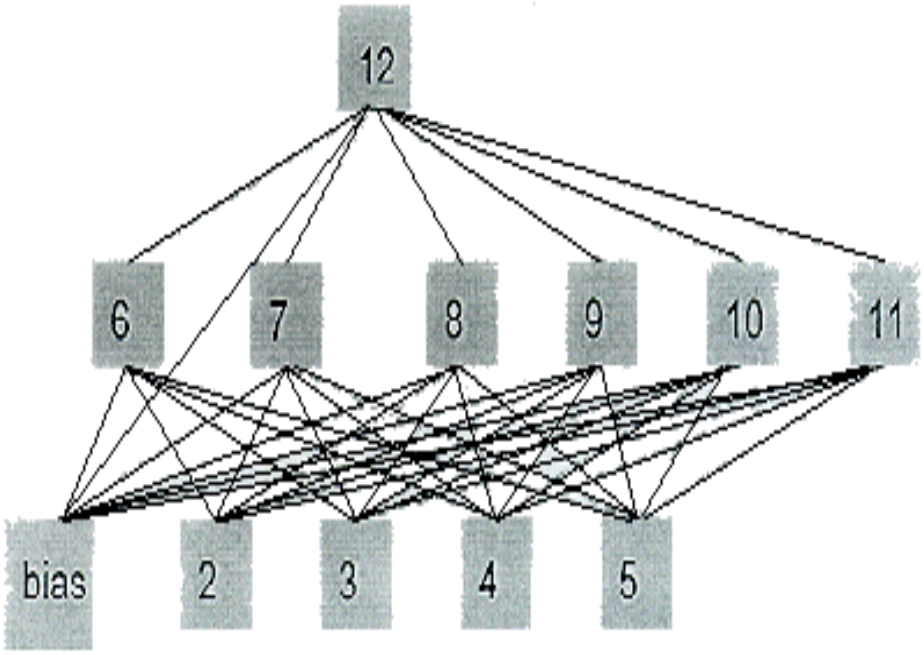


Figure 2-4 Neural Networks with Six Elements in the Hidden Layer (4-6-1)

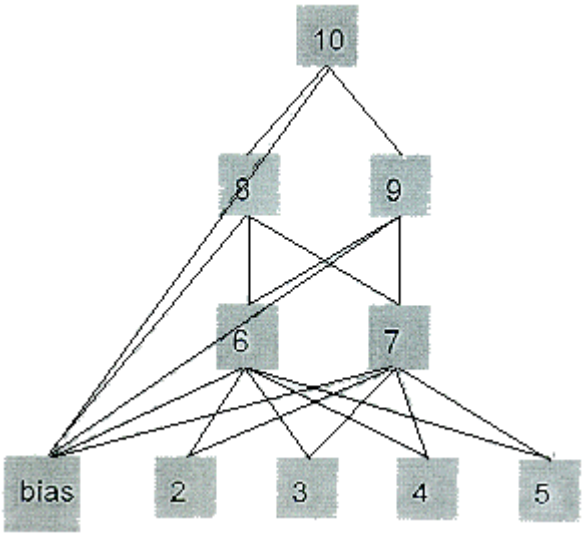


Figure 2-5 Neural Network With Two Hidden Layers (4-2-2-1)

Dorota Witkowska found that:

- These models are the best predictors of which companies are not going to fall into bankruptcy.
- The algorithms are less accurate when less than 10,000 iterations are performed.
- The classification error was less than 8 percent for networks 4-2-2-1 and 4-2-1; and 15.38 percent for network 4-6-1.

In conclusion, the back propagation algorithms need at least 200 – 600 observations to train the prediction model.[16]

2.3.3.2 Probabilistic neural networks

Zheng Rong Yang[19] at the University of Exeter, UK, developed this model. In this research, 2,408 companies were surveyed in the United Kingdom from 1989 to 1995. The financial statements of these 2,408 companies provided 33 financial ratios for each firm.

The relationship between financial ratios and company financial strength is not linear. In order to solve this constraint, a neural network model might be selected. Some of the models that have been used to predict bankruptcy since 1992 are probabilistic

neural networks, self-organization mapping, back-propagation neural networks, and probabilistic neural networks.[19] Also, Mr. Yang wanted to use templates because templates allow one the detection of critical financial problems during the research process. The most common methods used to define templates are

- K-means method
- Fuzzy c-means method
- Hohonen self-organization mapping

The main purpose of using templates is to minimize the misclassification probability.[19] Zheng Rong Yang chose to use a probabilistic neural network.

The methodology proposed by Mr. Yang was:

- Companies are chosen, and financial statements are gathered
- Two data sets are created. One data set will be used for training, and the other for testing
- The probabilistic neural network is trained
- The probabilistic neural network as an output provides a posterior probability. If the posterior probability of survival is greater than the posterior probability of failure, the company will survive
- Templates are created. In this research two templates were created: failure and survival.

Zheng Rong Yang used other prediction methods such as the logit analysis, linear discriminate analysis, and back-propagation neural networks to compare his results. As a conclusion, Mr. Yang found that the probabilistic neural network performed better than the other prediction models. The accuracy of the probabilistic neural network model was 95.5 percent accurate in predicting company survival, and 92.37 percent accurate in predicting company failure.

2.3.3.3 Genetic algorithm

This method was developed by Xiaotong Li and Jatinder N. D. Gupta[20] at the University of Alabama in Huntsville. Li and Gupta compared the predictions made by a neural network genetic algorithm to other prediction models such as logit, probit, logit with heteroscedasticity, and probit with heteroscedasticity. The data used in this study consisted of two data sets gathered by Altman, Frydman and Kao in 1985.[20] The first data set had 200 companies with four financial ratios. The second data set had 200 companies with six financial ratios. The financial ratios were:

- Cash Flow/Total Debt
- Retained Earnings/Total Assets
- Cash/Total Sales
- Total Debt/Total Assets
- Market Value of Equity/Total Capitalization
- Log (interest coverage+15)(log L)
- Quick Assets/Total Assets

The five steps used by Li and Gupta to train their prediction model were:[20]

- Generation of initial population
- Calculation of errors
- Reproduction
- Crossover
- Transformation

In order to evaluate the model performance, the two data sets mentioned before were subdivided into subsets. The first data set provided subsets where 6 companies failed and 14 succeeded. The second data set provided subsets where 9 companies failed, and 21 succeeded.

As a conclusion, Li and Gupta found that neural networks that use genetic algorithms performed better than the other prediction models mentioned before, even 100,000 iterations of their model.

2.3.3.4 Feed-forward back-propagation model

Gregory Golinski at New York University developed this prediction model in 1998. Although this is a common neural network model, the feed-forward back-propagation network is one of the most reliable ones (Figure 2-6).[15]

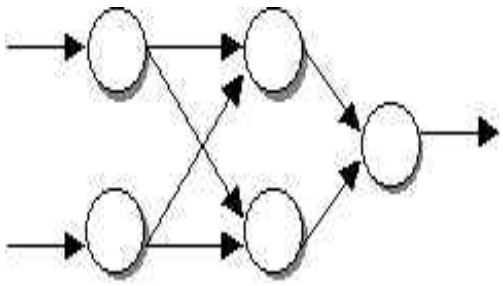


Figure 2-6 Feed-Forward Back-Propagation Neural Network

In his model, Gregory Golinski used five input nodes, five hidden nodes, and one output node. The ratios he used to build his prediction model were the same five ratios suggested by Altman:[5]

6. Market Value of Equity/Total Assets
7. Sales/Total Assets
8. EBIT/Total Assets
9. Retained Earnings/Total Assets
10. Working Capital/Total Assets

The data used by Golinski was obtained from Compustat Industrials. He analyzed information collected from 1981 to 1997. In order to train and test his model, Gregory Golinski chose 104 companies, fifty-two failed companies, and fifty-two healthy

companies. The results showed that the feed-forward back-propagation model provided a 96 percent prediction rate in the first year.

2.3.3.5 Probabilistic neural networks without patterns normalized

This study was developed by Z. R. Yang at University of Portsmouth, and Marjorie B. Platt and Harlan D. Platt at Northeastern University in 1998. In Their study, they compared different neural network models in bankruptcy prediction. The prediction models used were:

- Fisher discriminant analysis
- Back-propagation neural networks
- Probabilistic neural networks
- Probabilistic neural networks without the patterns normalized.

In the results found by Yang, Platt, and Platt, the probabilistic neural networks without the patterns normalized provided the best bankruptcy prediction model in the prediction of non-bankruptcy firms with 100 percent accuracy. Yang, Platt, and Platt studies used a sample size of 38 companies, including 30 successful companies, and 8 companies that failed. The data were obtained from the United States gas and oil industry.

2.3.3.6 Three-perceptron network

Marcus D. Odom, and Ramesh Sharda developed this prediction model in 1998.[22] This neural networks model consisted of five nodes in the input layer, 5 nodes in the hidden layer, and 1 node in the output layer (Figure 2-7).[22]

If the output is greater than 0.5, the company is classified as successful. Otherwise it is considered bankrupt. Odom and Sharda used information from companies that filed bankruptcy from 1975 to 1982. They used information from 129 companies, where sixty-four companies were healthy companies and sixty-five companies became

bankrupt. In order to train and test the model, the 129 companies were subdivided into two subsets. The first subset used to train the model consisted of thirty-six healthy companies and thirty-eight bankrupt companies. The second subset used to test the neural network consisted of twenty-eight healthy companies, and twenty-seven bankrupt companies. Odom and Sharda used 191,400 iterations to train the model. The input variables X1, X2, X3, X4, and X5 were the same as those recommended by Altman in 1968.[15] Using this neural network model, Odom and Sharda were able to predict bankruptcy with 81.48 percent accuracy.[22]

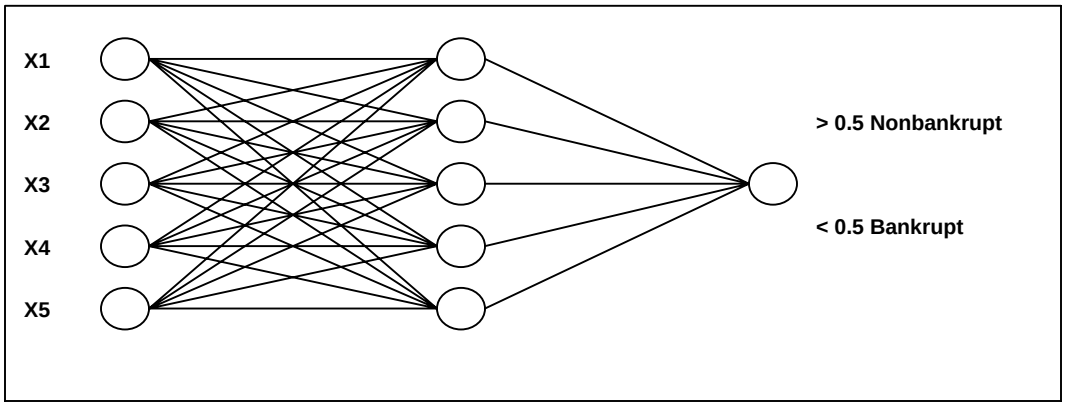


Figure 2-7 Three-Perceptron Network

2.4 Mistakes In Bankruptcy Prediction

The most common mistakes made in bankruptcy predictions are classified as Type I errors or Type II errors. A Type I error occurs when the prediction model classifies a company that filed bankruptcy as a healthy company; and a Type II error occurs when the model classifies a healthy company as a failed company.[11] Type I errors are usually more costly for model users.

In conclusion, even though the use of neural networks to predict business failures began in the early 1990s, there is no information concerning bankruptcy prediction in construction companies in the United States.

CHAPTER 3
RESEARCH

3.1 Type of Data to Collect

There is one type of data that might be collected in order to complete this dissertation. This type of data is financial information from public trade construction companies that have filed Chapter Seven or Chapter Eleven in recent years, and from companies that are seemingly healthy companies (companies that are presently in business). In order to train the algorithm, 50% of the data might come from healthy companies, and 50% from companies that went into bankruptcy. This information should contain:

- Name of the company
- Scope of work
- Yearly financial statements
- Information about the owner(s) and employee(s)
- Geographic dispersion
- Amount of work performed by the company
- Growth rate
- Other variables that could have generated bankruptcy

Moreover, it is important to mention that some of the neural networks models request specific types of data such as ratios or probabilities that can be extracted from other studies.

3.2 How Data Will Be Collected

The financial information from construction companies is going to be requested from specialized companies and Bankruptcy Courts. Some of the organizations that collect financial information from construction companies are:

3.2.1 Dun & Bradstreet

D&B[23] provides its users with financial and market information from different industries through web-based access. D&B has a database with information of more than 79 million companies. These companies are from 214 countries around the world. In its database, Dun & Bradstreet classifies its financial information of construction companies in fields such as concrete work, construction & mining equipment, contractors-specialized public buildings, construction & civil. The types of data that this organization collects are:

- Company name and location
- Location
- Number of employees
- Sales information
- Annual sales
- Base sales
- Trend sales
- Net worth
- Business and industry information
- Business credit rating of companies

3.2.2 U.S. Courts

US courts[24] provide electronic public access to court records. The main purpose of this webpage is to inform the public about the bankruptcy cases filed in the courts of the eleventh circuits, the Washington circuit and the Federal circuit. The information offered by this web site contains:

- Company's financial information

- Debtor's personal information
- Any other information filed in bankruptcy courts

3.2.3 FactSet

FactSet Research Systems Inc.[25] was founded in 1978. FactSet uses more than 200 databases in order to provide data for investment analysis. The main purpose of this company is to provide comprehensive financial information to financial professionals, investment bankers, and investment managers. Much information can be found at this webpage contains:

- Asset management information
- Corporate finance
- Institutional sales
- Research
- Trades
- Company analysis
- Financial analysis
- Real-time market data

3.2.4 Moody's industrial manual

The Moody's industrial manual[26] is an encyclopedia of American business. Its first publication was in 1909. The Moody's industrial manual provides companies' financial information, and companies' profiles. Some of its publications are:

- Moody's Analyses of Railroad Investments
- Moody's Transportation Manual
- Moody's Municipal and Government Manual
- Moody's OTC Industrial Manual

- Moody's Bank and Finance Manual
- Moody's Manual of Banks and Finance

3.2.5 The American bankruptcy institute

The American Bankruptcy Institute[27] is an organization created to provide The United States Congress and the public with impartial analysis of bankruptcy issues. The American Bankruptcy Institute has publications such as ABI Journal, Consumer Bankruptcy: Fundamentals of Chapter Seven and Chapter Eleven of the U.S. Bankruptcy Code, ABI Law Review, and the Creditors' Committee Manual.

3.2.6 Pricewaterhousecooper

Pricewaterhousecooper[28] is a company that works in more than 140 countries worldwide, providing financial information to financial professionals, and companies. Pricewaterhousecooper offers services such as:

- Assurance and business advisory services
- Business recovery services
- Corporate finance
- Dispute analysis and investigation
- Valuation and strategy

In the construction industry, Pricewaterhousecooper provide services such as project control services, corporate facility management, mergers and acquisitions, property and project risk management.

3.2.7 Onesource

OneSource[29] was created in 1987 as a division of Lotus Development Corporation. It became an independent company in 1993. "OneSource has partnered with leading business information providers including Dun & Bradstreet, the Financial Times, Market

tool used by major multinational firms and elite universities.[30]" The main purpose of this company is to provide business information to professionals involved in finance and management, marketing, and sales.

The information provided by this website includes:

- Company general information
- Company sales
- Number of Employees
- Net income
- Operational margin
- Stock price
- Assets
- Market capital
- Company and industry research
- Account prospecting and business development

3.2.8 Dodge Report

Dodge is a report prepared by Mc-Graw Hill construction31. It provides to construction companies information related to market and financial analysis in order to help professionals in the decision making process. Some of the information that can be found in these reports is:

- Competitive position
- Market trends & forecasts
- Market track
- Building stock database

3.3 The Kind of Construction Companies to Survey

Financial variables that generate the greatest impact will be identified using statistical methods. When the process is completed, the type of companies that are more vulnerable to bankruptcy will be identified. Finally, other variables from those companies such as type of work, net income, and location will be identified. It is important to identify companies that are actually in business, and with similar characteristics to the companies under study.

3.4 How Data Will Be Analyzed

In order to analyze the data mentioned before, commercial software that best fits our needs will be used. This software should meet the three following characteristics:

- Provide graphic results
- Be easy to use
- Have the necessary statistical tools required to analyze our data.

The most well known statistical programs in the market are:

- MINITAB: This software provides the user with graphical and statistical analysis. Minitab is easy to use, and it brings a complete compilation of statistic methods.
- SAS: This statistical program provides the user with a complete statistical data analysis package. The main disadvantage of this statistic package is that it takes a lot of time to learn how to use it.
- SPSS-W: This statistic package is normally used in social sciences. This software provides information that can be pasted into Microsoft Word.
- JMP: This statistic package is normally used in biological sciences. This was also developed by the SAS institute. This software mostly provides graphical outputs.
- S+: This is an object-oriented program. S+ uses a programming language that was designed for statistical analysis. The main advantage of this program is that it allows the user to combine existing statistical procedures with recently developed statistical procedures. The main disadvantage is that users might spend a lot of time learning the programming language.

- R: This statistics software can be considered as a modified version of S+. Also, it is important to mention that R has all the advantages and disadvantages of the S+ statistics software.

- EXCEL: This Microsoft product has some limitations when it is used to solve complex statistics problems. Even though EXCEL provides good quality graphics, other statistics packages provide more useful outputs.

R will be the statistical package that will be used to analyze the data collected due to its easy use, and its valuable graphic reports.

3.5 Software to Analyze Neural Networks

In order to build and analyze the financial ratios from healthy and bankrupt companies, the commercial software that best fits this research needs is going to be used. Presently, it is possible to find a great variety of software in the market that help users to build, train and test neural networks. It is important to consider that the software might be easy to use, and it must be visual-oriented. The most popular are:

- NeuroSolutions 4.2: NeuroSolutions 4.2[32] is the one of the most powerful and flexible development environment available on the market today. It makes it easy to build and train a neural network to solve problems. After the neural network is tested. NeuroSolutions 4.2 helps the user to transform his neural network solution to a custom application.

- TradingSolution 2.1: TradingSolutions 2.1[32] is a very helpful tool for financial modeling. It combines neural network and genetic algorithm technologies with traditional technical analysis.

- ABM (Attrasoft Boltzmann Machine) v2.70: [33] This software is developed and distributed by Attrasoft. ABM can simulate two types of neural networks, the Boltzmann Machine and the Hopfield Model. It can also support up to 10,000 external neurons.

- Netlab neural network software: Netlab[34] can simulate neural network algorithms and related models. It is primarily used in research, teaching and applications development.

- BrainMaker v3.7: BrainMaker Neural Network Software[35] uses one of the most effective algorithms available: back propagation. This software provides the user with different data analysis tools such as data correlator, cyclic analysis, graphs, sensitivity analysis, and what-if scenarios.

- NeuroShell 2: NeuroShell two was developed by the Ward Systems Group, Inc.[36] This software is mostly used with academic purposes because it provides the user with 16 neural networks architectures.

- Thinks and ThinksPro: Thinks and ThinksPro[37] have one some of the most effective training methods available in the market. It also has powerful dynamic graphing and visualization tools. This software is normally used in financial analysis, forecasting, function approximation decision-making and prediction.

- Easy N-N Plus: Easy Neural Networks[38] Plus generates multi-layer neural networks. Easy N-N plus can use numeric data, images or text. The neural networks display is updated dynamically allowing the user to see how the neural network works. It is usually used in forecasting, analysis, and prediction.

The topologies used by the software, learning time, and price influenced the selection of NeuroSolutions.

CHAPTER 4
FINANCIAL RATIOS

Glossary of Terms

Investopidia.com[39]-financial dictionary defines the following terms as:

1. Assets: Anything that an individual or a corporation owns that has economic value to its owner.

2. Book Value per Share: A measure used by owners of common shares in a firm to determine the level of safety associated with each individual share after all debts are paid accordingly.

3. Cash Dividends: Money paid to stockholders, normally out of the corporation's current earnings or accumulated profits.

4. Cash Flow: The amount of cash a company generates and uses during a period, calculated by adding non-cash charges (such as depreciation) to the net income after taxes.

5. Current Assets: It represents cash, accounts receivable, inventory, marketable securities, prepaid expenses, and other assets that can be converted to cash within one year.

6. Current Liabilities: It represents the amount owed for interest, accounts payable, short-term loans, expenses incurred but unpaid, and other debts due within one year.

7. Depreciation: An expense recorded to reduce the value of a long-term tangible asset. Since it is a non-cash expense, it increases free cash flow while decreasing the amount of a company's reported earnings.

8. Dividends: A cash payment, using profits, announced by a company's board of directors and distributed among stockholders.

9. Gross Profit: It is their revenue minus cost of goods sold (also called gross margin).

10. Interest Expense: The amount reported by a company as an expense for borrowed money or long-term debt.

11. Inventory: Inventory can be either raw materials, finished items already available for sale, or goods in the process of being manufactured. Inventory is recorded as an asset on a company's balance sheet.

12. Long term Debt: Loans and financial obligations, lasting over one year, on which interest is paid.

13. Net Income: Company's total earnings, reflecting revenues adjusted for costs of doing business, depreciation, interest, taxes, and other expenses.

14. Net Sales: The amount a seller receives from the buyer after costs associated with the sale are deducted.

15. Outstanding Shares: The number of shares that are currently owned by investors. This includes restricted shares (shares owned by the company's officers and insiders) and shares held by the public.

16. Quick Assets: Assets that can be easily be converted into cash or are already in cash form.

17. Retained Earnings: The percentage of net earnings not paid out in dividends, but retained by the company to be reinvested in its core business or to pay debt.

18. Total Equity: A term describing stock, or any security, representing an ownership interest.

19. Total Liabilities: A legal debt or obligation estimated via accrual accounting.

20. Working Capital: A valuation metric that is calculated as current assets minus current liabilities.

4.1 Financial Ratios

Financial ratios are frequently used to quantitatively analyze financial statements of a company through the calculation of numerical relationships or ratios.[39] Moreover, financial ratios provide information about companies' strengths and weaknesses. There are two types of financial ratios:

- Financial ratios calculated by using financial information from a given year.
- Financial ratios calculated by using financial information from different years.

Also, financial ratios are grouped into categories. Some of the most important measures are liquidity analysis ratios, profitability analysis ratios, leverage analysis

ratios, activity analysis ratios, capital structure analysis ratio, and capital market analysis ratios. Although each of these categories contains many analysis ratios, this research will be limited to using those provided by the financial statements.

4.1.1 Liquidity Analysis Ratios

Liquidity analysis ratios give insight to the company's short-term financial condition. A liquidity ratio measures "the ability of a company to meet its short-term financial obligations without having to liquidate its long-term assets, or cease operations. [40]" Some of the most commonly used liquidity analysis ratios are the quick ratio and the current ratio.

4.1.1.1 Quick ratio

The quick ratio measures the relationship of assets that a company can quickly liquidate to its current liabilities. The assets in a quick ratio do not include inventory items. A quick ratio equal to or higher than one indicates that the company has good liquidity. A quick ratio lower than one indicates that a company is not able to meet its financial obligations. A typical quick ratio is 2:1.

$$\text{Quick Ratio} = \text{Quick Assets} / \text{Current Liabilities} \qquad (6)$$

4.1.1.2 Current ratio

The current ratio measures the capacity of a company to pay its liabilities by using its current assets. A current ratio higher than 2.5 indicates that a company has great liquidity. However, current ratios lower than one indicate that a company is unable to meet its current obligations with current assets; consequently, this company is considered economically bankrupt.

$$\text{Current Ratio} = \text{Current Assets} / \text{Current Liabilities} \qquad (7)$$

4.1.2 Profitability Analysis Ratio

Profitability analysis ratios provide insight to a company's capital employed and return on sales. This ratio measures the efficiency of operations and the company pricing policies.[41] Some of the most commonly used profitability analysis ratios are return-on-assets ratio, return-on-equity ratio, net profit margin ratio, gross profit margin ratio, return-on-investment ratio, and return-on-sales ratio.

4.1.2.1 Return-on-assets ratio

The return-on-assets (ROA) ratio measures how effective a company has been at putting its assets to work.[42] It measures the profitability of assets based on the rate earned on each dollar invested in assets. This ratio is useful when it is compared to the amount of interest paid by the company. If the ROA is greater than the interest paid, the company is receiving profits. Otherwise, the company is losing money.

$$\text{Return-on-Assets} = \text{Net Income} / \text{Total Assets} \quad (8)$$

Net income can be defined as company's total earnings after paying taxes, operation expenses, interest, and depreciation.

4.1.2.2 Return-on-equity ratio

This financial ratio measures the company shareholder's profitability after all expenses and taxes are paid. The return on equity ratio also measures the average profit that a company makes per each dollar of equity. This financial ratio should be higher than one.

$$\text{Return-on-Equity} = \text{Net Income} / \text{Total Equity} \quad (9)$$

4.1.2.3 Net profit margin ratio

The net profit margin ratio measures the percentage of gains after subtracting expenses. This ratio also indicates how much profit a company has earned per dollar of

turnover (sales). This financial ratio should be greater than one in order to have profits.

Net Profit Margin Ratio= Net Income After Tax / Total Sales (10)

4.1.2.4 Gross profit margin ratio

This ratio measures how much money a company is earning (total revenue) per dollar of sales. This ratio is calculated before charging overhead. A low gross profit margin ratio indicates that the prices of goods are increasing faster than the selling prices, and would indicate to a company that their pricing structure may need to be evaluated and adjusted more frequently.

Gross Profit Margin Ratio = Gross Profit / Turnover (11)

Where gross profit can be defined as total income before deductions. The gross profit is calculated as the difference between net sales and the cost of goods sold.

Gross Profit = Net Sales – Cost of Goods Sold (12)

4.1.2.5 Return-on-investment ratio

This ratio measures the company's profitability on the assets after all expenses and taxes are charged. A low ratio indicates that the owner or creditors should have invested their money on another project, or that management is not doing a good job.

Return-on-Investment = Net Income After Taxes / Total Assets (13)

4.1.2.6 Return-on-sales ratio

The return on sales ratio can help to demonstrate whether a company is making an adequate return compared to the effort the company is making on its sales. This ratio indicates if the prices a company is charging are right or should be increased. This ratio

is most informative when computed several years. If the trend shows that the ratio is decreasing, it means that a company is earning less on its sales than in the past. If corrective measures are not taken, the company could be heading for serious financial problems.

Return-on-Sales Ratio = (Net Income (before interest and tax) / Turnover) (14)

4.1.3 Leverage Analysis Ratios

Leverage analysis ratios give an idea of how a company generates cash flow, and how effectively a company pays its financial obligations. Moreover, leverage analysis ratios calculate the proportion of the owner and creditors' investment. Leverage ratios that will be analyzed are debt to assets ratio, equity to assets ratio, debt to equity ratio, and times-covered ratio.

4.1.3.1 Debt-to-assets ratio

This ratio gives an indication of the amount of company assets that are owned by creditors. A low debt-to-Assets ratio means that the company is closer to the goal of debt-free operation.[43] Companies with debt-to-assets ratios higher than the average for that industry will have problems borrowing extra funds.

Debt-to-Assets Ratio = Total Liabilities / Total Assets (15)

4.1.3.2 Equity-to-assets ratio

This ratio measures the amount of the total assets that were financed by the owner's equity capital. A high equity-to-assets ratio means that most of the company's assets were bought by the owner's money instead of creditors' money.

Equity-to-Assets Ratio = Total Equity / Total Assets (16)

4.1.3.3 Debt-to-equity ratio

This ratio measures the amount of equity capital that has been combined with debt capital. A low debt-to-equity ratio means that most of the capital has been supplied by the owner instead of by creditors. The debt-to-equity ratio measures how much a company is leveraged. A high debt to equity ratio sends a message to the company that it should reduce its debt.

Debt-to-Equity Ratio = Total Liabilities / Total Equity (17)

4.1.3.4 Times-covered ratio

This ratio measures how much of the company's gross profit is used to cover annual interest payment. A times-covered ratio lower than one shows that a company is insolvent because it is unable to meet its interest obligations.

Times-Covered Ratio = Income Before Interest and Tax / Total Interest Expenses (18)

4.1.3.5 Interest coverage ratio

The interest coverage ratio measures "the number of times a company could make its interest payments with its earnings before interest and taxes.[44]" The higher the ratio, the lower the company's debt loads.

Interest Coverage Ratio = Income Before Interest and Income Tax Expenses / Interest Expense (19)

4.1.4 Activity Analysis Ratios

The activity analysis ratios measure how successful the company has been in collecting its receivables, and the quality of the receivables. Also, this ratio measures how effectively a company is managing its assets. Some of the most common activity

analysis ratios are inventory turnover ratio, accounts receivable turnover ratio, and total assets to turnover ratio.

4.1.4.1 Inventory to turnover ratio

The inventory turnover ratio measures annual inventory turnover telling how often a business' inventory turns over during a year. A high inventory to turnover ratio may indicate that the company is losing sales. This ratio should be compared to the industry average.

Inventory Turnover Ratio = Cost of Goods Sold / Average Inventories (20)

4.1.4.2 Accounts receivable to turnover ratio

This ratio measures how fast (average length of time) customers pay their bills. A low account receivable turnover ratio indicates that a company has creditors who are slow in making payments or that some receivables will never be collected (bad debts).

Accounts Receivable Turnover Ratio = Net Sales / Average Account Receivable (21)

4.1.4.3 Total assets to turnover ratio

The total assets to turnover ratio compares the assets that the company has used to generate a turnover, with the turnover generated. A high assets turnover ratio indicates that a company is highly efficient using its assets to produce turnover.

Assets Turnover Ratio = Total Asset / Turnover (22)

4.1.5 Capital Market Analysis Ratios

Capital market analysis ratios measure the performance of the common stock of the company. The most common capital market analysis ratios are market-to-book ratio, dividend-yield ratio, price-to-earning ratio, and dividend-to-payout ratio.

4.1.5.1 Market-to-book ratio

The market-to-book ratio measures management's success in creating value for the company's stockholders. Historical standards show that a market-to-book ratio of two is normal. Presently, average market-to-book value ratios are higher (Figure 4-1).[45]

Market-to-Book Ratio = Price per Share / Book Value per Share (23)

Where:

Book Value per are = Total Owner's Equity / Number of Shares Outstanding (24)

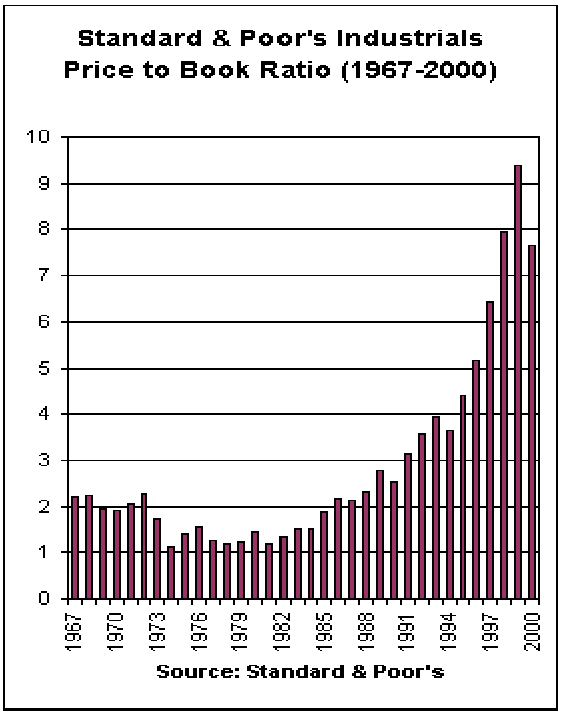


Figure 4-1 Historical Market to Book value Ratio

4.1.5.2 Dividend-yield ratio

The dividend-yield ratio compares current market value of a company's shares with the latest dividends paid by the company. A high dividend-yield ratio indicates to investors that the business is profitable or that the company has no investment opportunity.

Dividend-Yield Ratio = Annual Dividends per Common Share / Market Price of Common Stock per Share (25)

4.1.5.3 Price-to-earning ratio

The price-to-earning ratio provides an idea of how many times the market is willing to pay for the current earning of the company. A high price-to-earning ratio means that the market anticipates a future profitable growth.

Price-to-Earning Ratio = Market Price of Common Stock per Share / Earnings per Share (26)

4.1.5.4 Dividend-to-payout ratio

The dividend-to-payout ratio measures how well earnings support the dividend payments. Normally, young companies have a low dividend payout ratio. In normal practice the dividend-to-payout ratio should not exceed two-thirds of earnings, to allow for the reinvestment of capital.

Dividend-to-Payout Ratio = Cash Dividends / Net Income (27)

4.1.6 Bankruptcy Analysis Ratios

Bankruptcy analysis ratios can predict "financial problems up to three years prior to bankruptcy.[45]" The most common bankruptcy analysis ratios in use are networking capital ratio, retained earnings to total assets, EBIT-to-total assets, sales-to-total assets, equity-to-debt, and cash flow-to-debt.

4.1.6.1 Net working capital ratio

This ratio measures the company's proportion of assets in net current assets. The net working capital is represented by the residue of the current assets. Constant operating losses will cause current assets to decline relative to total assets. A negative net working capital ratio indicates a possible business failure.

Net Working Capital Ratio = Working Capital / Total Assets (28)

Where:

Working Capital = Current Assets – Current Liabilities (29)

4.1.6.2 Retained earnings to total assets ratio

This ratio measures what portion of the earnings will not be returned as dividends. These retained earnings are normally used to increase the company assets. Also called the bankruptcy analysis ratio, if it is low, it will indicate to new companies that they will have financial problems.

Retained Earning to Total Assets Ratio = Retained Earnings / Total Assets (30)

4.1.6.3 Net income-before-interest-and-taxes (EBIT)-to-total assets ratio

This ratio measures how productive a company's assets are. If earnings generated by company assets are lower than liabilities, the company will have financial problems. The higher this ratio is, the better the financial strength of the company.

Net Income plus Tax Ratio = Net Income plus Tax / Total Assets (31)

4.1.6.4 Sales-to-total assets analysis ratio

The sales-to-total assets analysis ratio indicates management's skills to function in competitive situations, while not excluding intangible assets. Also, this ratio measures the company's talent to generate turnover given its asset base. The higher this ratio is, the better for the company.

Sales-to-Total Assets ratio = Total Sales / Total Assets (32)

4.1.6.5 Equity-to-debt analysis ratio

The equity-to-debt ratio calculates the relative amount of a company's assets that can lose value before that company becomes insolvent. Companies with equity to debt ratio higher than 2 are considered safe.

Equity-to-Debt Ratio = (Market Value of Common plus Preferred Stock) / (Total Current plus long term Debt) (33)

4.1.6.6 Cash flow-to-debt analysis ratio

This bankruptcy ratio indicates whether a company has enough money to pay its debts when the due dates draw near. This financial ratio should not be compared to the same ratio of other companies or industries. If the cash flow to debt ratio is lower than one, the company will have liquidity problems.

Cash Flow-to-Debt Ratio = Cash Flow / Total Debt (34)

Where:

Cash Flow = Net Income + Depreciation (35)

4.1.7 Cash Flow Analysis Ratios

The net income variables in equations 4.1.2.1, 4.1.2.2, 4.1.2.3, and 4.1.3.4 were replaced with cash flow variables in order to see whether cash flow ratios affect construction companies. The new analysis ratios are:

- Return-on-Assets = Cash Flow / Total Assets (36)
- Return-on-Equity = Cash Flow / Total Equity (37)
- Net Profit Margin Ratio= Cash Flow / Total Sales (38)
- Times-Covered Ratio = Cash Flow / Total Interest Charges (39)

4.2 Data Collected

Table 4-1 provides a summary of the type of information gathered from each one of the data sources mentioned in Chapter 3. Financial statements from 67 heavy construction companies have been collected, where 34 were regarded as healthy companies (construction companies that are currently in business) and 33 were unhealthy (companies that have filed bankruptcy under Chapter Seven or Chapter Eleven). From Table 4-1, it is possible to appreciate that not all the data sources provided valuable

information. Sources such as U.S. Courts provided limited information about each company's filings. The American Bankruptcy Institute provides information about conferences, publications, and statistics, but it does not provide any specific information about the companies that filed bankruptcy.

Data sources such as OneSource, Hoover's, Emergent Online, and Compustat summarize the information collected by Dun & Bradstreet and other companies that gather financial information. In the case of Factset, this company uses information collected from Compustat.

Table 4-1 Data Summary (Data analyzed from 67 different companies)

Variables	Dun & Bradstreet	U.S. Courts	FactSet	Moody's industrial manual	The American Bankruptcy Institute	Pricewaterhousecooper	OneSource	Hoover's	Mergent Online	Compustat
Quick Ratio	-	-	-	X	-	-	X	X	X	X
Current Ratio	-	-	-	X	-	-	X	X	X	X
Return on Assets	-	-	-	X	-	-	X	X	X	X
Return on Equity	-	-	-	X	-	-	X	X	X	X
Net Profit Margin Ratio	-	-	-	X	-	-	X	X	X	X
Gross Profit Margin Ratio	-	-	-	X	-	-	X	X	X	X
Return on Investment	-	-	-	X	-	-	X	X	X	X
Return On Sales Ratio	-	-	-	X	-	-	X	X	X	X

Table 4-1 Continued

Variables	Dun & Bradstreet	U.S. Courts	FactSet	Moody's industrial manual	The American Bankruptcy Institute	Pricewaterhousecooper	OneSource	Hoover's	Mergent Online	Compustat
Debt / Assets Ratio	-	-	-	X	-	-	X	X	X	X
Equity / Assets Ratio	-	-	-	X	-	-	X	X	X	X
Debt / Equity Ratio	-	-	-	X	-	-	X	X	X	X
Times-Covered Ratio	-	-	-	X	-	-	X	X	X	X
Interest Coverage Ratio	-	-	-	X	-	-	X	X	X	X
Inventory Turnover Ratio	-	-	-	X	-	-	X	X	X	X
Accounts Receivable Turnover Ratio	-	-	-	X	-	-	X	X	X	X
Total Assets Turnover Ratio	-	-	-	X	-	-	X	X	X	X
Market to Book Ratio	-	-	-	X	-	-	X	X	X	X
Dividend Yield Ratio	-	-	-	X	-	-	X	X	X	X
Price Earning Ratio	-	-	-	X	-	-	X	X	X	X
Dividend Payout Ratio	-	-	-	X	-	-	X	X	X	X

Variables	Dun & Bradstreet	U.S. Courts	FactSet	Moody's industrial manual	The American Bankruptcy Institute	Pricewaterhousecooper	OneSource	Hoover's	Mergent Online	Compustat
Net working Capital Ratio	-	-	-	X	-	-	X	X	X	X
Retained Earnings to Total Assets	-	-	-	X	-	-	X	X	X	X
EBIT to Total Assets	-	-	-	X	-	-	X	X	X	X
Sales to Total Assets	-	-	-	X	-	-	X	X	X	X
Equity to Debt	-	-	-	X	-	-	X	X	X	X
Cash Flow to Debt	-	-	-	X	-	-	X	X	X	X
Cash Flow to Total Assets Ratio				X			X	X	X	X
Cash Flow to Total Equity				X			X	X	X	X
Cash Flow to Total Sales				X			X	X	X	X
Cash Flow to Interest Expenses				X			X	X	X	X
Type of work	-	-	-	X	-	-	X	X	X	X
Time in Business	-	-	-	X	-	-	X	X	X	X
Geographic dispersion	-	-	-	X	-	-	X	X	X	X
Number of Companies	0	0	0	1	0	0	5	29	4	28

CHAPTER 5
DATA ANALYSIS

As mentioned in Chapter 4, twenty-six financial ratios were calculated from sixty-seven companies. Although the best prediction model would be one that includes all possible financial ratios, many of those ratios provide the same information that other ratios do. In order to avoid data repetition and also to reduce the number of inputs in the neural network model, a boxplot from each financial ratio was created. These boxplots show how the data from healthy companies and unhealthy companies are distributed, along with the data tendency. A healthy company can be defined as a company that is presently in business, and an unhealthy company can be defined as a company that have filed bankruptcy under Chapter Seven or Chapter Eleven. Thereafter, a cross correlation matrix was computed for each year of data. Finally, each financial ratio was compared to the other financial ratios by graphically using the values calculated in the cross correlation matrix.

As soon as all the financial information was obtained, each boxplot was checked. If the boxplot representing data of the healthy companies showed appreciable differences compared to the boxplot representing the data if unhealthy companies, that financial ratio was selected for use in the model. After these comparisons were made, each financial ratio was compared graphically with the other financial ratios, using the information from the cross correlation matrix. If the correlation value between two selected financial ratios

was close to 1 or –1, the financial ratio with bigger differences on the boxplots was selected and the other one rejected.

5.1 Boxplots

Because there was a considerable difference among the data values from each company, data were standardized using the following equation.

$$Xj = (Xi - \text{mean}) / \text{Standard Deviation} \qquad (40)$$

Where Xi is the financial ratio calculated from the companies' financial statements.

5.1.1 Financial Ratios One Year Before Financial Troubles

Figures 5-1 to 5-7 show the boxplots of twenty-six financial ratios one year before financial troubles. Also, Appendix C contains the complete set of information including R-language commands and all the correlation comparisons. In all instances, the ratio information of the unhealthy firms is shown on the left.

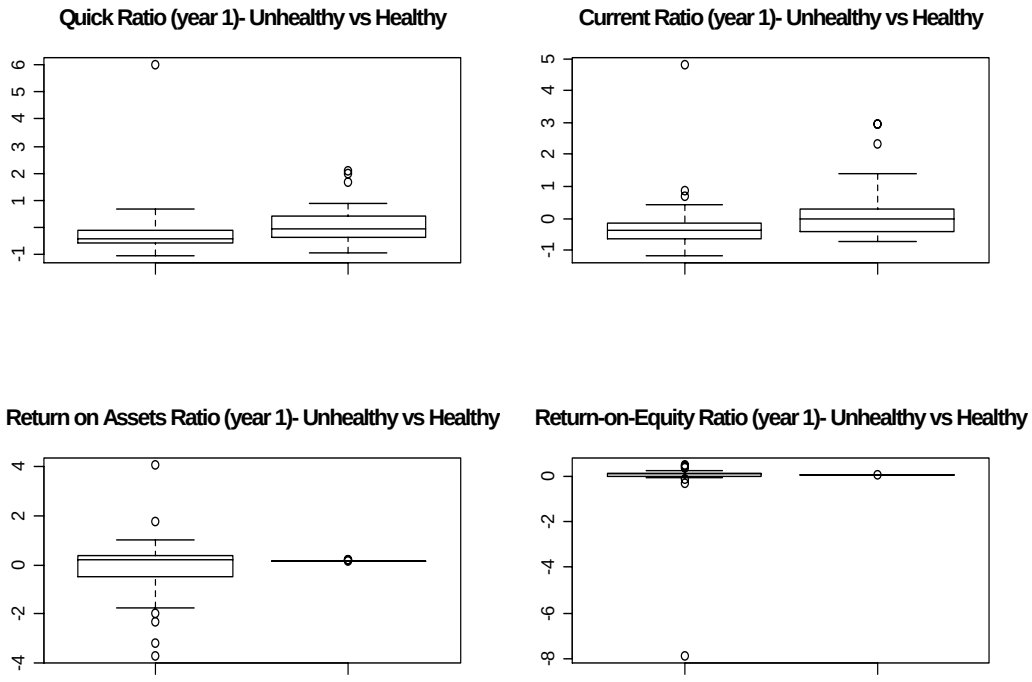


Figure 5-1 Boxplots Financial Ratios (Quick Ratio, Current Ratio, Return-on-Assets Ratio, and Return-on-Equity Ratio)

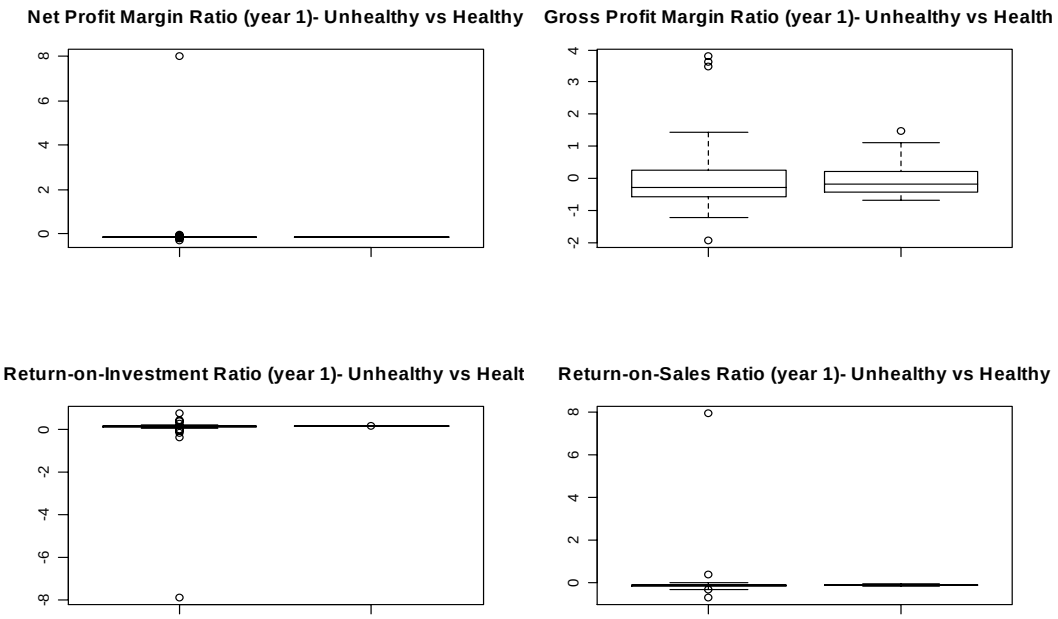


Figure 5-2 Boxplots Financial Ratios (Net Profit Margin Ratio, Gross Profit Margin Ratio, Return-on-Assets Ratio, and Return-on-Sales Ratio)

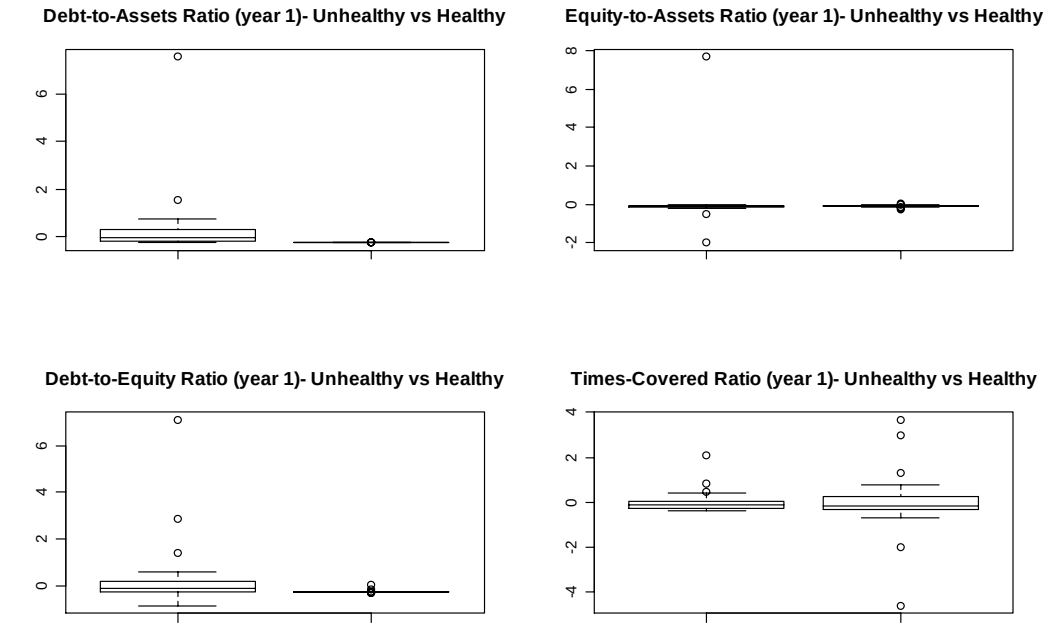


Figure 5-3 Boxplots Financial Ratios (Debt-to-Assets Ratio, Equity-to-Assets Ratio, Debt-to-Equity Ratio, and Times Covered Ratio)

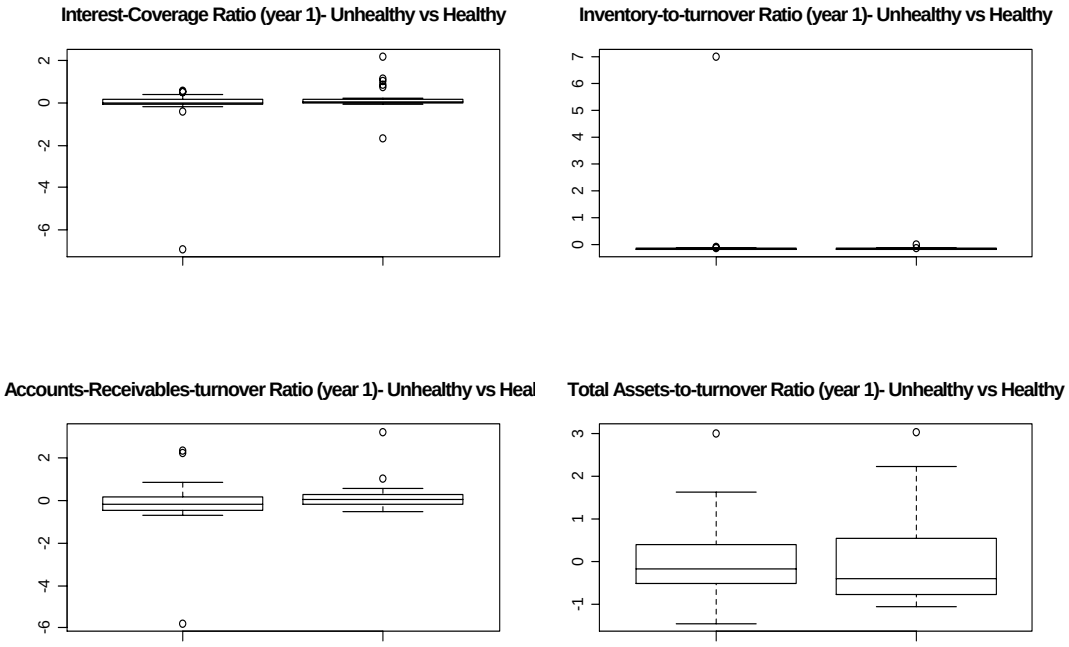


Figure 5-4 Boxplots Financial Ratios (Interest Coverage Ratio, Inventory-to-Turnover Ratio, Accounts Receivables-to-Turnover Ratio, and Total Assets-to-Turnover Ratio)

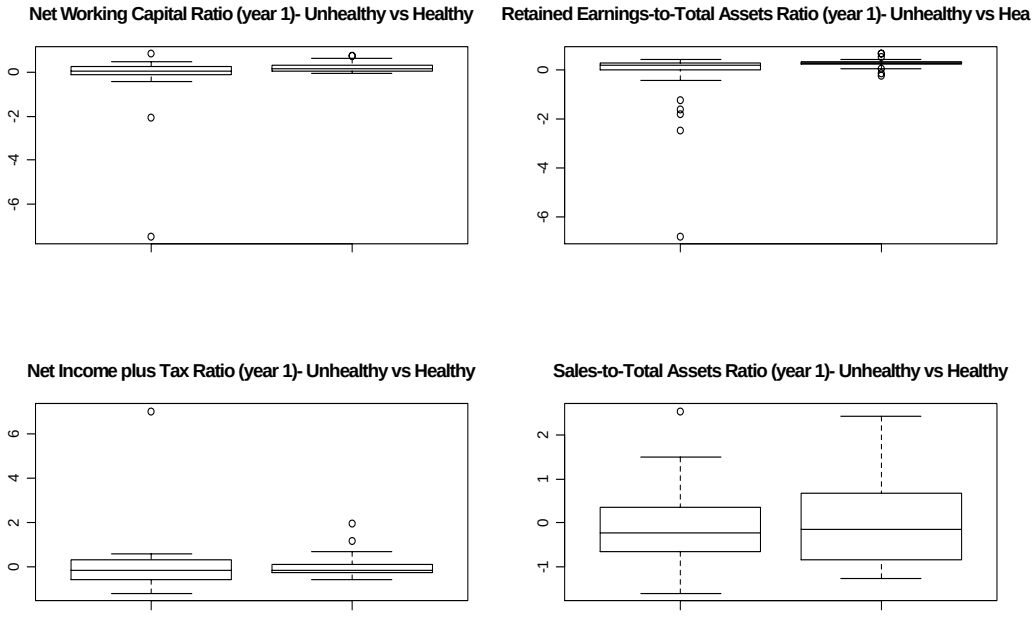


Figure 5-5 Boxplots Financial Ratios (Net Working Capital Ratio, Retained Earnings-to-Total Assets Ratio, Net Income Plus Tax Ratio, and Sales-to-Total Assets Ratio)

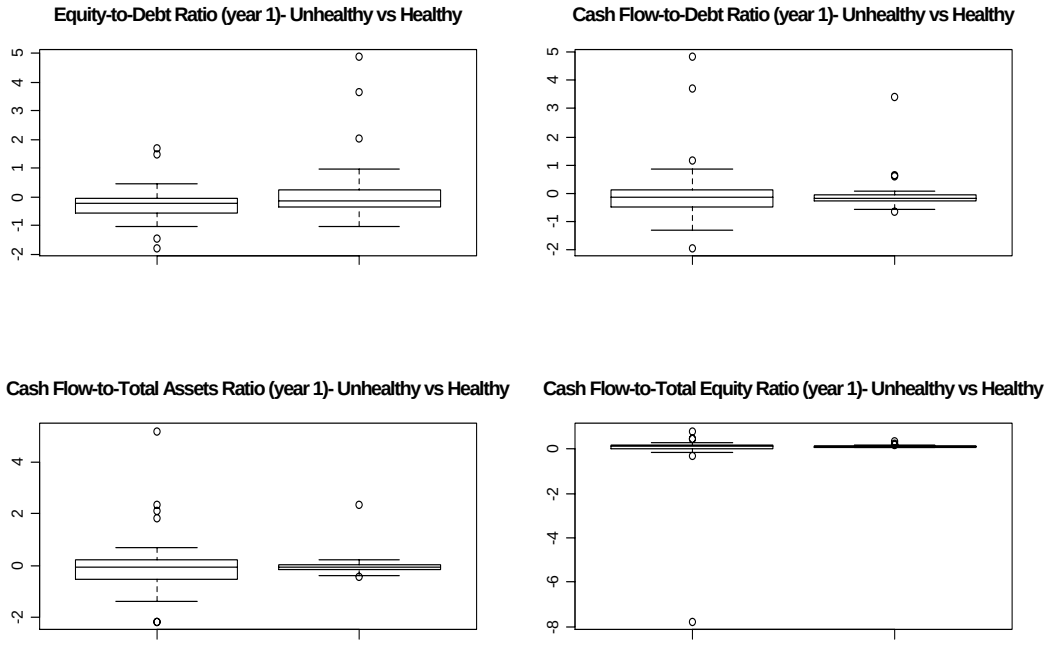


Figure 5-6 Boxplots Financial Ratios (Equity-to-Debt Ratio, Cash Flow-to-Debt Ratio, Cash Flow-to-Total Assets Ratio, and Cash Flow-to-Total Equity Ratio)

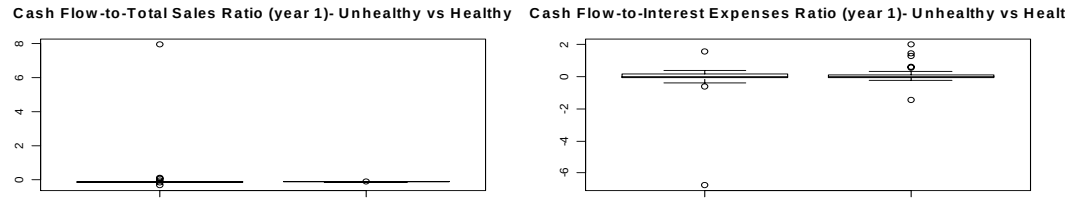


Figure 5-7 Boxplots Financial Ratios (Cash Flow-to-Total Sales Ratio, and Cash Flow-to-Interest Expenses Ratio)

After reviewing each one of the figures, eight ratios were chosen.

- Quick Ratio
- Current Ratio
- Gross Profit Margin Ratio
- Debt-to-Assets Ratio
- Debt-to-Equity Ratio
- Account Receivables-to-Turnover Ratio
- Total Assets-to-Turnover Ratio
- Equity-to-Debt Ratio

These financial ratios were compared (Figure 5-8 to Figure 5-10) using the information from the cross correlation matrix, in order to find whether or not they are independent from each other.

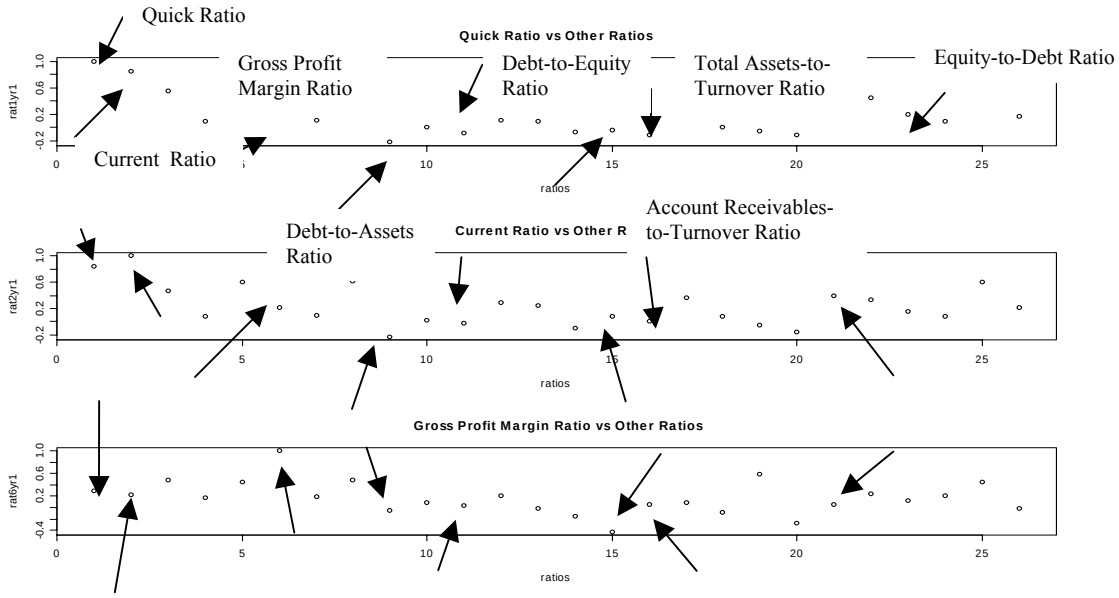


Figure 5-8 Comparison of Correlations (Quick Ratio, Current Ratio, and Gross Profit Margin Ratio) Arrows indicate financial ratios chosen as preliminary inputs

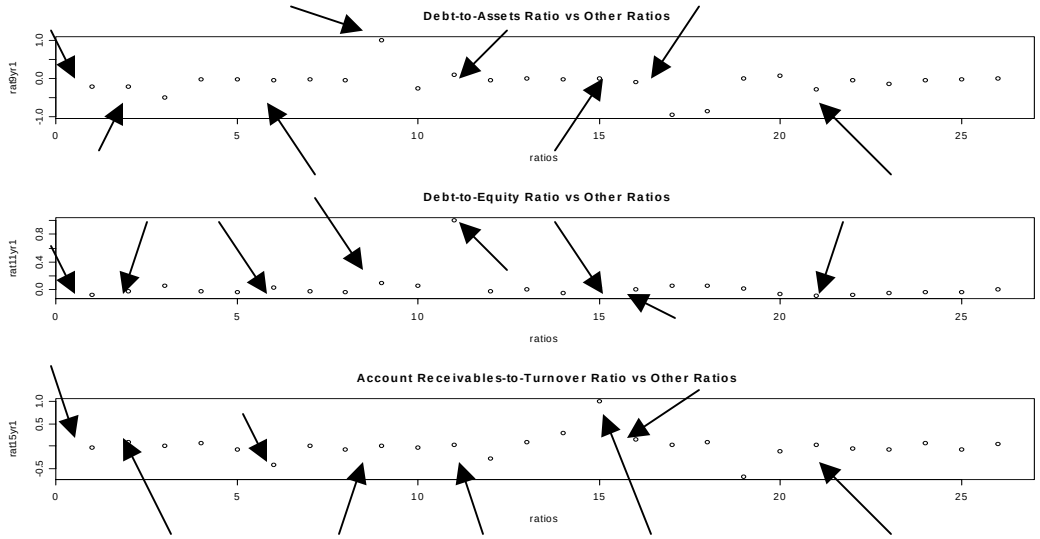


Figure 5-9 Comparison of Correlations (Debt-to-Assets Ratio, Debt-to-Equity Ratio, and Account Receivables-to-Turnover Ratio) Arrows indicate financial ratios chosen as preliminary inputs

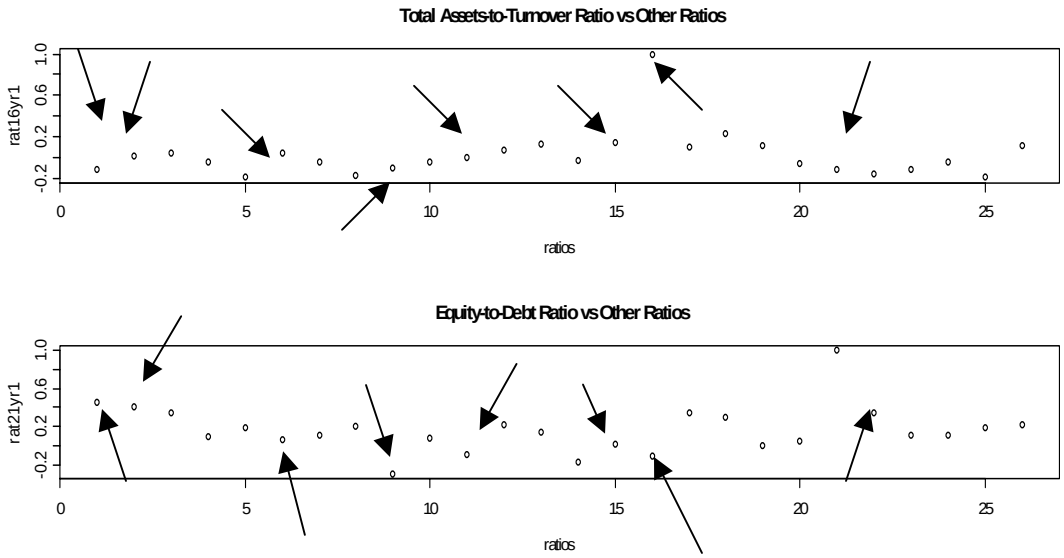


Figure 5-10 Comparison of Correlations (Total Assets-to-Turnover Ratio, and Equity-to-Debt Ratio) Arrows indicate financial ratios chosen as preliminary inputs

The quick ratio and the current ratio have a high correlation equal to 0.84. Also, the correlation between the quick ratio and the equity-to-debt ratio is equal to 0.45, and the correlation between the current ratio and the equity-to-debt ratio is equal to 0.40. The quick ratio was rejected because it has a high correlation (close to 1) with the current ratio, and because its correlation with the equity-to-debt ratio is higher than the correlation between the current ratio and the equity-to-debt ratio. Therefore, seven financial ratios were selected for entry in the neural network model to predict bankruptcy one year before it occurs:

- Current Ratio
- Gross Profit Margin Ratio
- Debt-to-Assets Ratio
- Debt-to-Equity Ratio
- Account Receivables-to-Turnover Ratio
- Total Assets-to-Turnover Ratio
- Equity-to-Debt Ratio

5.1.2 Financial Ratios Two Years Before Financial Troubles

Figures 5-11 to 5-17 show the boxplots of twenty-six financial ratios two years before financial troubles. Also, Appendix D contains the complete set of information including R-language commands and all the correlation comparisons.

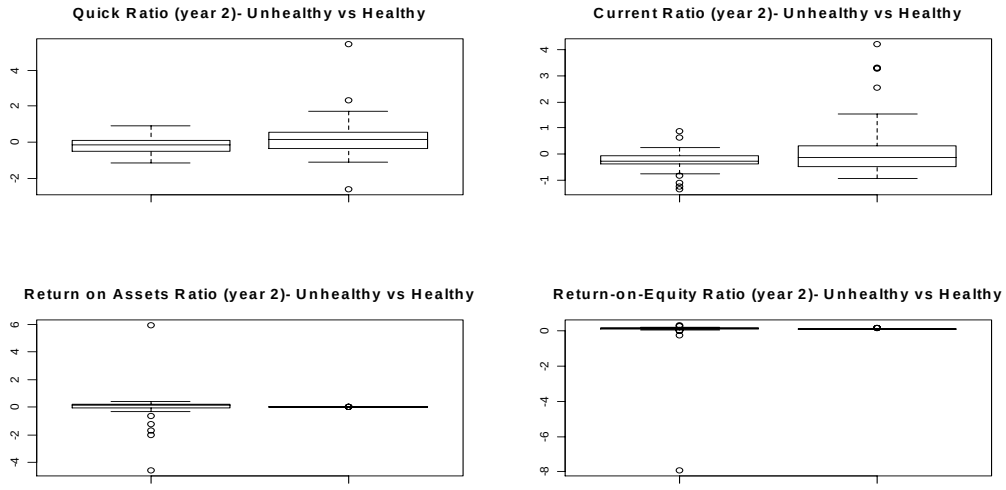


Figure 5-11 Boxplots Financial Ratios (Quick Ratio, Current Ratio, Return-on-Assets Ratio, and Return-on-Equity Ratio)

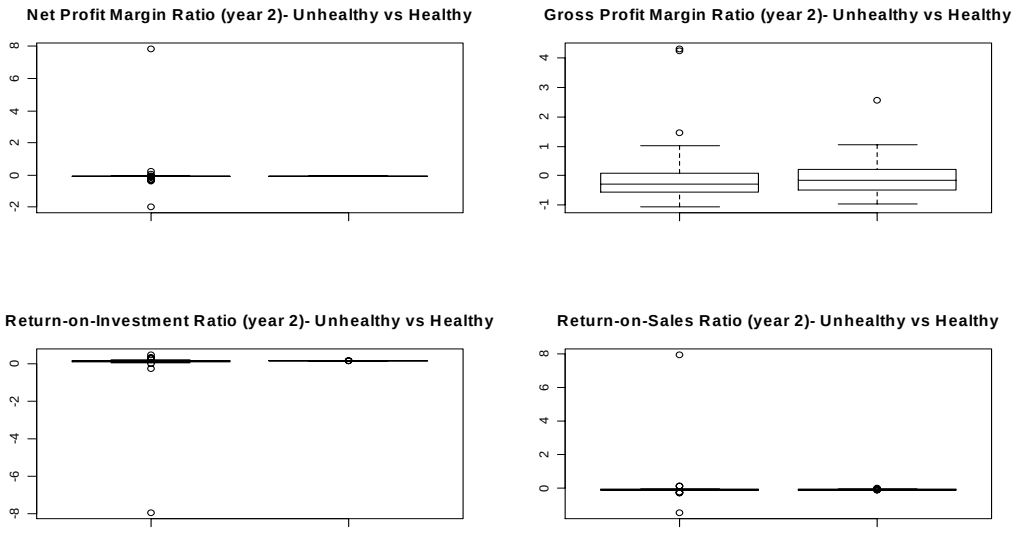


Figure 5-12 Boxplots Financial Ratios (Net Profit Margin Ratio, Gross Profit Margin Ratio, Return-on-Assets Ratio, and Return-on-Sales Ratio)

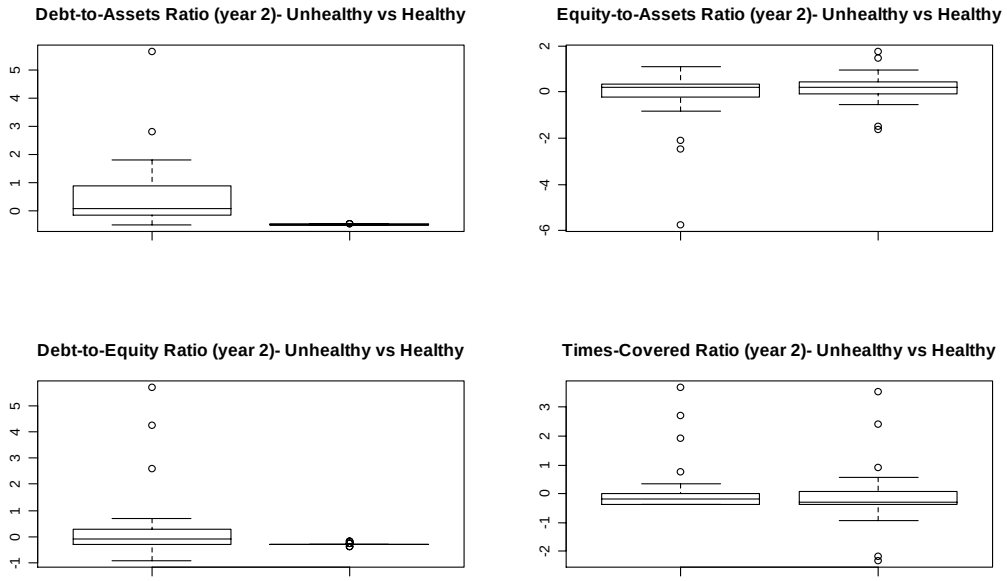


Figure 5-13 Boxplots Financial Ratios (Debt-to-Assets Ratio, Equity-to-Assets Ratio, Debt-to-Equity Ratio, and Times Covered Ratio)

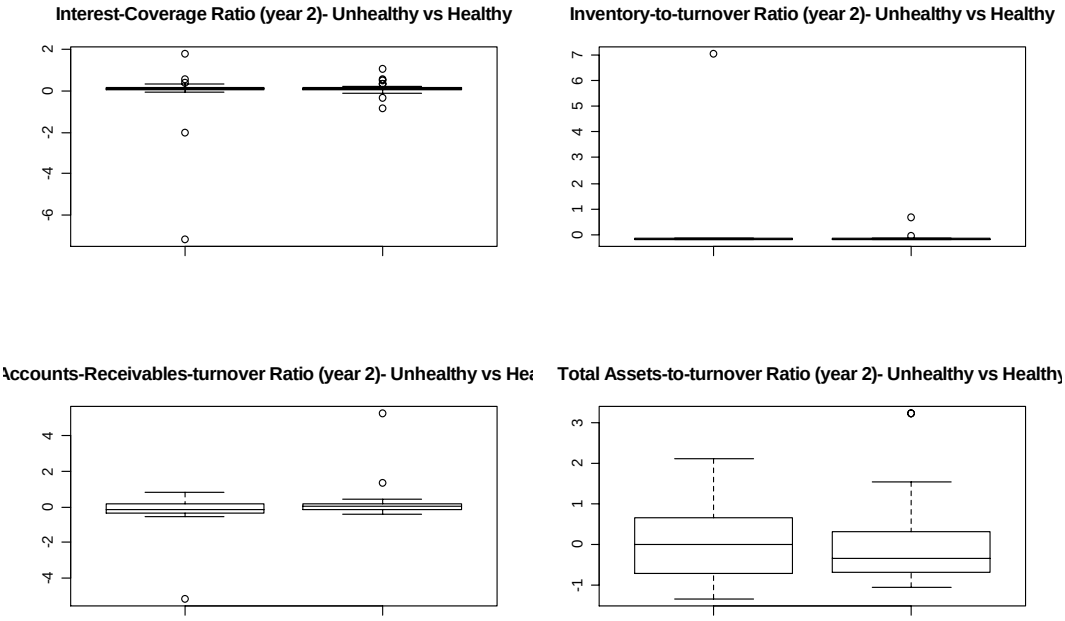


Figure 5-14 Boxplots Financial Ratios (Interest Coverage Ratio, Inventory-to-Turnover Ratio, Accounts Receivables-to-Turnover Ratio, and Total Assets-to-Turnover Ratio)

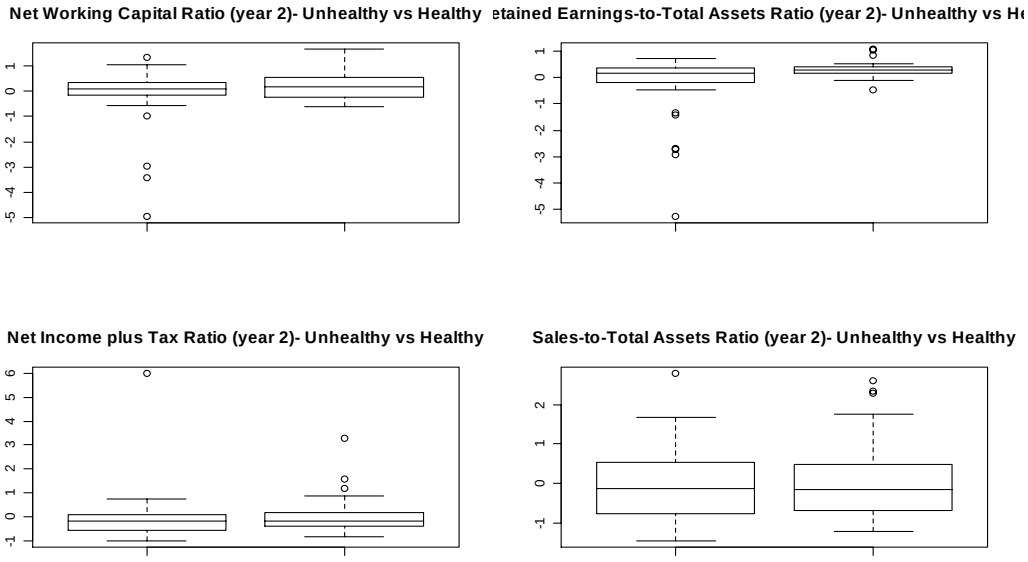


Figure 5-15 Boxplots Financial Ratios (Net Working Capital Ratio, Retained Earnings-to-Total Assets Ratio, Net Income Plus Tax Ratio, and Sales-to-Total Assets Ratio)

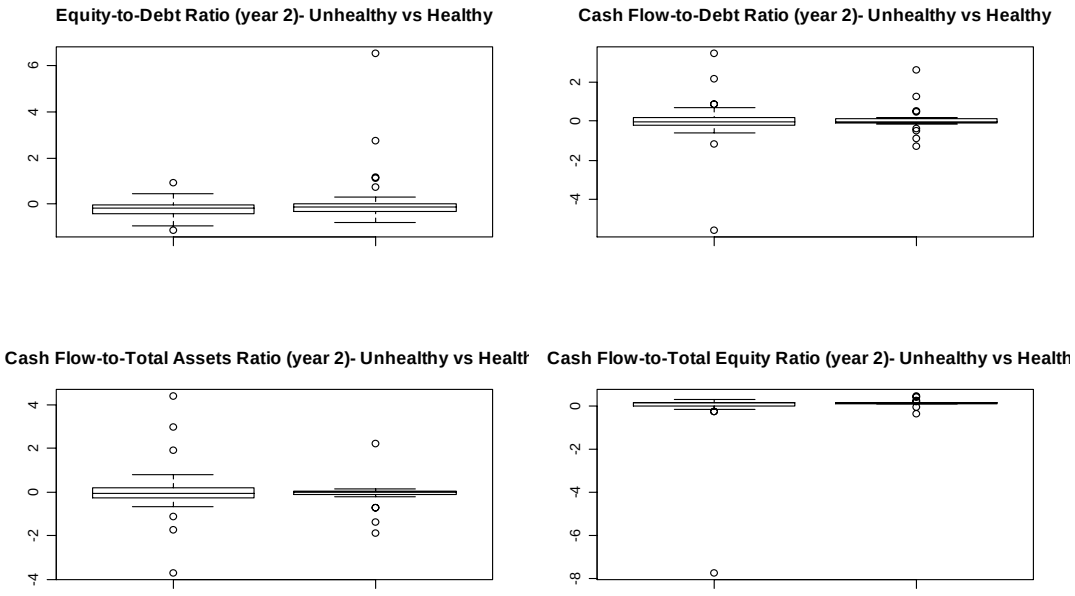


Figure 5-16 Boxplots Financial Ratios (Equity-to-Debt Ratio, Cash Flow-to-Debt Ratio, Cash Flow-to-Total Assets Ratio, and Cash Flow-to-Total Equity Ratio)

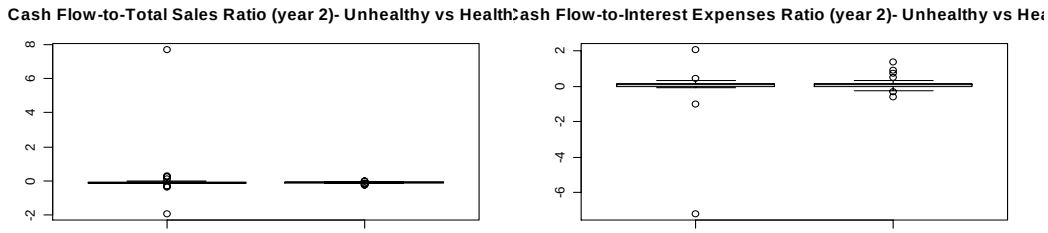


Figure 5-17 Boxplots Financial Ratios (Cash Flow-to-Total Sales Ratio, and Cash Flow-to-Interest Expenses Ratio)

After reviewing each one of the figures, eight ratios were chosen:

- Quick Ratio
- Current Ratio
- Gross Profit Margin Ratio
- Debt-to-Assets Ratio
- Debt-to-Equity Ratio
- Account Receivables-to-Turnover Ratio
- Total Assets-to-Turnover Ratio
- Equity-to-Debt Ratio

These financial ratios were compared (Figure 5-18 to Figure 5-20), using the information from the cross correlation matrix, in order to find whether or not they are independent to each other.

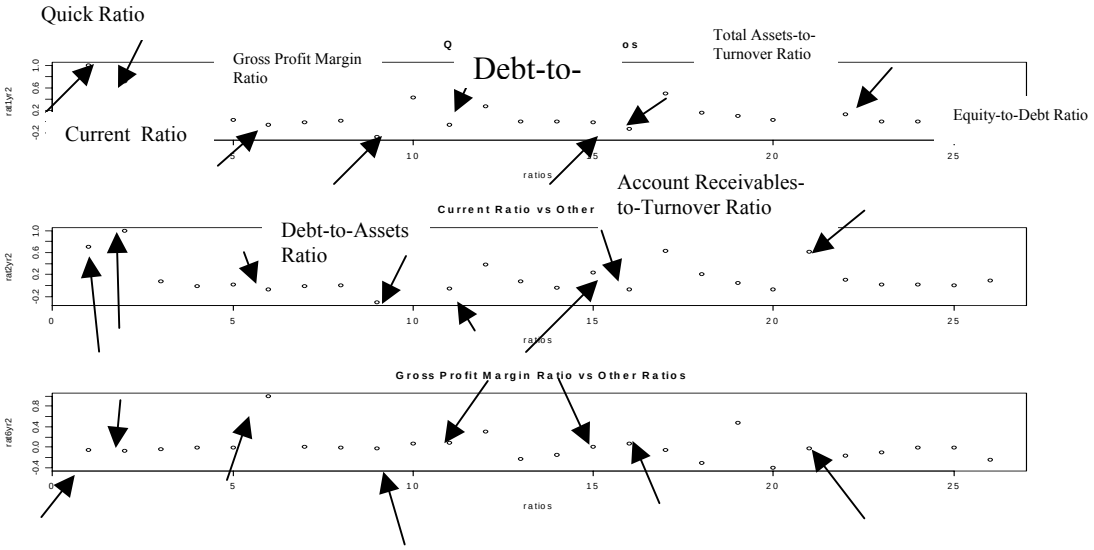


Figure 5-18 Comparison of Correlations (Quick Ratio, Current Ratio, and Gross Profit Margin Ratio) Arrows indicate financial ratios chosen as preliminary inputs

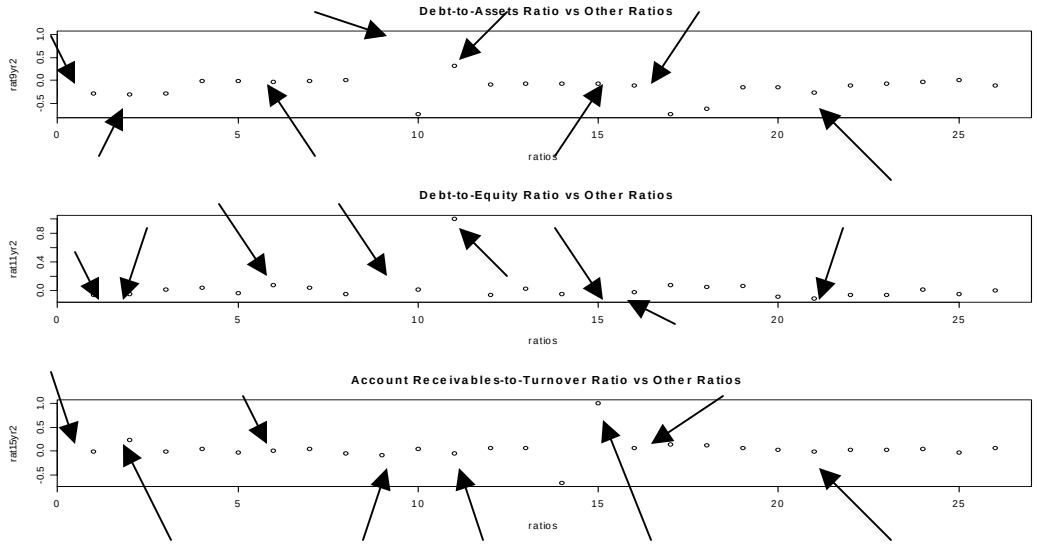


Figure 5-19 Comparison of Correlations (Debt-to-Assets Ratio, Debt-to-Equity Ratio, and Account Receivables-to-Turnover Ratio) Arrows indicate financial ratios chosen as preliminary inputs

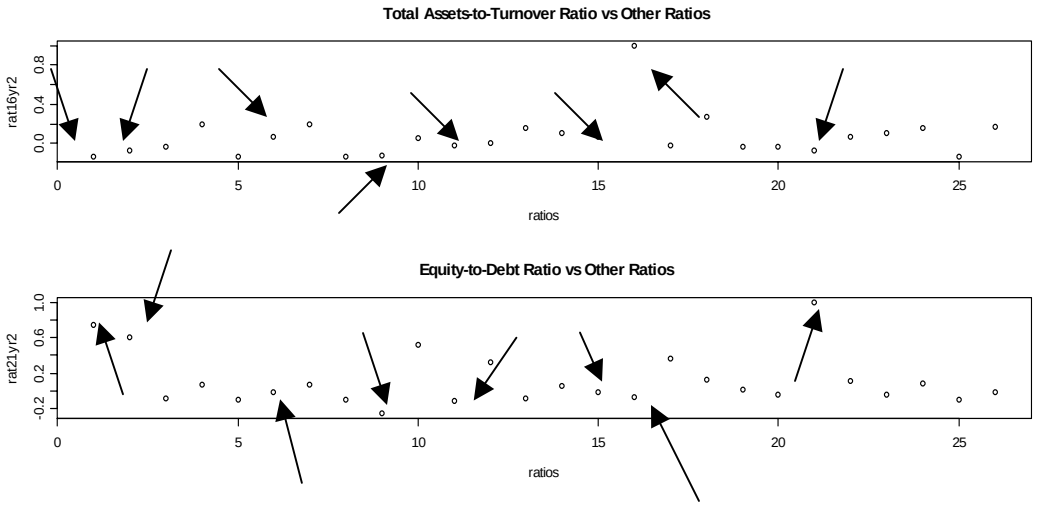


Figure 5-20 Comparison of Correlations (Total Assets-to-Turnover Ratio, and Equity-to-Debt Ratio) Arrows indicate financial ratios chosen as preliminary inputs

Choosing the financial ratios for year 2, the quick ratio and the current ratio have a high correlation equal to 0.71. Also, the correlation between the quick ratio and the equity-to-debt ratio is equal to 0.75, and the correlation between the current ratio and the

equity-to-debt ratio is equal to 0.61. For these reasons, the quick ratio was rejected. Therefore, seven financial ratios were selected for use in the neural network model to predict bankruptcy two years before it occurs: (Note that the same variables were also selected for the one year prior to bankruptcy model.)

- Current Ratio
- Gross Profit Margin Ratio
- Debt-to-Assets Ratio
- Debt-to-Equity Ratio
- Account Receivables-to-Turnover Ratio
- Total Assets-to-Turnover Ratio
- Equity-to-Debt Ratio

5.1.3 Financial Ratios Three Years Before Financial Troubles

Figures 5-21 to 5-27 show the boxplots of twenty-six financial ratios three years before financial troubles. Also, Appendix E contains the complete set of information including R-language commands and all the correlation comparisons.

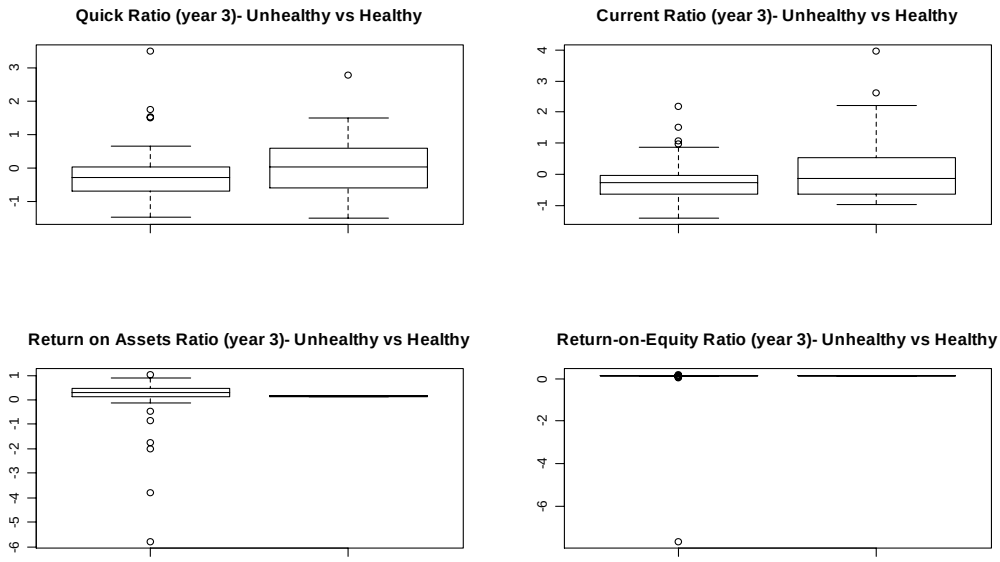


Figure 5-21 Boxplots Financial Ratios (Quick Ratio, Current Ratio, Return-on-Assets Ratio, and Return-on-Equity Ratio)

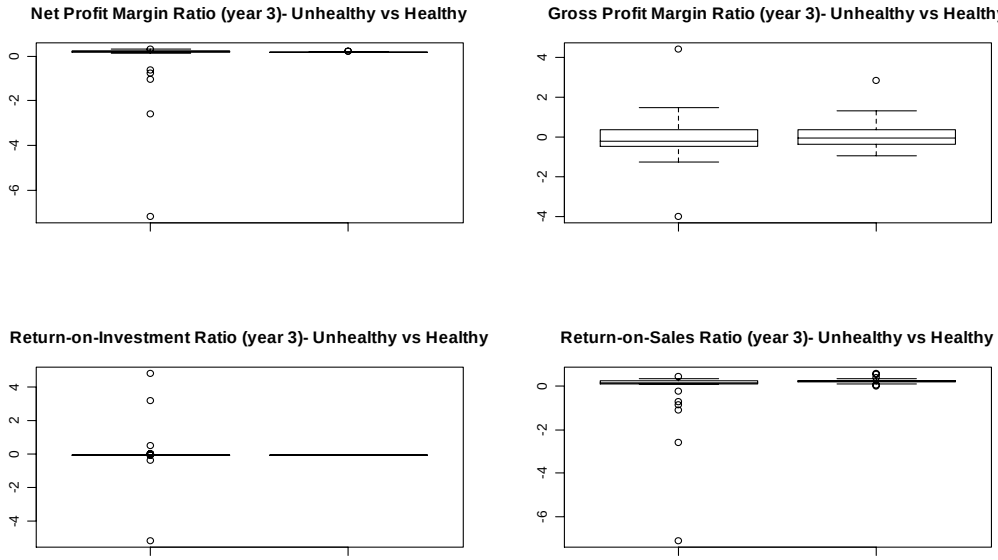


Figure 5-22 Boxplots Financial Ratios (Net Profit Margin Ratio, Gross Profit Margin Ratio, Return-on-Assets Ratio, and Return-on-Sales Ratio)

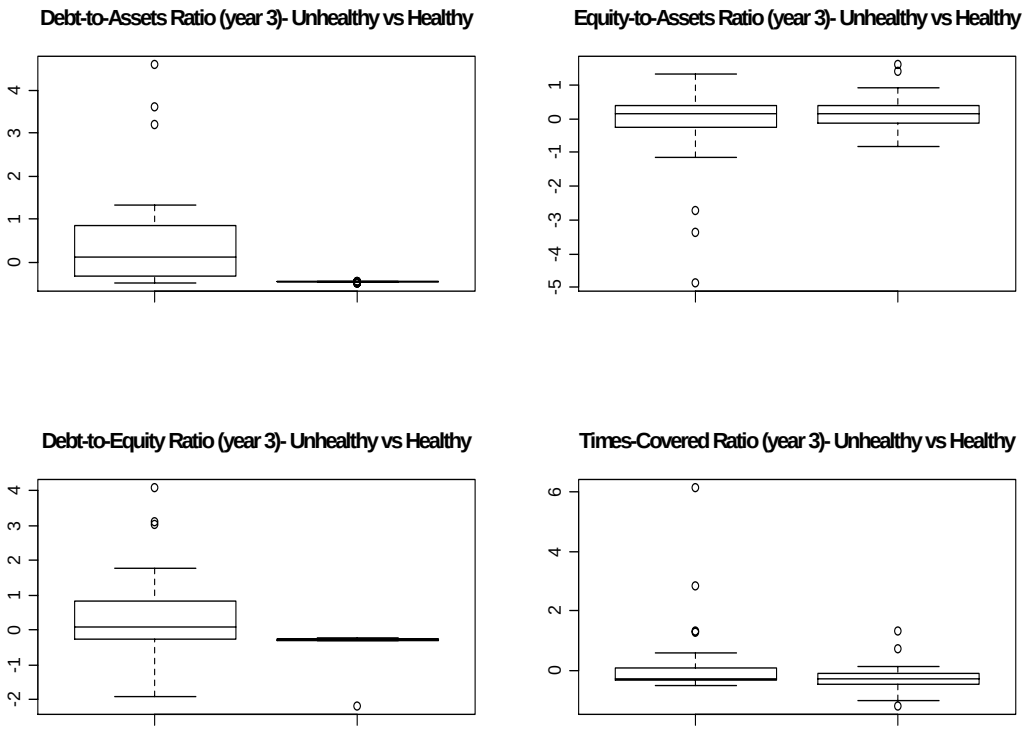


Figure 5-23 Boxplots Financial Ratios (Debt-to-Assets Ratio, Equity-to-Assets Ratio, Debt-to-Equity Ratio, and Times Covered Ratio)

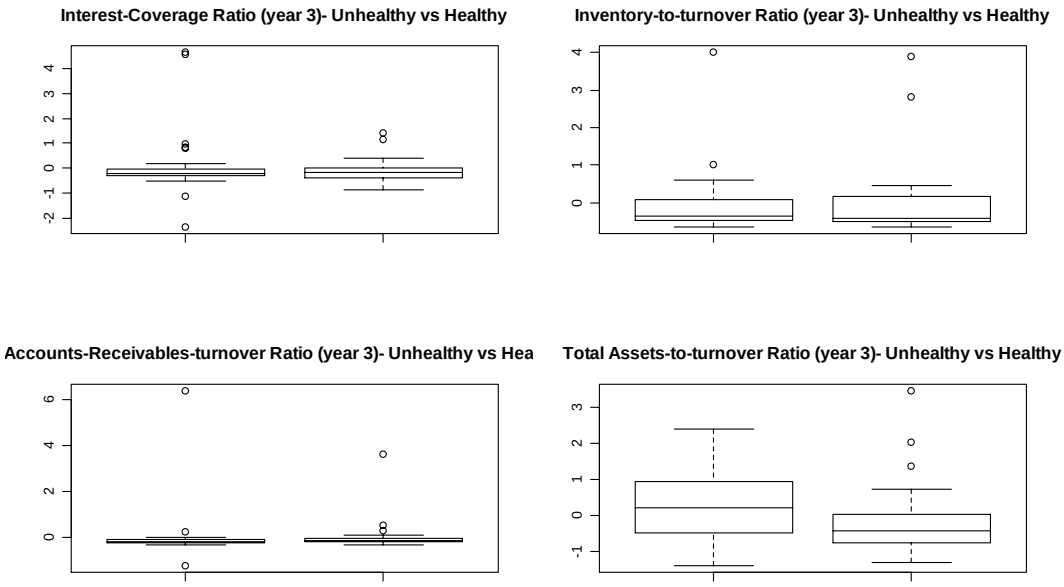


Figure 5-24 Boxplots Financial Ratios (Interest Coverage Ratio, Inventory-to-Turnover Ratio, Accounts Receivables-to-Turnover Ratio, and Total Assets-to-Turnover Ratio)

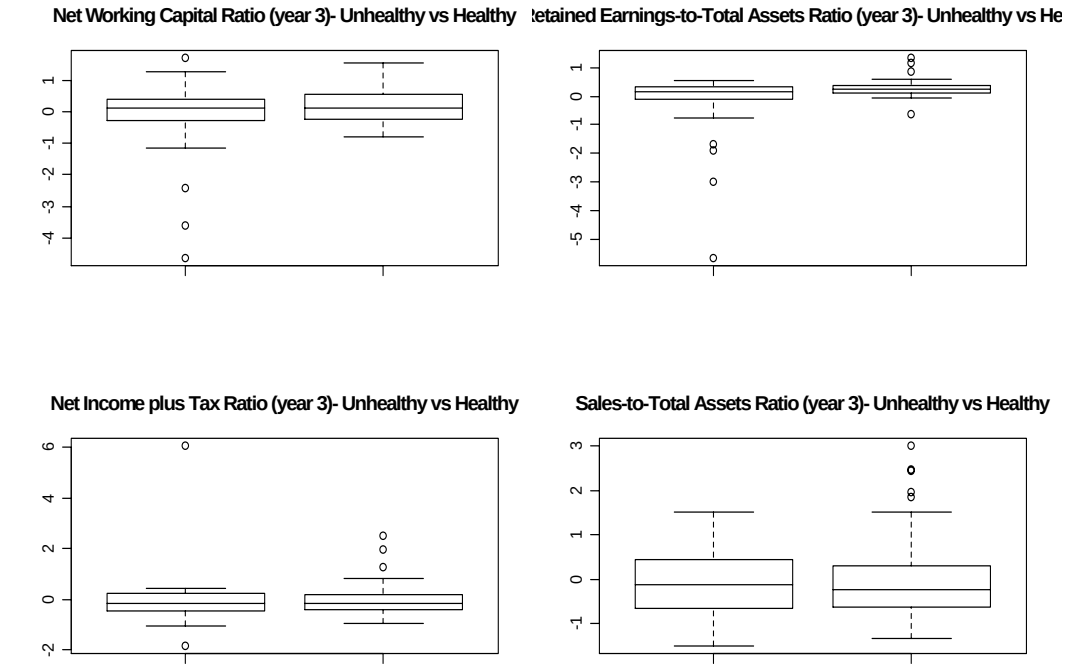


Figure 5-25 Boxplots Financial Ratios (Net Working Capital Ratio, Retained Earnings-to-Total Assets Ratio, Net Income Plus Tax Ratio, and Sales-to-Total Assets Ratio)

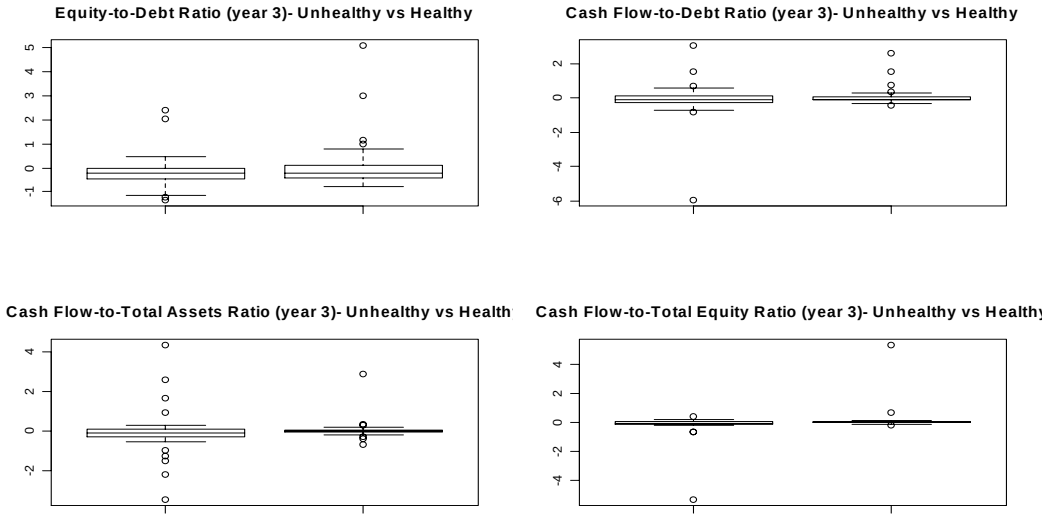


Figure 5-26 Boxplots Financial Ratios (Equity-to-Debt Ratio, Cash Flow-to-Debt Ratio, Cash Flow-to-Total Assets Ratio, and Cash Flow-to-Total Equity Ratio)

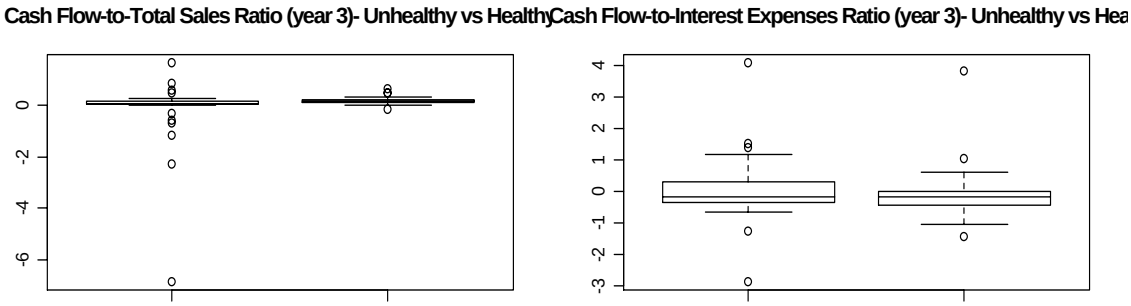


Figure 5-27 Boxplots Financial Ratios (Cash Flow-to-Total Sales Ratio, and Cash Flow-to-Interest Expenses Ratio)

After reviewing each one of the figures, seven ratios were chosen:

- Current Ratio
- Gross Profit Margin Ratio
- Debt-to-Assets Ratio
- Debt-to-Equity Ratio
- Account Receivables-to-Turnover Ratio
- Total Assets-to-Turnover Ratio
- Equity-to-Debt Ratio

These financial ratios were compared (Figure 5-18 to Figure 5-20), using the

information from the cross correlation matrix, in order to find whether or not they are independent from each other.

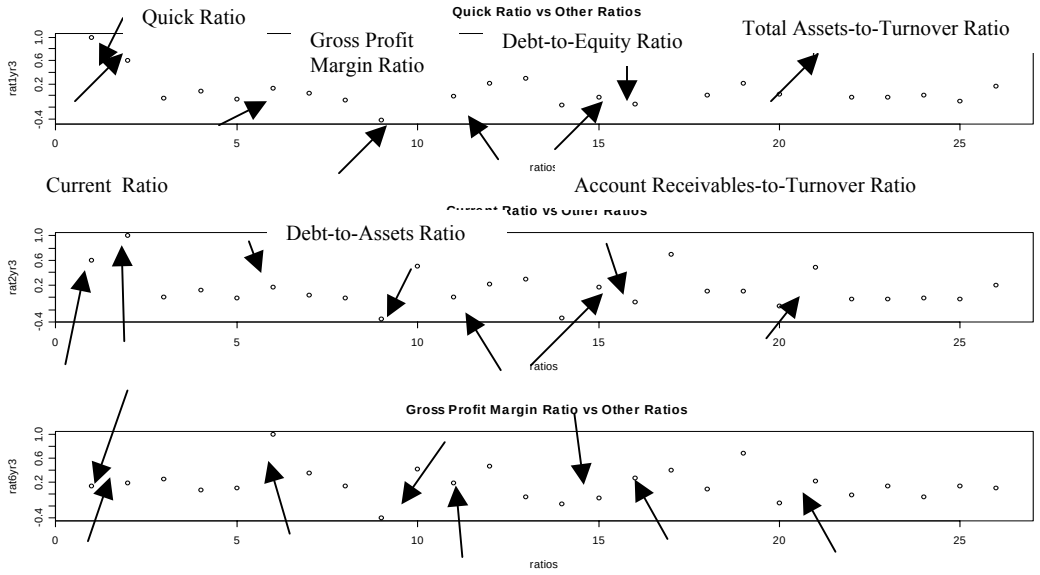


Figure 5-28 Comparison of Correlations (Quick Ratio, Current Ratio, and Gross Profit Margin Ratio) Arrows indicate financial ratios chosen as preliminary inputs

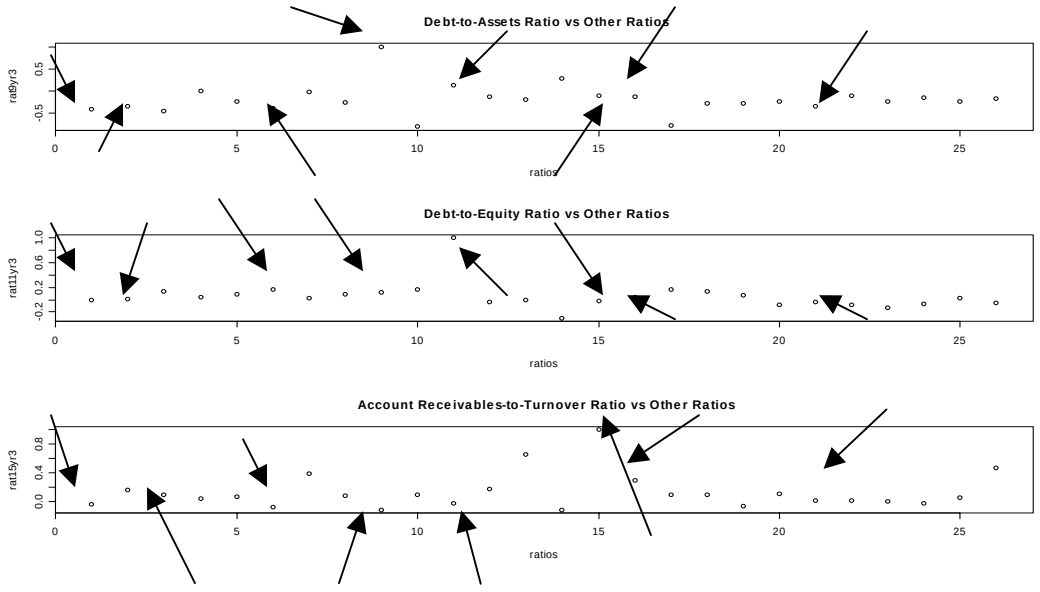


Figure 5-29 Comparison of Correlations (Debt-to-Assets Ratio, Debt-to-Equity Ratio, and Account Receivables-to-Turnover Ratio) Arrows indicate financial ratios chosen as preliminary inputs

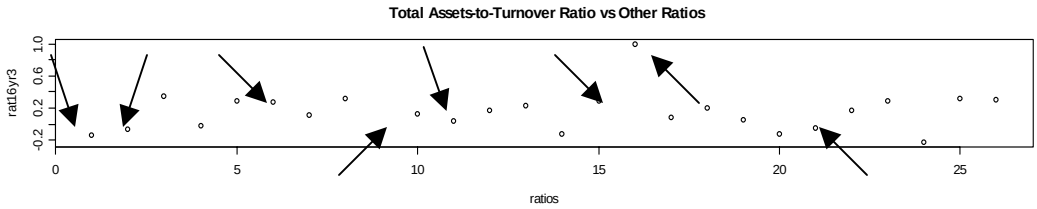


Figure 5-30 Comparison of Correlations (Total Assets-to-Turnover Ratio) Arrows indicate financial ratios chosen as preliminary inputs

Choosing the financial ratios for year 3, the quick ratio and the current ratio had the highest correlation equal to 0.60. The correlation between these two financial ratios is high, although it is not as high as it was when it was calculated for year 1 (0.84), and year 2 (0.71). For this reason, the quick ratio was rejected. Also, the equity-to-debt ratio was not selected as a variable for this year, as it was for the other two years, because the boxplots do not show an appreciable difference between the data of the healthy and unhealthy firms. Seven financial ratios were input into the neural network model to predict bankruptcy three years before it occurs:

- Current Ratio
- Gross Profit Margin Ratio
- Debt-to-Assets Ratio
- Debt-to-Equity Ratio
- Account Receivables-to-Turnover Ratio
- Total Assets-to-Turnover Ratio
- Equity-to-Debt Ratio

In conclusion, the same financial ratios will serve as inputs for the neural network models that will predict bankruptcy one, two and three years before it happens:

- Current Ratio
- Gross Profit Margin Ratio
- Debt-to-Assets Ratio
- Debt-to-Equity Ratio
- Account Receivables-to-Turnover Ratio
- Total Assets-to-Turnover Ratio
- Equity-to-Debt Ratio

CHAPTER 6
NEURAL NETWORK MODEL

As mentioned in Chapter 5, seven financial ratios (current ratio, gross profit margin ratio, debt-to-assets ratio, debt-to-equity ratio, account receivables-to-turnover ratio, total assets-to-turnover ratio, and equity-to-debt ratio) were used to train the neural network models for one and two years before business failure. The neural network model predicting business failure three years before bankruptcy was trained first using six financial ratios (current ratio, gross profit margin ratio, debt-to-assets ratio, debt-to-equity ratio, account receivables-to-turnover ratio, and total assets-to-turnover ratio.) Thereafter, the neural network model was trained again using the seven financial ratios used to train the other two prediction models (one and two years before business failure), in order to compare the results and check whether or not the inclusion of the equity-to-debt ratio improved the predictability of the neural network model.

The software selected to design, train and test the neural network models was NeuroSolutions. This software was developed by NeuroDimensions, a company based in Gainesville, Florida. The backpropagation algorithm was used to train the models because it is very strong in classification. Also, this software was chosen because it fulfills the criteria mentioned in Chapter 3 (the software should be easy to use, and it must be visually-oriented).

6.1 How to Create a Neural Network Model

6.1.1 Data Format

Before using NeuroSolutions, it is important to explain how the data should be organized in order to train and test the neural network model. Microsoft Excel was used to input and test data due to its simplicity. In order to use Microsoft Excel, the following three recommendations should be followed. First, columns must have a column label as "first row". This label should not have spaces in between words because ASCII data recognizes spaces as comas, and each one of the words on the label will be considered a different label or column. Consequently, there will be more labels than actual columns containing data.

Second, the last column should identify whether or not the construction company is a healthy or an unhealthy company. In order to represent this outcome, a letter should be used in order to avoid confusion with numbers. Also, it is important to use just one letter. If more than one letter is used, it should be specified in the **Tag Symbolic Desired Panel** (Figure 6-6). This panel identifies if the information contained in the column is a string of characters. In order to train and test the neural network models, the letters used were H for healthy, and U for unhealthy.

Third, the file should not be saved as an Excel document. The right way to save the file is as a ***.CSV** file (comma separated value file). This option can be found on the **Save As** option under the **Save as type:** menu (**File menu**) Figure 6-1.

Not following the three recommendations will cause the neural network software to be unable to recognize the data provided.

6.1.2 How to build a Neural Network Model

The following steps should be followed in order to create and train a neural network model using NeuroSolutions.

6.1.2.1 Step1: How to start

After NeuroSolutions is installed, its icon will be placed on the desktop. As soon as the program is running, a blank page is displayed by the software (Figure 6-2). In order to begin building a neural network, the **NExpert** button located on the control bar should be pressed.

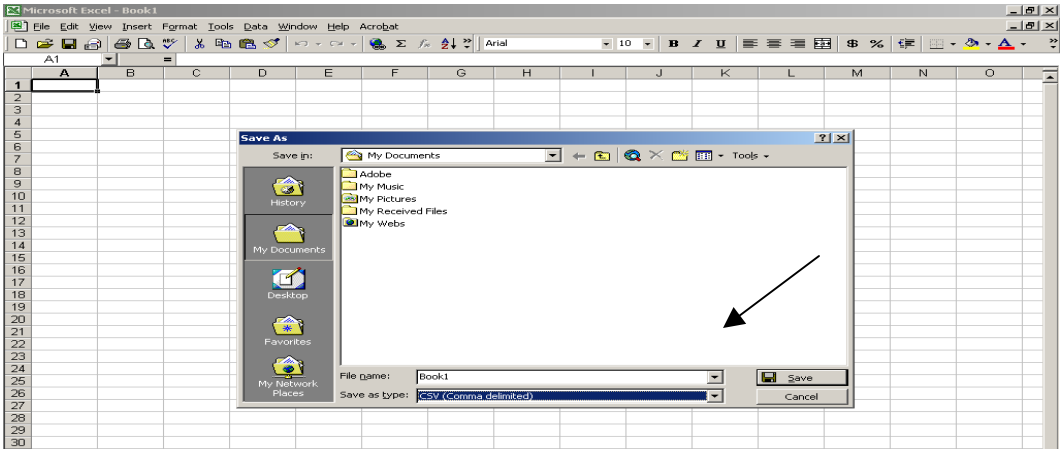


Figure 6-1 Saving an Excel file as a *.CSV

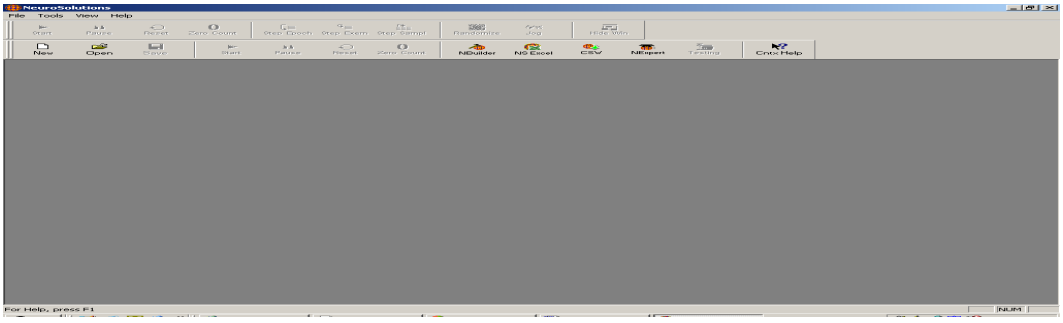


Figure 6-2 NeuroSolutions Starting Page

6.1.2.2 Step 2: Problem type selection panel

This panel will help the user to choose the algorithm that best fits the user requirements (Figure 6-3). The problem type selection panel provides the user with four different alternatives:

1. Classification: This option allows the user to classify an input as a part of a group
2. Function Approximation: This option finds a continuous value for each input
3. Prediction: This information allows the user to find the next value of a time-series using data from the past
4. Clustering: Group data with similar characteristics without the knowledge of those characteristics.

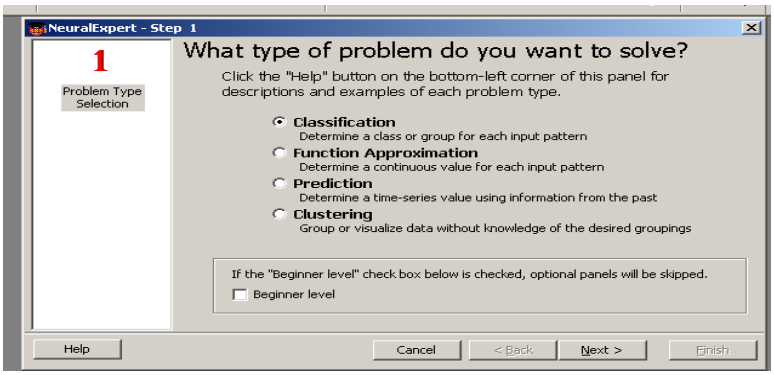


Figure 6-3 Problem Type Selection Panel

Since the data gathered from the construction companies classifies them as either healthy or unhealthy, and because the model wants to find if a company can be classified as healthy or unhealthy; the type of problem that better fits the neural network objectives was a **Classification** problem.

6.1.2.3 Step 3: Input file selection panel

The purpose of this selection panel is to help the user to find and select the input file. The user should click on the **Browse** button, and find the specific file where the training data are located, which in this case would be the Excel file. In order to check whether the information contained on the file is correct, this selection panel provides the

user the opportunity to review the information contained by the file when the **View File** button is pressed (Figure 6-4).

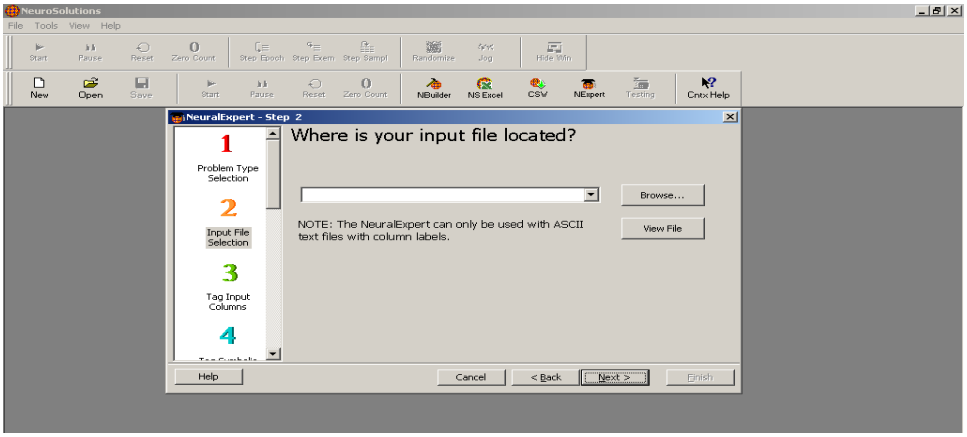


Figure 6-4 Input File Selection Panel

6.1.2.4 Step 4: Tag input columns panel

The tag input columns panel determines which data will be used as input data, and which one as an output. On the tag input columns panel, the names assigned to each one of the columns are listed next to checked boxes. If the data contained in a column will be used as an output, the box should be unchecked (Figure 6-5). Examples of input columns are the columns with the financial ratios. On the other hand, an example of an output column is the column having the classification data (H: healthy or U: unhealthy).

6.1.2.5 Step 5: Tag symbolic desire panel

The tag symbolic desire panel asks the user whether or not data contained in any of the columns can be considered as a string of characters. If data constitute a string of characters, the box that represents that column should be selected. If the data in columns do not have strings of characters, none of the boxes should be selected (Figure 6-6). An example of a string of characters would be the word **healthy**. This word is understood by NeuroSolutins as a string of characters because it has more than one letter.

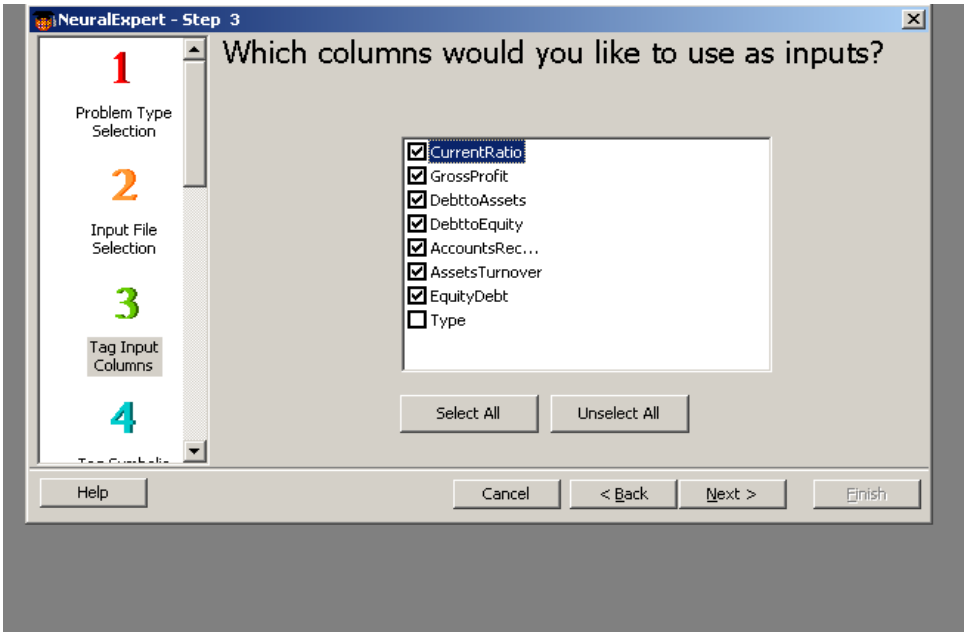


Figure 6-5 Tag Input Columns Panel

6.1.2.6 Step 6: Desired file selection panel

The desired file selection panel helps the user indicate where a file containing the output data is located. If the data are contained in the same file as the input data, the **Use Input File for Desired File** button should be pressed; otherwise, the **Browse** button would help the user to find the file.

Thereafter, the **Shuffle Data File** button located at the bottom of this selection panel should be chosen. This button helps the user to randomly order the data because the data chosen as inputs must not be organized (Figure 6-7).

6.1.2.7 Step 7: Tag desired columns panel

The tag desired columns panel asks the user to select which one of the columns will be used as an output. Because this column was not selected when the input columns were selected (tagged), the output column is selected by default (Figure 6-8).

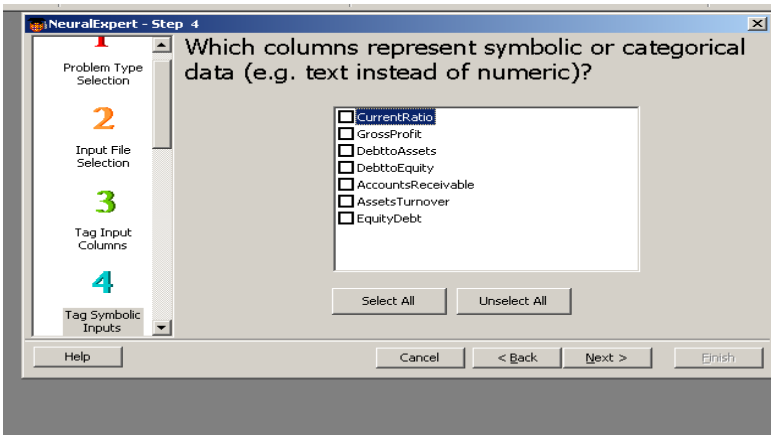


Figure 6-6 Tag Symbolic Desire Panel

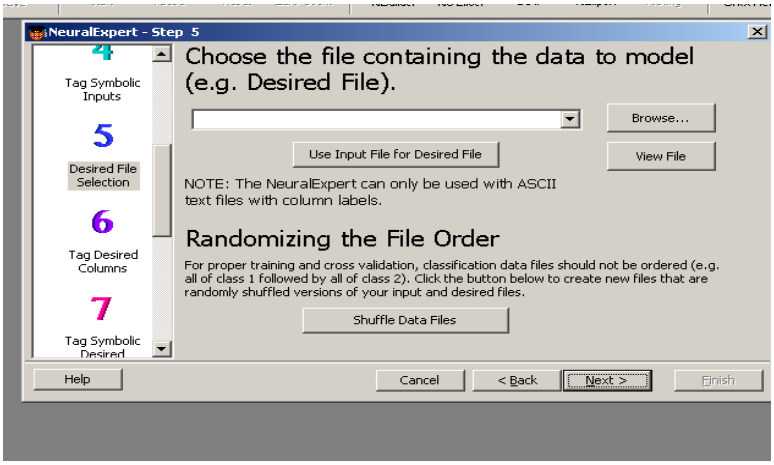


Figure 6-7 Desired File Selection Panel

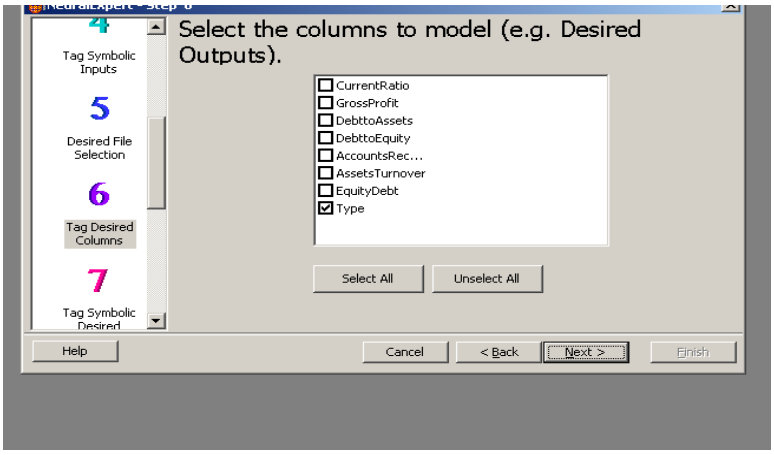


Figure 6-8 Tag Desired Columns Panel

6.1.2.8 Step 8: Generalization protection panel

The generalization protection panel requests the user to select how much of the data should be used for the cross validation process (Figure 6-9). The neural network uses the cross validation data during the training process to check how the neural network performs on data for which the model has not been trained. The cross validation method is used for estimating generalization error based on "resampling.[46]" The cross validation process also determines when the neural network model is trained.

When the data available has less than 100 rows, the amount of data to be used for the cross validation process should be zero (**None**). If the data available has more than 100 rows but less than 1,000 rows, the amount of data to be used for the cross validation process should be twenty percent (**Normal**). Finally, when the data available has more than 1,000 rows, the amount of data to be used for the cross validation process should be forty percent (**High**).

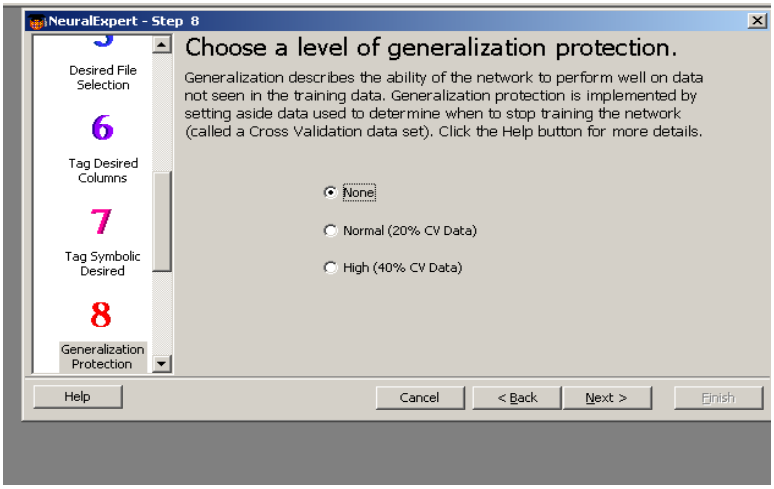


Figure 6-9 Tag Desired Columns Panel

6.1.2.9 Step 9: Out of sample testing panel

The out of sample testing panel sets aside the amount of data that the user specifies for testing the model (Figure 6-10). When the data has less than 100 rows, no data

should be selected as testing data because it considerably decreases the amount of data used to train the model. In order to train the model, the best alternative is to randomly choose a group of healthy and unhealthy companies and use them to check how the model is performing.

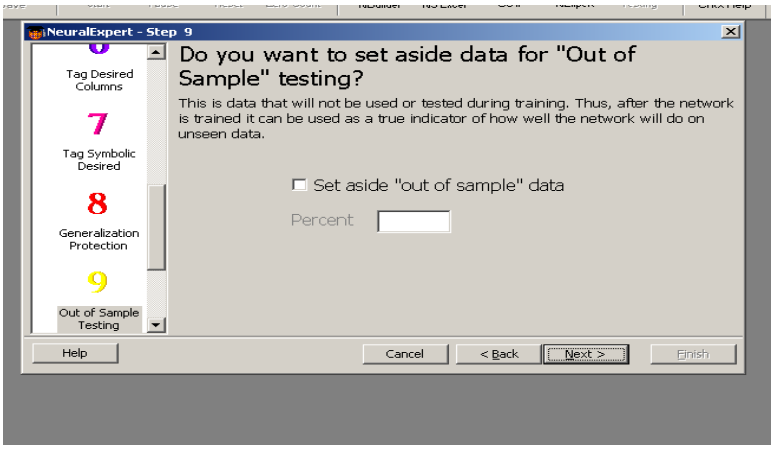


Figure 6-10 Out of Sample Testing Panel

6.1.2.10 Step 10: Genetic optimization panel

The genetic optimization panel helps the user to find the best network. This function automatically trains many networks with different parameters in order to find the best one as defined by the user. The training process should begin using a neural network with a low level of genetic optimization. Afterward, neural networks should be built using different levels of genetic optimization, up to the highest level. The results of this should be compared among them in order to choose the better predicting model. This panel offers four options (Figure 6-12):

21. None: This level of genetic optimization uses a neural network, even though some of its connectors or hidden components perform no work.

22. Low: This level of genetic optimization checks and improves the learning rates only.

23. Medium: The medium level of genetic optimization focuses on improving the learning rates and the number of nodes in the hidden layers.

24. High: The high levels of genetic optimization (recommended) focus on the improvement and optimization of the most available parameters. The training process of a neural network with a high level of genetic optimization takes longer than training a neural network using the others' genetic optimization levels.

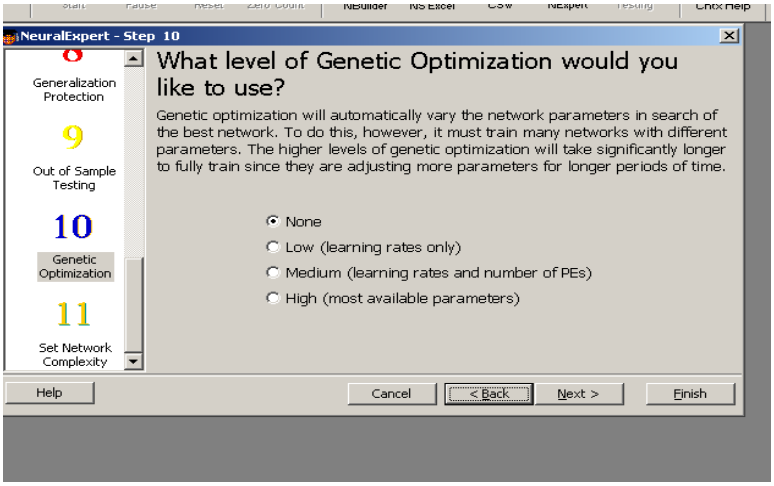


Figure 6-11 Genetic Optimization Panel

6.1.2.11 Step 11: Network complexity panel

The network complexity panel allows the user to choose the level of complexity of the neural network. As mentioned in Chapter 2, the number of processing elements and hidden layers determine the level of complexity. The best way to choose the level of complexity is to begin training the neural network model using a low complexity level model. If the results are not satisfactory (low prediction capabilities), the model should be trained again using a medium complexity level model. After the new level of complexity is chosen, the user should press the **Finish** button located at the bottom of the panel in order to create the neural network (Figure 6-14). Finally, if the results obtained from training the model using a medium complexity level are not satisfactory, a high complexity level model should be trained (Figure 6-13).

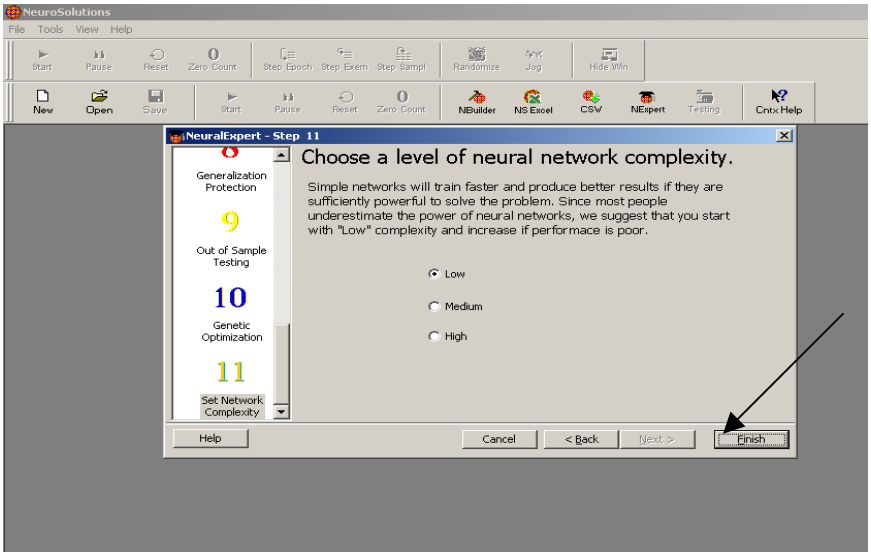


Figure 6-12 Network Complexity Panel

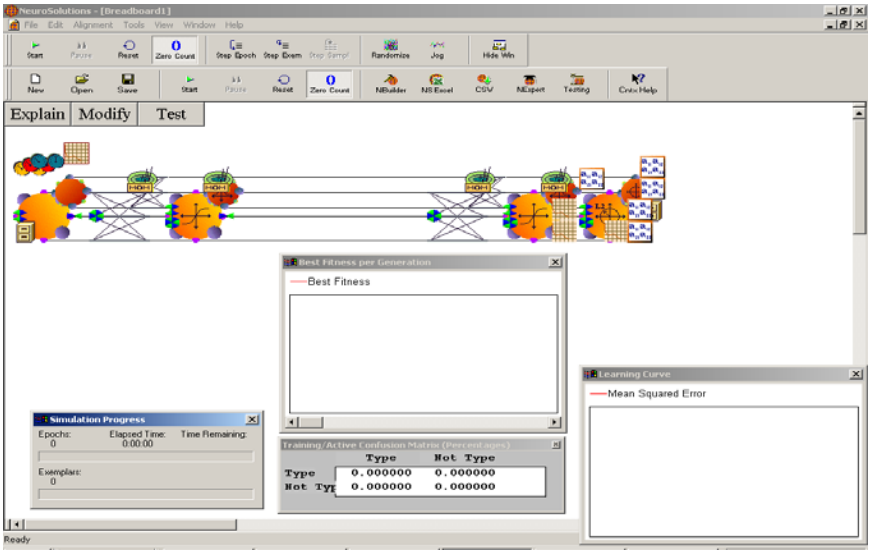


Figure 6-13 Neural Network

6.2 Training and Testing the Model

6.2.1 Training a Neural Network Model

After the neural network is built, the model can be trained by pressing the **Start** button located in the control bar (Figure 6-14). Figure 6-15 shows how the neural network is trained. The model runs 1,000 epochs per chromosome, and 25 chromosomes per generation. An epoch can be defined as the set of complete pattern of samples to be

presented during the training of a network. A chromosome can be defined as the solution to a problem; it is made of the neural network parameters to be optimized. On the screen, the user can see one chart that illustrates the best fitness per generation and another that shows the learning curve. Also, two matrices are located at the bottom of the screen. These matrices show the results of the cross validation process, and the results of the tests (Figure 6-15). Each one of these matrices places a U (unhealthy) and H (healthy) on each one of the axes. These letters appear there because they were used in the type column to identify whether a company was healthy or unhealthy. The first row shows the results of testing the unhealthy companies. The number on the left indicates the percentage of unhealthy companies classified correctly (unhealthy), and the number on the right indicates the percentage of unhealthy companies classified incorrectly (healthy.) The second row shows the results of testing the healthy companies. The number on the left indicates the percentage of healthy companies classified incorrectly (unhealthy), and the number on the right indicates the percentage of healthy companies classified correctly (healthy).

6.2.2 Testing a Neural Network Model

In order to test the model, the **Testing** button should be pressed. This button is located in the control bar (Figure 6-15). This function opens the **TestingWizard** to help the user to test the model following logically ordered steps.

6.2.2.1 Step 1: Test Data Panel

In this step, the file containing the data set that will be used to test the model is selected. As mentioned before, when the data has less than 100 rows, the best option is to use all the data to train the model. Thereafter, a sample is randomly selected from the data. This sample should be saved as a new file under a different name. Figure 6-16

shows the panel used to select the testing data. On this panel, three spaces have to be selected. The first one should have the testing option. For the other two spaces, the user has to browse to find the file containing the testing data. The same file should be selected in both spaces just if the sample data contains also the desired responses [columns that specifies whether or not a company is healthy (H) or unhealthy (U)].

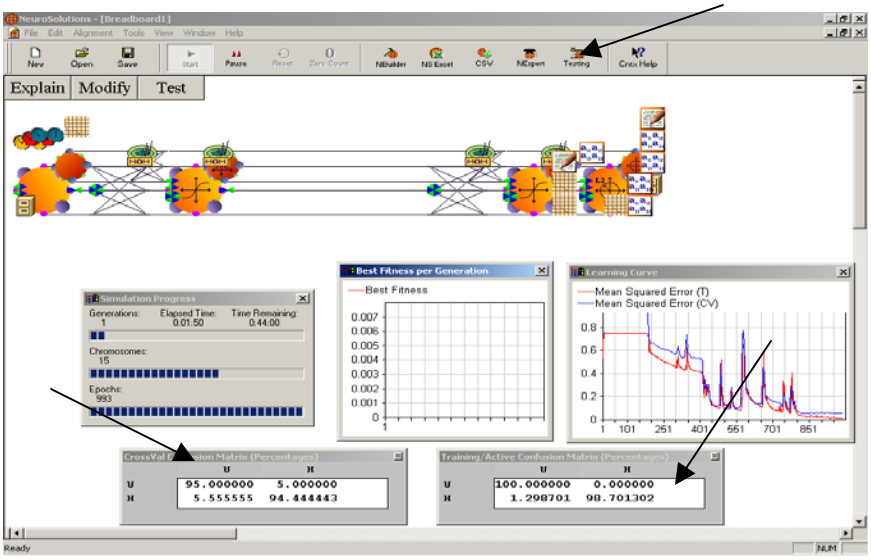


Figure 6-14 Training a Neural Network Model

6.2.2.2 Step 2: Output to Produce Panel

This panel asks the user about the type of output the program should produce. NeuroSolutions automatically shows the pre-defined outputs and the desired values on screen (Figure 6-17).

6.2.2.3 Step 3: Finish Panel

This panel asks the user if the NeuroSolutions should test the model (Figure 6-18). Pressing the finish button located at the bottom of the panel, NeuroSolutions automatically tests the model and presents the results in a new window.

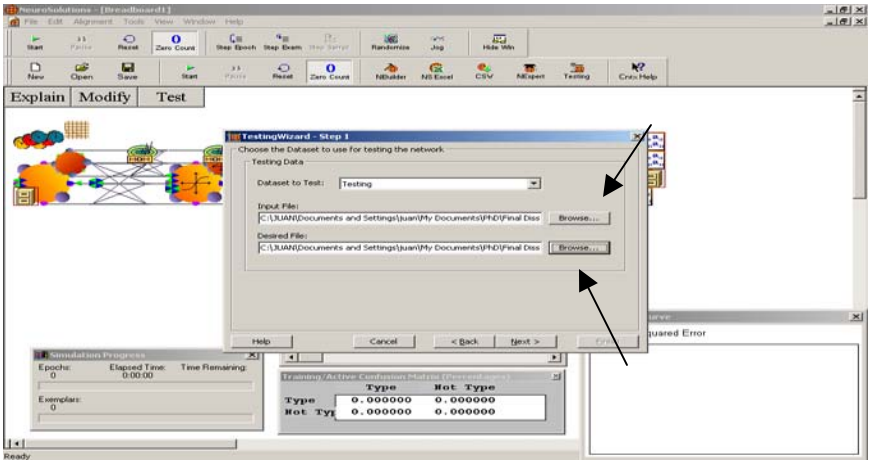


Figure 6-15 TestingWizard (Step 1: Selecting the test data)

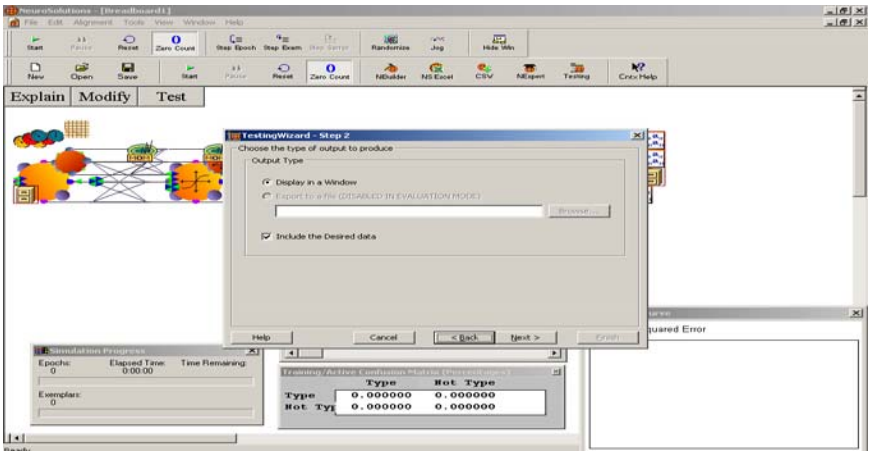


Figure 6-16 Output to Produce Panel

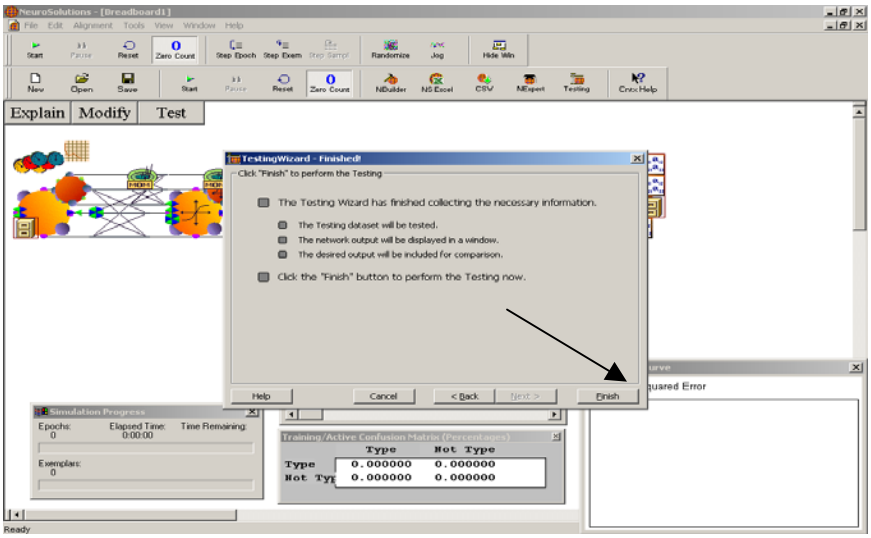


Figure 6-17 Finish Panel

6.3 Neural Network Models

Three neural networks models were trained to predict bankruptcy one, two, and three years before it happens. These three neural networks are classified as Feedforward models, which means that in these models the output is valid directly after the presentation of an input. They were trained to predict bankruptcy with the Static Back Propagation algorithm. "The Back propagation algorithm propagates the errors through the network and allows adaptation of the hidden layers.[47]"

6.3.1 Bankruptcy Prediction Model (One Year in Advance)

The first neural network model was trained using data from healthy construction companies (Appendix A) from the last year it is available, and with data from unhealthy construction companies (Appendix B) one year before business failure. This neural network model (Figure 6-19) has the seven variables chosen in Chapter 5 in the input layer. Subsequently, the model has two hidden layers with two elements in each layer, and finally the output layer with one element that classifies the construction company as either healthy or unhealthy.

As illustrated in Figure 6-20, after this model was trained, this neural network model classified healthy construction companies as healthy companies 88.89 percent of the time, and as unhealthy companies 11.11 percent of the time. Furthermore, this model was able to classify unhealthy companies as unhealthy100 percent of the time (Table 6-1). As mentioned in Chapter 2, Type I error occurs when the prediction model classifies a company that filed bankruptcy as a healthy company. Because Type I errors are usually more costly for model users, this prediction model represents a potential advantage to owners and financial institutions since it was able to correctly classify unhealthy companies 100 percent of the time during this research development.

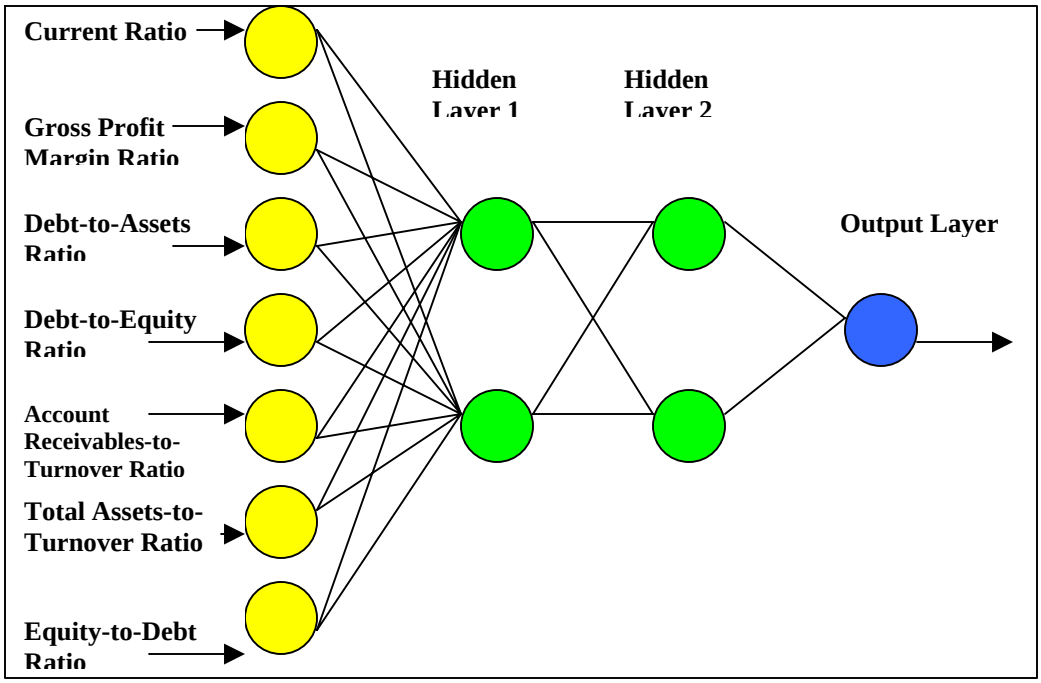


Figure 6-18 Neural Network Model One Year Before Business Failure

Table 6-1 Results Neural Network Model (One Year Before Bankruptcy)

Actual	Bankrupt	Non-bankrupt	Total
Bankrupt	88.89%	11.11%	100%
Non-bankrupt	0%	100%	100%

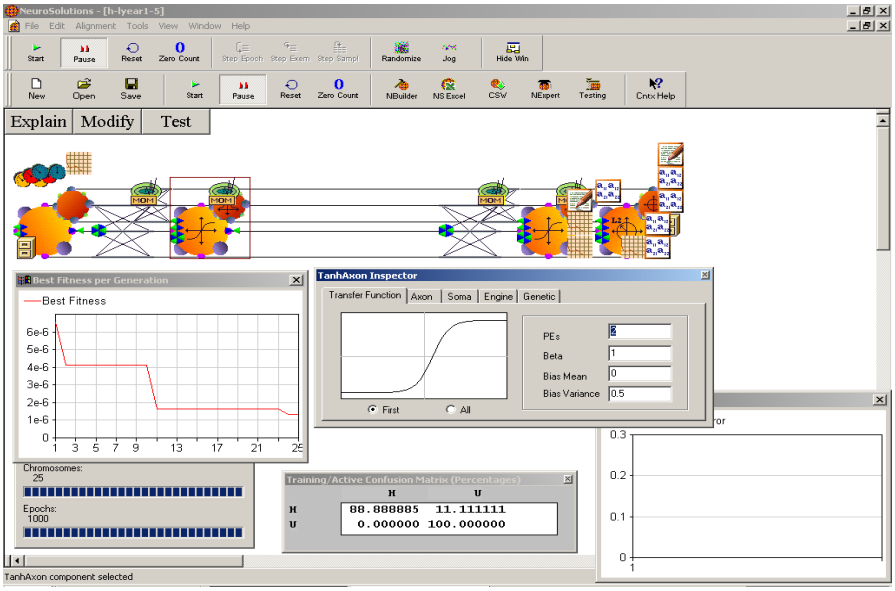


Figure 6-19 Testing the Neural Network Model (One Year Before Business Failure)

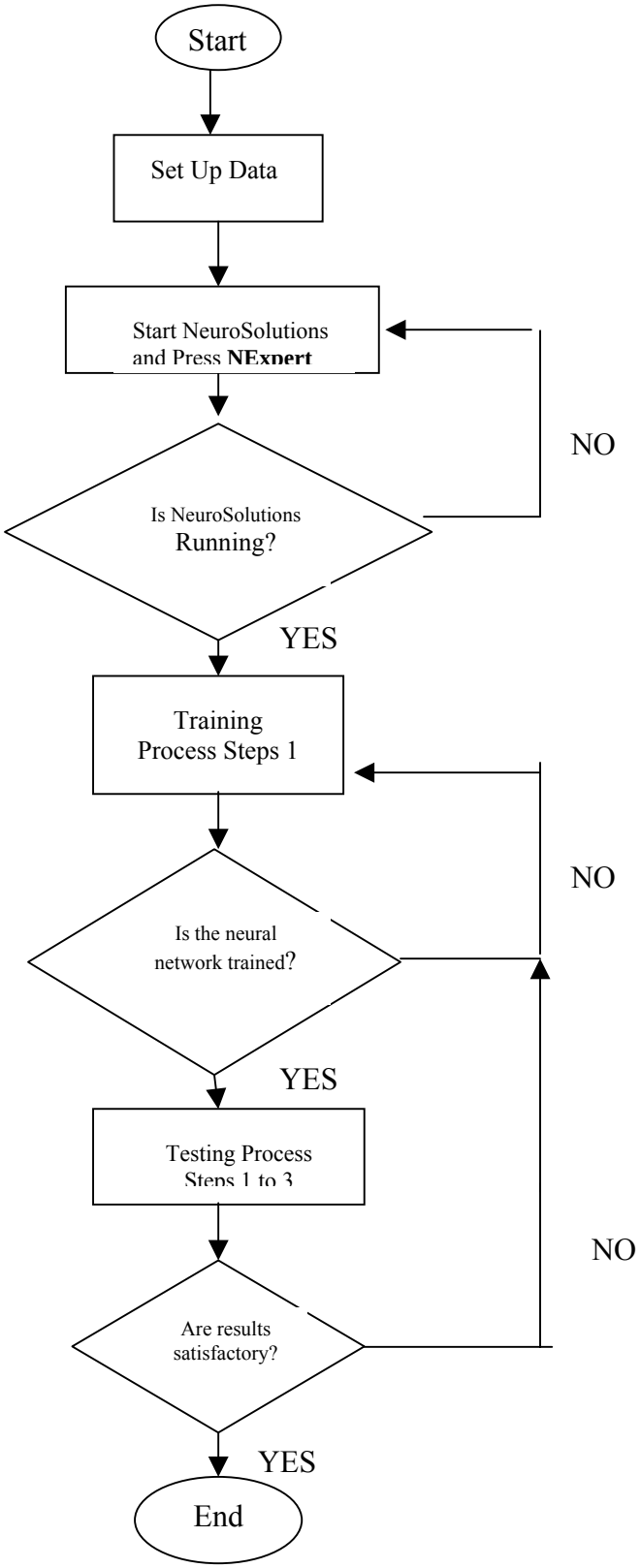


Figure 6-20 Flowchart Training and Testing Process

6.3.2 Bankruptcy Prediction Model (Two Years in Advance)

The second neural network model was trained using data from healthy construction companies (Appendix A) from one year before the last year it is available, and with data from unhealthy construction companies (Appendix B) two years before business failure. This neural network model (Figure 6-21) has the seven variables chosen in Chapter 5 in the input layer. Subsequently, it has two hidden layers with seven elements in the first hidden layer, and two elements in the second hidden layer. Finally the output layer has one element that classifies the construction company as either healthy or unhealthy.

As illustrated in Figure 6-22, this neural network model classified healthy construction companies as healthy companies 90 percent of the time, and as unhealthy companies 10 percent of the time. Furthermore, this model was able to classify unhealthy companies as unhealthy 77.78 percent of the time, and unhealthy companies as healthy companies 22.22 percent of the time (Table 6-2). As also mentioned in Chapter 2, Type II error occurs when the model classifies a healthy company as a failed company. This prediction model reduces the Type II error compared to the one-year-in-advance prediction model, but increases the Type I error that, as mentioned before, is usually more costly for model users.

Table 6-2 Results Neural Network Model (Two Years Before Bankruptcy)

Actual	Bankrupt	Non-bankrupt	Total
Bankrupt	90%	10%	100%
Non-bankrupt	22.22%	77.78%	100%

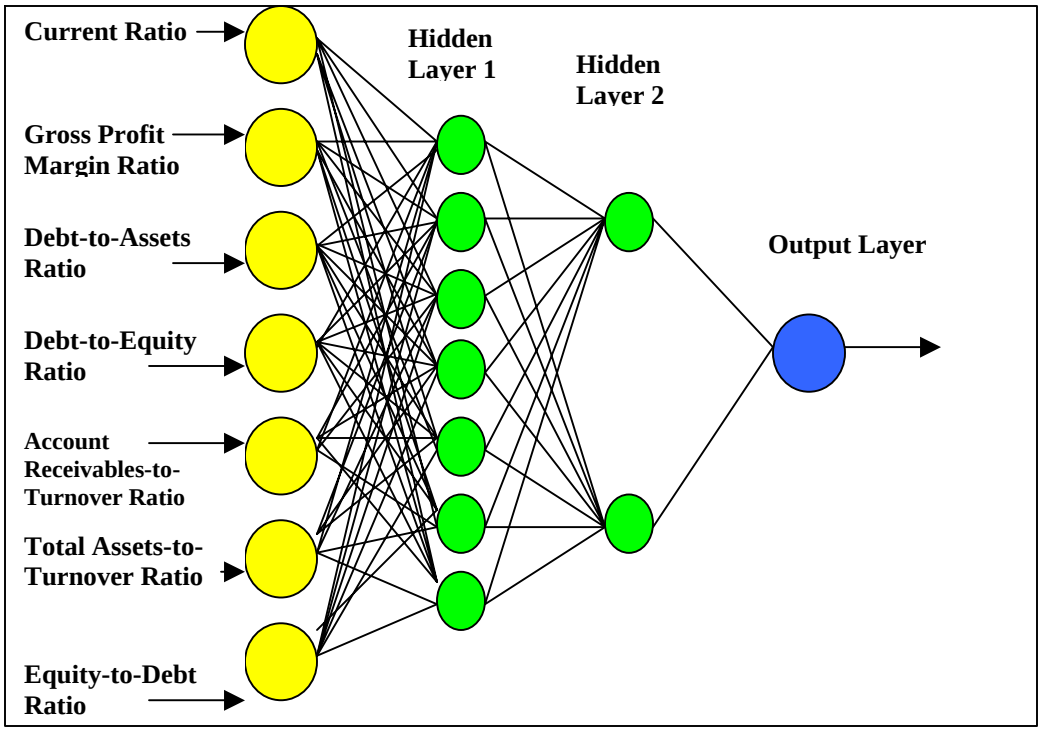


Figure 6-21 Neural Network Model Two Years Before Business Failure

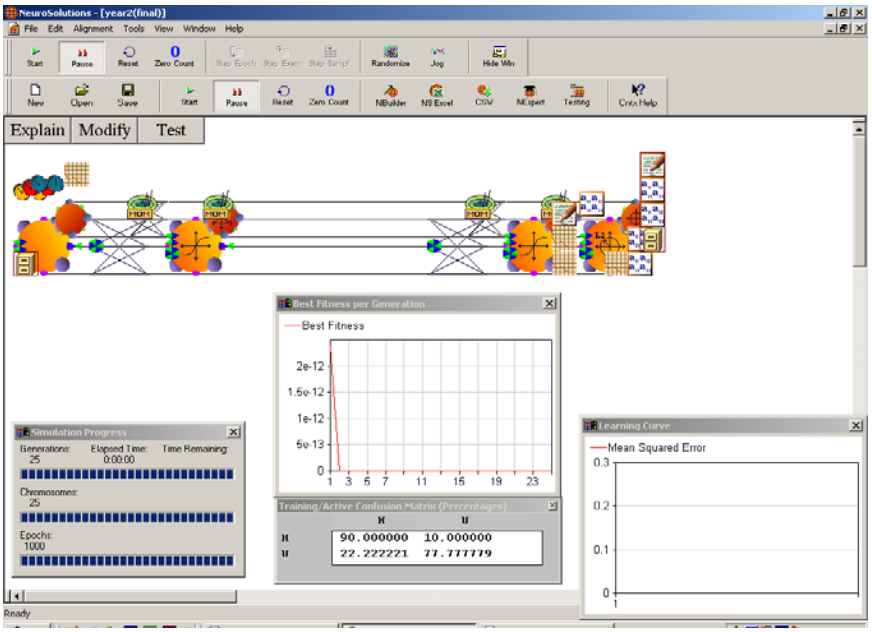


Figure 6-22 Testing the Neural Network Model (Two Years Before Business Failure)

6.3.3 Bankruptcy Prediction Model (Three Years in Advance)

The Third neural network model was trained using data from healthy construction companies (Appendix A) from two years before the last year available, and with data from unhealthy construction companies (Appendix B) three years before business failure. This neural network model (Figure 6-23) had, in the beginning, the six variables chosen in Chapter 5 in the input layer. Subsequently, it has two hidden layers with six elements in the first hidden layer and two in the second hidden layer. The output layer has one element that classifies the construction company as either healthy or unhealthy.

As illustrated in Figure 6-24, this neural network model classified healthy construction companies as healthy companies 55.56 percent of the time, and as unhealthy companies 44.44 percent of the time. Additionally, this model was able to classify unhealthy companies as unhealthy 76.92 percent of the time, and unhealthy companies as healthy companies 23.08 percent of the time (Table 6-3). Although this neural network model makes the same amount of Type I error as the two-years-before-business failure prediction model, it considerably increases the amount of Type II error compared to the other two prediction models mentioned before.

Table 6-3 Results Neural Network Model (Three Years Before Bankruptcy)

Actual	Bankrupt	Non-bankrupt	Total
Bankrupt	76.92%	23.08%	100%
Non-bankrupt	44.44%	55.56%	100%

The neural network models used the financial variables chosen in Chapter 5 as input variables. The first two prediction models (one and two years before business failure models) used the same seven input variables, but the third model (three years before business failure model) used just six variables because based on the results provided by the boxplots. In order to determine whether the seventh variable (Equity-to-

Debt Ratio) affects the prediction capabilities of this neural network model, this model was retrained and tested using the same seven variables used to train and test the other two prediction models (one and two years before business failure models.) This neural network model (Figure 6-25) has seven variables, five in the input layer. Subsequently, it has two hidden layer with eight elements in the first hidden layer and two in the second hidden layer. The output layer has one element that classifies the construction company as either healthy or unhealthy.

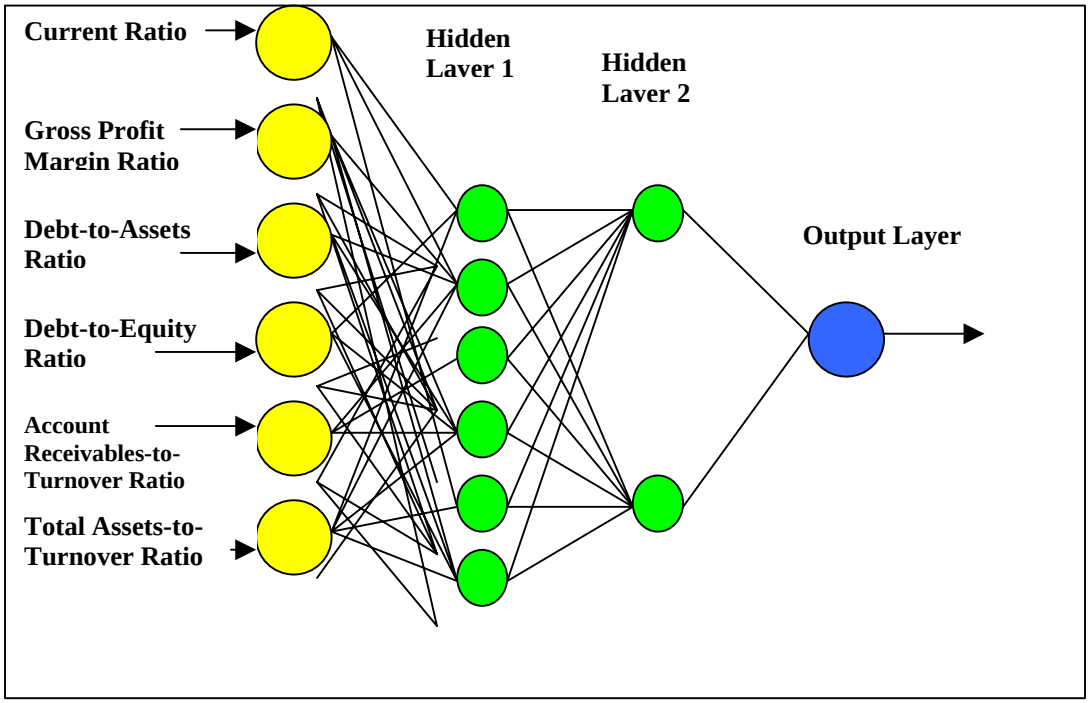


Figure 6-23 Neural Network Model Three Years Before Business Failure

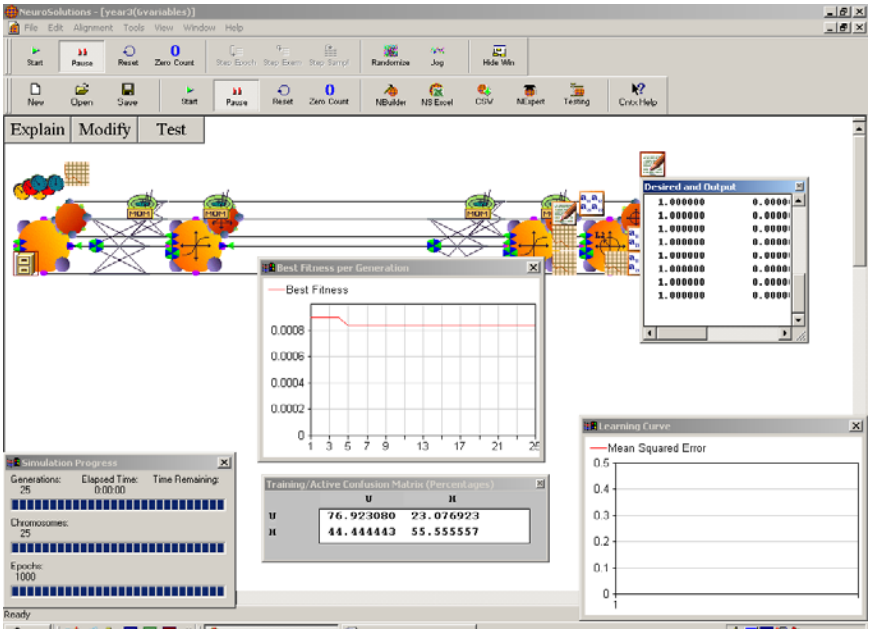


Figure 6-24 Testing the Neural Network Model (Three Years Before Business Failure)

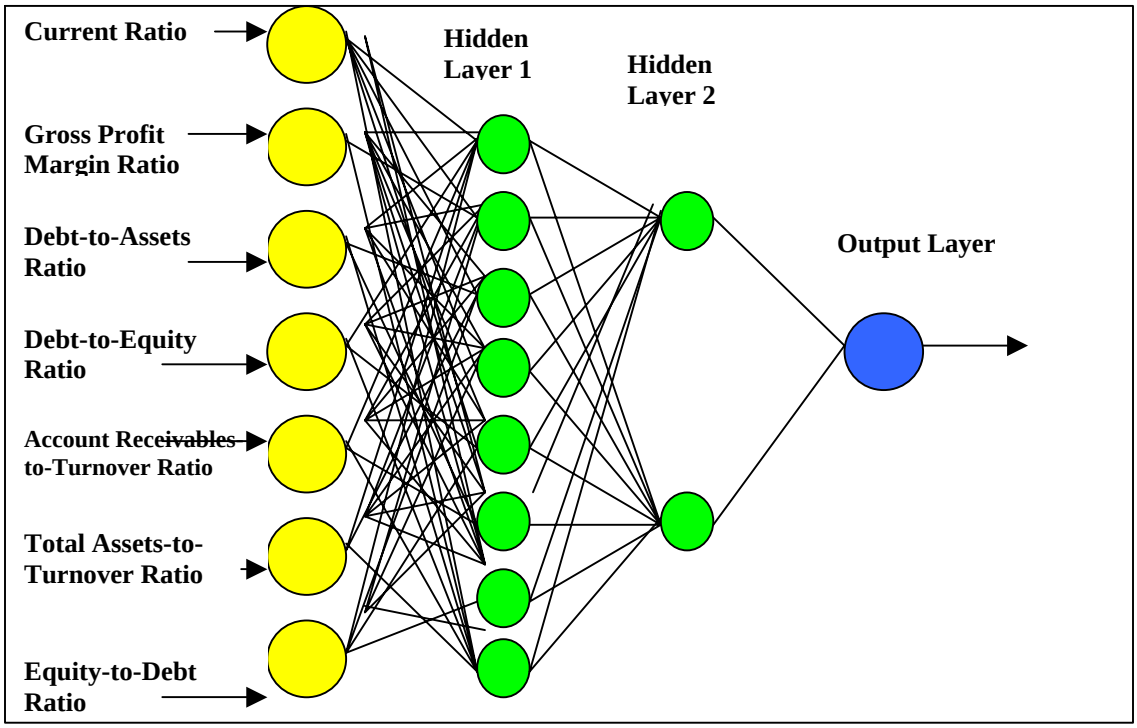


Figure 6-25 Neural Network Model Three Years Before Business Failure

This neural network model (Figure 6-26) classified healthy construction companies as healthy companies 77.78 percent of the time, and as unhealthy companies 22.22 percent of the time. As well, this model was able to classify unhealthy companies as

unhealthy 69.23 percent of the time, and unhealthy companies as healthy companies 30.77 percent of the time. Although this neural network model reduces the amount of Type II error compared to the six-inputs model, it increases the amount of Type II error compared to the six variables model.

6.3.4 Bankruptcy Prediction Model (General Model)

The three models described before can predict whether or not a construction company will fall into bankruptcy depending on what data was used to train the model (one, two, and three years in advance.) A single general prediction model was trained using combined data from one, two and three years before business failure, but the results found were not the best ones. The best neural network model predictor (Figure 6-27) had, in the beginning, the seven variables used in the other three models (one, two, and three years prediction models) in the input layer. Subsequently, it had two hidden layers with four elements in the first hidden layer and two in the second hidden layer. The output layer has one element that classifies the construction company as either healthy or unhealthy.

The general neural network model (Figure 6-27) classified healthy construction companies as healthy companies 32.14 percent of the time, and as unhealthy companies 67.86 percent of the time. As well, this model was able to classify unhealthy companies as unhealthy only 38.71 percent of the time, and unhealthy companies as healthy companies 61.29 percent of the time. The classification properties of this prediction model are extremely low, with a high Type I and Type II error. This prediction model should not be used for prediction purposes.

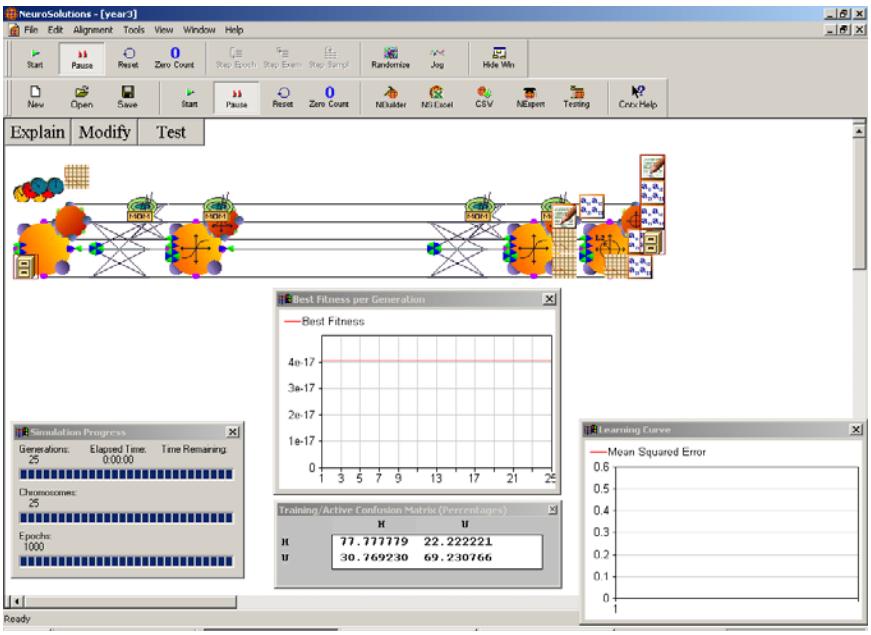


Figure 6-26 Testing the Neural Network Model (Three Years Before Business Failure)

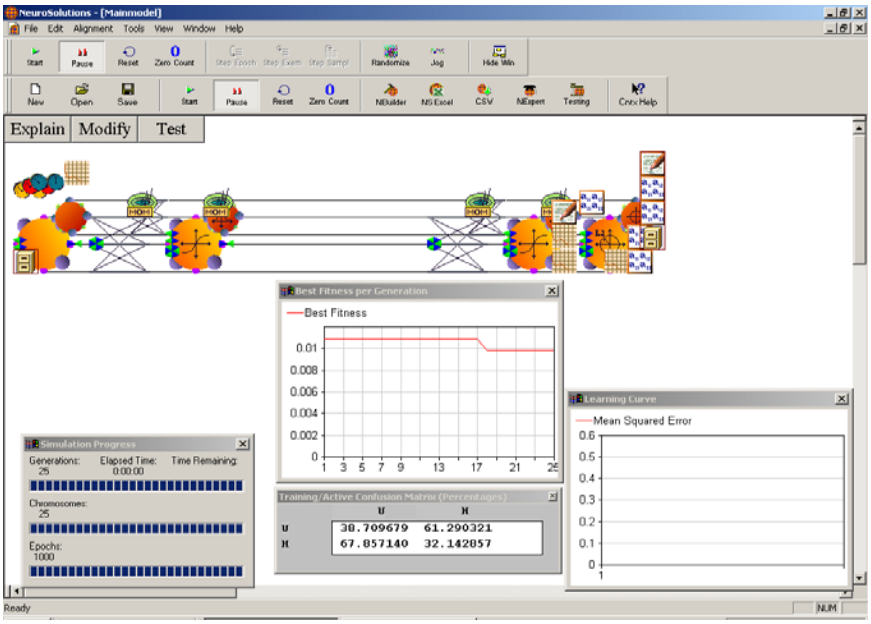


Figure 6-27 General Model

6.4 Altman's Z-Score Model

As mentioned in Chapter 2, one of the most famous bankruptcy prediction models is the one developed by Altman in 1968. This statistical model also called the Altman's Z-Score model uses a multiple discriminate analysis to predict business failure. Although

this model was created in 1968, the z-score model is still in use for bankruptcy prediction. As mentioned in Chapter 2, the financial variables used by Altman were working capital/total assets, retained earnings/total assets, earnings before interest and taxes/total assets, market value of equity/book value of total liabilities, and sales/total assets.

In order to compare the results obtained using the neural network models, financial ratios randomly chosen from the construction companies used in developing the neural network model were selected to test the z-score model. If the output value obtained using Altman's model is less than 1.81, the company is classified as unhealthy. If the value is higher than 2.67, the company is classified as healthy, and for values between 1.81 and 2.67 (Gray Area), the model is unable to classify the company as healthy or unhealthy. Table 6-1, 6-2 and 6-3 show the result obtained (H: healthy, U: unhealthy, and G: Gray Area).

Table 6-4 Results Altman's Model (One Year Before Business Failure)

Working capital/total assets	Retained earnings/ total assets	EBIT/ total Assets	Sales/ total assets	Market value of equity/ total liabilities	Expected	Altman's	Results
0.18	0.29	0.16	1.95	0.73	U	1.96	G
0.26	-0.36	0.32	1.08	0.1	U	1.09	U
0.11	0.32	0.16	1.97	0.6	U	1.98	G
0.19	0.44	0.03	1.46	1.04	U	1.47	U
0.12	0.21	0.26	3.3	0.49	U	3.31	H
0.27	0.21	0.27	1.85	0.34	U	1.87	G
0.1	0.03	0.14	0.99	0.75	U	1.00	U
-0.12	-5.05	0.09	0.34	0.42	U	0.27	U
-0.14	-0.17	0.15	1.1	0.15	U	1.10	U
0.27	-0.37	0.09	1.19	-0.11	U	1.19	U
0.21	0.41	0.4	2.76	1.02	H	2.78	H
-0.08	-0.32	0.14	1.52	-0.26	H	1.52	G
0.25	0.59	0.19	0.86	2.41	H	0.89	U

Table 6-4 Continued

Working capital/total assets	Retained earnings / total assets	EBIT/ total assets	Sales/ total assets	Market value of equity/ total liabilities	Expected	Altman's	Results
0.44	-0.02	0.21	1.37	4.88	H	1.41	U
0.22	0.05	0.13	2.43	0.27	H	2.44	G
0.41	0.86	0.24	1.82	1.47	H	1.85	G
0.09	0.88	0.12	2.25	3.79	H	2.29	G
0.04	0.14	0.14	1.66	1.49	H	1.67	U
0.37	-0.67	0.39	2.96	0.62	H	2.97	H

Table 6-5 Results Altman's Model (Two Years Before Business Failure)

Working capital/total assets	Retained earnings/ total assets	EBIT/ total assets	Sales/ total assets	Market value of equity/ total liabilities	Expected	Altman's	Results
0.04	0.31	0.32	1.70	0.60	U	1.71	U
0.25	0.28	0.18	1.77	0.51	U	1.78	U
0.26	0.12	0.13	1.72	0.51	U	1.73	U
-0.94	-1.48	0.06	3.58	-0.39	U	3.54	H
0.18	0.26	0.18	1.72	0.53	U	1.73	U
0.16	-0.26	0.30	0.98	0.10	U	0.99	U
0.03	-0.02	0.05	0.21	0.65	U	0.22	U
0.37	-2.69	0.01	0.06	-0.04	U	0.03	U
0.13	-0.06	0.11	0.91	0.26	U	0.92	U
0.19	-0.08	0.22	0.99	0.16	U	1.00	U
0.11	0.20	0.15	1.29	0.33	H	1.30	U
-0.07	0.17	0.16	0.43	0.53	H	0.44	U
0.09	0.14	0.10	0.57	0.75	H	0.59	U
0.54	-0.04	0.21	1.00	8.74	H	1.06	U
0.16	0.91	0.06	1.85	2.12	H	1.88	G
0.17	0.12	0.14	1.38	2.19	H	1.40	U
0.30	0.29	0.27	1.10	1.63	H	1.13	U
-0.10	0.18	0.13	0.62	0.42	H	0.62	U
0.57	0.27	0.08	0.51	0.63	H	0.53	U
0.02	0.01	0.14	0.42	0.52	H	0.43	U

Table 6-6 Results Altman's Model (Three Years Before Business Failure)

Working capital/total assets	Retained earnings/ total assets	EBIT/ total Assets	Sales/ total assets	Market value of equity/ total liabilities	Expected	Altman's	Results
0.27	0.13	0.14	1.92	0.46	U	1.93	G
0.21	0.44	0.28	1.04	0.92	U	1.07	U
-0.81	-1.72	-0.02	0.59	-0.48	U	0.55	U
0.15	0.23	0.16	2.06	0.58	U	2.07	G
0.15	0.28	0.26	1.99	0.68	U	2.01	G
0.26	0.22	0.16	1.86	0.41	U	1.87	G
-1.25	-1.53	-0.21	0.37	-0.41	U	0.32	U
0.35	-5.00	0.07	0.21	3.22	U	0.17	U
0.33	-0.22	0.07	0.16	1.16	U	0.17	U
-1.64	-0.15	-0.03	0.45	-0.59	U	0.43	U
0.32	-0.07	0.12	1.09	0.27	U	1.10	U
0.21	0.02	0.20	0.82	0.31	U	0.83	U
0.24	0.69	0.22	0.81	3.82	H	0.85	U
0.37	-0.07	0.22	1.04	5.94	H	1.09	U
0.25	0.46	0.34	1.90	1.13	H	1.92	G
0.33	0.95	0.27	2.43	1.10	H	2.46	G
0.14	1.11	-0.01	1.12	1.96	H	1.15	U
0.31	0.10	0.14	0.90	1.77	H	0.92	U
0.32	0.27	0.32	1.20	1.58	H	1.23	U
0.35	-0.61	0.40	3.27	0.43	H	3.28	H
0.16	0.09	0.23	0.99	1.44	H	1.00	U

The results obtained using the z-score model for data one year before business failure (Table 6-4) indicate that the model classified healthy construction companies as healthy companies 22.22 percent of the time, as unhealthy companies 33.33 percent of the time, and the model does not recognize the company as healthy or unhealthy 44.44 percent of the time. As well, this model was able to classify unhealthy companies as unhealthy 60 percent of the time, unhealthy companies as healthy companies 10 percent of the time, and the model could not recognize whether or not the company was healthy or unhealthy 30 percent of the time.

Table 6-7 Results Z-Score Model (One Year Before Bankruptcy)

Actual	Bankrupt	Non-bankrupt	Gray Area	Total
Bankrupt	6	1	3	10
	60%	10%	30%	100%
Non-Bankrupt	3	2	4	9
	33.33%	22.22%	44.44%	100%

The results obtained using the z-score model for data two years before business failure (Table 6-5) show that the model classified healthy construction companies as healthy companies zero percent of the time, as unhealthy companies 90 percent of the time, and the model does not recognize the company as healthy or unhealthy 10 percent of the time. As well, this model was able to classify unhealthy companies as unhealthy 90 percent of the time, and unhealthy companies as healthy companies 10 percent of the time.

Table 6-8 Results Z-Score Model (Two Years Before Bankruptcy)

Actual	Bankrupt	Non-bankrupt	Gray Area	Total
Bankrupt	9	1	0	10
	90%	10%	0%	100%
Non-Bankrupt	9	0	1	10
	90%	0%	10%	100%

The results obtained using the z-score model for data three years before business failure (Table 6-6) indicate that the model classified healthy construction companies as healthy companies 11.11 percent of the time, as unhealthy companies 66.67 percent of the time, and the model does not recognize the company as healthy or unhealthy 22.22 percent of the time. As well, this model was able to classify unhealthy companies as unhealthy 66.67 percent of the time, unhealthy companies as healthy companies zero percent of the time, and the z-score model was unable to recognize whether the company was healthy or unhealthy 33.33 percent of the time.

Table 6-9 Results Z-Score Model (Three Years Before Bankruptcy)

Actual	Bankrupt	Non-bankrupt	Gray Area	Total
Bankrupt	8	0	4	12
	66.67%	0%	33.33%	100%
Non-Bankrupt	6	1	2	9
	66.67%	11.11%	22.22%	100%

These results show that the z-score model generates higher Type I and Type II error than the neural network models. In conclusion, the neural network models are better predictors for one, two and three years before business failure.

6.5 Weights of the Financial Ratios

As mentioned before, one problem with using neural networks is that the user cannot know the importance of each one of the inputs in the model (weight.) In order to solve this problem, a numerical exercise was conducted. A weight of one was given to each one of the seven variables. The data used for each variable was the mean of the data for each one of the years. As soon as the variable means are multiplied by the weight, these variables are added together to find a base number. Thereafter, the weight of one of the variables was changed from 1 to 5; meanwhile the other weights were kept as one. Finally, the value of the additions, when each one of the variables had a weight of 5 was compared to the results from the other variables, and the ones with higher increments were chosen as the most important variables. Table 6-7, 6-8 and 6-9 show this exercise for one, two and three years correspondingly.

Table 6-7 Variable Weights (One Year Before Bankruptcy)

Ratio2	**Ratio6**	**Ratio9**	**Ratio11**	**Ratio15**	**Ratio16**	**Ratio21**	**Output**
1.65	19.83	21.06	26.02	5.61	1.18	0.65	
Weights 1	Weights 2	Weights 3	Weights 4	Weights 5	Weights 6	Weights 7	
1	1	1	1	1	1	1	76.00
2	1	1	1	1	1	1	77.66
Weights 1	Weights 2	Weights 3	Weights 4	Weights 5	Weights 6	Weights 7	
3	1	1	1	1	1	1	79.31

Table 6-7 Continued

Ratio2	Ratio6	Ratio9	Ratio11	Ratio15	Ratio16	Ratio21	Output
4	1	1	1	1	1	1	80.97
5	1	1	1	1	1	1	82.62
1	1	1	1	1	1	1	76.00
1	2	1	1	1	1	1	95.83
1	3	1	1	1	1	1	115.65
1	4	1	1	1	1	1	135.48
1	5	1	1	1	1	1	155.31
1	1	1	1	1	1	1	76.00
1	1	2	1	1	1	1	97.07
1	1	3	1	1	1	1	118.13
1	1	4	1	1	1	1	139.19
1	1	5	1	1	1	1	160.26
1	1	1	1	1	1	1	76.00
1	1	1	2	1	1	1	102.02
1	1	1	3	1	1	1	128.04
1	1	1	4	1	1	1	154.06
1	1	1	5	1	1	1	180.08
1	1	1	1	1	1	1	76.00
1	1	1	1	2	1	1	81.61
1	1	1	1	3	1	1	87.22
1	1	1	1	4	1	1	92.83
1	1	1	1	5	1	1	98.45
1	1	1	1	1	1	1	76.00
1	1	1	1	1	2	1	77.18
1	1	1	1	1	3	1	78.36
1	1	1	1	1	4	1	79.54
1	1	1	1	1	5	1	80.72
1	1	1	1	1	1	1	76.00
1	1	1	1	1	1	2	76.65
1	1	1	1	1	1	3	77.29
1	1	1	1	1	1	4	77.94
1	1	1	1	1	1	5	78.59

Table 6-8 Variable Weights (Two Years Before Bankruptcy)

Ratio2	Ratio6	Ratio9	Ratio11	Ratio15	Ratio16	Ratio21	Output
1.58	20.54	15.71	30.02	5.53	1.19	0.74	
1	1	1	1	1	1	1	75.32
2	1	1	1	1	1	1	76.90
3	1	1	1	1	1	1	78.48
4	1	1	1	1	1	1	80.06
5	1	1	1	1	1	1	81.63
1	1	1	1	1	1	1	75.32
1	2	1	1	1	1	1	95.87
1	3	1	1	1	1	1	116.41

Table 6-8 Continued

Ratio2	Ratio6	Ratio9	Ratio11	Ratio15	Ratio16	Ratio21	Output
1	4	1	1	1	1	1	136.96
1	5	1	1	1	1	1	157.50
1	1	1	1	1	1	1	75.32
1	1	2	1	1	1	1	91.04
1	1	3	1	1	1	1	106.75
1	1	4	1	1	1	1	122.47
1	1	5	1	1	1	1	138.18
1	1	1	1	1	1	1	75.32
1	1	1	2	1	1	1	105.34
1	1	1	3	1	1	1	135.36
1	1	1	4	1	1	1	165.38
1	1	1	5	1	1	1	195.40
1	1	1	1	1	1	1	75.32
1	1	1	1	2	1	1	80.85
1	1	1	1	3	1	1	86.38
1	1	1	1	4	1	1	91.91
1	1	1	1	5	1	1	97.44
1	1	1	1	1	1	1	75.32
1	1	1	1	1	2	1	76.52
1	1	1	1	1	3	1	77.71
1	1	1	1	1	4	1	78.91
1	1	1	1	1	5	1	80.10
1	1	1	1	1	1	1	75.32
1	1	1	1	1	1	2	76.07
1	1	1	1	1	1	3	76.81
1	1	1	1	1	1	4	77.55
1	1	1	1	1	1	5	78.30

Table 6-9 Variable Weights (Three Years Before Bankruptcy)

Ratio2	Ratio6	Ratio9	Ratio11	Ratio15	Ratio16	Ratio21	Output
1.70	17.21	15.79	19.08	9.35	1.15	0.77	
1	1	1	1	1	1	1	65.06
2	1	1	1	1	1	1	66.76
3	1	1	1	1	1	1	68.46
4	1	1	1	1	1	1	70.16
5	1	1	1	1	1	1	71.86
1	1	1	1	1	1	1	65.06
1	2	1	1	1	1	1	82.26
1	3	1	1	1	1	1	99.47
1	4	1	1	1	1	1	116.68
1	5	1	1	1	1	1	133.89
1	1	1	1	1	1	1	65.06
1	1	2	1	1	1	1	80.85
1	1	3	1	1	1	1	96.64
1	1	4	1	1	1	1	112.43

Table 6-9 Continued

Weights 1	Weights 2	Weights 3	Weights 4	Weights 5	Weights 6	Weights 7	
1	1	5	1	1	1	1	128.22
1	1	1	1	1	1	1	65.06
1	1	1	2	1	1	1	84.14
1	1	1	3	1	1	1	103.22
1	1	1	4	1	1	1	122.31
1	1	1	5	1	1	1	141.39
1	1	1	1	1	1	1	65.06
1	1	1	1	2	1	1	74.40
1	1	1	1	3	1	1	83.75
1	1	1	1	4	1	1	93.10
1	1	1	1	5	1	1	102.45
1	1	1	1	1	1	1	65.06
1	1	1	1	1	2	1	66.20
1	1	1	1	1	3	1	67.35
1	1	1	1	1	4	1	68.50
1	1	1	1	1	5	1	69.65
1	1	1	1	1	1	1	65.06
1	1	1	1	1	1	2	65.83
1	1	1	1	1	1	3	66.60
1	1	1	1	1	1	4	67.37
1	1	1	1	1	1	5	68.14

It is appreciable on Table 6-7 (data one year before business failure) that the financial ratio that shows the higher increment when the weights are changed is the debt-to-equity ratio. The second most important change is presented by the debt-to-assets ratio, and the third most important increment is presented by the gross profit-to-margin ratio. On the other hand, for the two-year and three-year models (Table 6-8 and 6-9) the financial ratio that presents the highest change was also the debt-to-equity ratio, but the financial ratio that presents the second highest change was the gross profit-to-margin ratio, that was third for the one-year before business failure data. The financial ratio that presents the third highest change was the debt-to-assets ratio that was second using one year before business failure data. These results show that for the same variation some ratios present higher changes due to their means being appreciable higher than the other

financial variables. This indicates that variations in these ratios will have a higher influence on the financial condition of a company.

6.6 Gray Point

When a construction company uses the neural network model to check whether it is healthy or unhealthy, the results obtained from the neural network model are two probabilities as shown in Table 6-10. U indicates the probability for that company to be unhealthy, and H represents the probability for that company to be healthy.

Table 6-10 Example of Results

U (Pu)	H (Ph)
0.4733	0.6899

Probability ratios were used to understand the results provided by the neural networks. Probability ratios can be defined as "**a ratio of the probability that an event will occur versus the probability that the event will not occur.**[48]" The probability ratios used were:

If $P_H > P_U$, give the Healthy probability ratio $HPR = P_H / P_U$. (41)

If $P_H < P_U$, give the Unhealthy probability ratio $UPR = P_U / P_H$. (42)

Where HPR (Healthy Company probability Ratio) can be defined as the probability that the company is healthy relative to it being unhealthy, and UOR (Unhealthy Company Probability Ratio) can be defined as the probability that the company is unhealthy relative to it being healthy.

Using as example the data in Table 6-10, The P_H is equal to 0.6899, and P_U is equal to 0.4733. Because $P_H > P_U$, the probability ratio used would be $HOR = P_H / P_U$. HOR=0.6899/0.4733= 1.46. This results means that the company is 1.46 times as likely to be healthy then unhealthy.

When the probability ratio is equal to one is very unlikely, the case when the probability ratio is close to one can happen. Probability ratios close to one can generate uncertainty. In this case, the best alternative is to use a different prediction method and compare its results with the results obtained from the neural network model in order to reduce uncertainty. When the probability ratio is less than one, the ratio indicates that the user chose the wrong equation.

In order to test how the probability ratios work, data from five construction companies was randomly chosen and tested using the one-year before bankruptcy neural network model. Table 6-11 shows the results obtained.

Table 6-11 Results Using Probability Ratios

	U	H	Desired	Output	HOR	UOR
1	0.467896	0.766256	H	H	1.64	
2	0.041994	0.978147	H	H	23.29	
3	0.179695	0.850593	H	H	4.73	
4	0.571101	0.5788	U	H		1.01
5	0.790335	0.74378	U	U		1.06

The first three construction companies were healthy companies. The neural network model correctly classified these companies as healthy companies. Although the corresponded HOR (Healthy Company Probability Ratio) were higher than one, the HOR for the first company (1.64) was closer to one than the other two (23.29 and 4.73). This indicates that there was a level of uncertainty in the results obtained for that company. The other two companies used to test the model were unhealthy companies. The neural network model misclassified the fourth company as healthy. The UOR (Unhealthy Company Probability Ratio) for this company was equal to 1.01, which indicates that the company was healthy when it was not. Also because the UOR was close to one that

indicates that there was a high level of uncertainty in the results provided by the neural network model. In this case, the neural network model made a misclassification error. The fifth company was correctly classified as unhealthy company. Although the results were correct, the UOR obtained for this company was equal to 1.06. This UOR was close to one, what indicates a high level of uncertainty about the accuracy of the classification.

CHAPTER 7
CONCLUSIONS AND RECOMNENDATIONS

7.1 Conclusions

The following conclusions were obtained from this research:

- The Neural networks trained are a reliable tool to predict business failure in construction companies.

- The results obtained by using the three neural network models were: the one year before business failure model (7-2-2-1) was able to classified correctly healthy construction companies 88.89 percent of the time, and unhealthy companies 100 percent of the time. The two years before business failure model (7-7-2-1) was able to classified correctly healthy construction companies 90 percent of the time, and unhealthy companies 77.78 percent of the time. The three years before business failure model (7-8-2-1) was able to classified correctly healthy construction companies 77.78 percent of the time, and unhealthy companies 69.23 percent of the time.

- There are three significant financial ratios in bankruptcy prediction: debt-to-equity ratio, debt-to-assets ratio and gross profit margin ratio.

- The three financial ratios are the primary ratios in bankruptcy prediction for the type of construction companies used in this research (heavy construction, utility construction, and commercial construction.) This does not guarantee that these financial ratios are good bankruptcy predictors for all types of construction companies, since they have yet to be tested.

- When the information from a construction company is used to check whether the company is healthy or unhealthy, the neural network model will provide the user with two numeric indicators. These numbers are the probability for that company will be healthy and the probability that it will be unhealthy. The higher probability will indicate whether the company is healthy or unhealthy.

- The results provided by a neural network do not have a “gray area”. Instead, those results have a possible “gray point”. That can occur when the probability that the company is healthy is the same as if the company is unhealthy. The probability ratio formulas presented in Chapter Six should be used in order to understand the results provided by the neural network model, and measure the level of uncertainty.

- The accuracy of the model can be improved if more data from public construction companies and from private construction companies are used to train the model.

- The neural network models cannot predict catastrophic events in the economy such as the economic effects of September 11, 2001.

7.2 Research Limitations

The following research limitations were found during the development of this dissertation:

- Unwillingness of private construction companies to share financial data.

- The data collected was from public trade construction companies and did not include privately owned companies.

- Data from construction companies (heavy construction, utility construction, and commercial construction) were used to train and test the model. This model has not been trained or tested using data from other construction fields.

- The software used to train and test the neural networks was a student version. This version limited the development of a software application. Although it proved adequate for this initial study.

7.3 Recommendations

The following recommendations are based on the results of this research:

- An upgraded version of NeuroSolutions should be used in order to develop software that can be used by construction companies to check their financial strength.

- More data should be collected from public trade construction companies to improve the accuracy of the neural network model.

- Data from private companies should be collected and added to the existing data.

- Financial ratios should be calculated and analyzed using data from private companies. Results can be compared with our original model to determine if it is applicable over a large range of construction company types. The same should be done for smaller companies.

- Data from other sectors of the construction industry such as building construction should be gathered to improve the accuracy of the model. The inclusion of other construction fields will also help to create a general model applicable to any type of construction company.

- Surety companies should be surveyed to determine the financial ratios they use to measure the fiscal health status of a construction company. If it is determined that surety companies use different financial ratios from the ones identified and used in this research, a new neural network model should be trained and tested. Its results should be compared to the existing neural network.

- A computer with a faster processor should be used in order to reduce the training time when large amount of data can be obtained.

APPENDIX A
FINANCIAL RATIOS-HEALTHY COMPANIES

Table A-1 Financial Ratios Healthy Companies 1 and 2

	Company 1			Company 2		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	0.95	0.86	1.00	1.64	1.41	1.65
Current Ratio	1.08	1.03	1.21	1.64	1.41	1.65
Return on Assets Ratio	-0.04	-0.03	0.06	-0.01	0.01	0.01
Return on Equity Ratio	-0.77	-0.34	0.28	-0.05	0.04	0.03
Net Profit Margin Ratio	0.01	-0.003	0.04	-0.02	-0.01	0.00
Gross Profit Margin Ratio	27.85	23.47	27.70	14.05	11.34	11.55
Return on Investment	0.01	-0.003	0.04	-0.02	-0.01	0.004
Return on Sales Ratio	1.37	0.19	5.69	-3.65	-1.28	0.39
Debt to Assets Ratio	0.97	0.94	0.83	0.71	0.75	0.77
Equity to Assets Ratio	0.03	0.06	0.17	0.29	0.25	0.23
Debt to Equity Ratio	28.15	15.06	4.99	2.46	2.99	3.34
Times-Covered Ratio	-9.20	-17.68	-11.14	3.51	4.12	4.60
Interest Coverage Ratio	-0.45	-0.14	-2.29	-0.91	-0.46	0.16
Inventory to Turnover Ratio	5.55	5.90	5.20	N/A	N/A	N/A
Accounts Receivable Turnover Ratio	2.55	2.84	2.76	5.87	9.31	9.63
Total Assets Turnover Ratio	1.61	1.36	1.35	1.00	0.77	0.63
Net Working Capital Ratio	0.05	0.01	0.11	0.10	0.11	0.12
Retained Earnings to Total Assets Ratio	0.06	0.15	0.03	0.23	0.20	0.18
Net Income plus Tax Ratio	0.17	0.17	0.21	0.14	0.15	0.18
Sales to Total Assets Analysis Ratio	0.62	0.73	0.74	1.00	1.29	1.58
Equity to Debt Analysis Ratio	0.04	0.07	0.20	0.41	0.33	0.30
Cash Flow to Debt Analysis Ratio	-0.01	0.00	0.09	0.02	0.06	0.05
Cash Flow to Total Assets Ratio	-0.01	0.00	0.07	0.02	0.04	0.04
Cash Flow to Total Equity	-0.17	0.05	0.44	0.06	0.18	0.16
Cash Flow to Total Sales	-0.01	0.00	0.10	0.02	0.03	0.02
Cash Flow to Interest Expenses	0.31	-0.30	-3.99	0.40	1.24	0.91

Table A-2 Financial Ratios Healthy Companies 3 and 4

	Company 3			Company 4		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	0.96	0.36	0.59	1.93	1.80	2.32
Current Ratio	1.21	0.55	0.78	2.09	1.94	2.48
Return on Assets Ratio	0.03	0.05	0.05	0.05	0.06	0.07
Return on Equity Ratio	0.09	0.13	0.13	0.09	0.08	0.10
Net Profit Margin Ratio	0.10	0.11	0.12	0.05	0.06	0.07
Gross Profit Margin Ratio	44.16	36.58	40.88	16.56	17.71	21.72
Return on Investment	0.03	0.05	0.05	0.05	0.06	0.07

Table A-2 Continued

Return on Sales Ratio	16.14	17.49	19.99	9.22	8.76	6.96
Debt to Assets Ratio	0.65	0.66	0.65	0.61	0.57	0.54
Equity to Assets Ratio	0.35	0.34	0.35	0.39	0.43	0.46
Debt to Equity Ratio	1.85	1.90	1.83	1.57	1.33	1.15
Times-Covered Ratio	5.89	7.33	7.77	6.08	4.98	5.55
Interest Coverage Ratio	2.15	3.50	3.80	3.39	2.46	1.78
Inventory to Turnover Ratio	7.17	9.68	10.04	33.99	35.77	30.99
Accounts Receivable Turnover Ratio	8.69	9.79	7.26	9.95	9.81	8.85
Total Assets Turnover Ratio	2.99	2.31	2.52	1.61	1.74	1.63
Net Working Capital Ratio	0.02	-0.07	-0.03	0.10	0.09	0.14
Retained Earnings to Total Assets Ratio	0.16	0.17	0.18	0.14	0.14	0.14
Net Income plus Tax Ratio	0.15	0.16	0.16	0.10	0.10	0.13
Sales to Total Assets Analysis Ratio	0.33	0.43	0.40	0.62	0.57	0.61
Equity to Debt Analysis Ratio	0.54	0.53	0.55	0.64	0.75	0.87
Cash Flow to Debt Analysis Ratio	0.11	0.13	0.13	0.09	0.09	0.15
Cash Flow to Total Assets Ratio	0.07	0.09	0.09	0.05	0.05	0.08
Cash Flow to Total Equity	0.21	0.25	0.24	0.14	0.13	0.17
Cash Flow to Total Sales	0.22	0.20	0.21	0.09	0.09	0.13
Cash Flow to Interest Expenses	2.95	3.96	4.07	3.16	2.64	3.27

Table A-3 Financial Ratios Healthy Companies 5 and 6

	Company 5			**Company 6**		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	0.87	0.89	0.82	0.76	0.85	0.80
Current Ratio	1.02	0.99	0.92	1.21	1.11	1.02
Return on Assets Ratio	-0.06	0.07	0.03	0.05	0.05	0.01
Return on Equity Ratio	-0.10	0.07	0.15	0.15	0.19	0.02
Net Profit Margin Ratio	-0.06	0.02	0.60	0.02	0.02	0.01
Gross Profit Margin Ratio	22.63	31.11	10.05	5.52	4.94	4.74
Return on Investment	-0.04	0.07	0.04	0.052	0.054	0.041
Return on Sales Ratio	-7.32	11.23	5.83	3.04	2.62	2.07
Debt to Assets Ratio	0.75	0.75	0.73	0.69	0.72	0.74
Equity to Assets Ratio	0.25	0.25	0.27	0.31	0.28	0.26
Debt to Equity Ratio	3.05	3.04	2.74	2.19	2.55	2.92
Times-Covered Ratio	3.69	4.44	7.87	48.07	55.15	17.00
Interest Coverage Ratio	-1.19	1.60	4.57	26.50	29.20	7.41
Inventory to Turnover Ratio	15.08	9.52	52.63	10.06	21.04	21.73
Accounts Receivable Turnover Ratio	7.80	2.31	11.22	13.84	19.78	15.87

Table A-3 Continued

Total Assets Turnover Ratio	2.49	3.89	0.81	0.39	0.32	0.34
Net Working Capital Ratio	0.003	-0.002	-0.02	0.11	0.06	0.01
Retained Earnings to Total Assets Ratio	0.07	0.11	0.13	0.21	0.20	0.16
Net Income plus Tax Ratio	0.09	0.08	0.12	0.14	0.16	0.14
Sales to Total Assets Analysis Ratio	0.40	0.26	1.23	2.55	3.17	2.90
Equity to Debt Analysis Ratio	0.33	0.33	0.36	0.46	0.39	0.34
Cash Flow to Debt Analysis Ratio	0.02	0.06	0.09	0.10	0.11	0.04
Cash Flow to Total Assets Ratio	0.01	0.04	0.07	0.07	0.08	0.03
Cash Flow to Total Equity	0.05	0.18	0.26	0.22	0.27	0.12
Cash Flow to Total Sales	0.03	0.17	0.06	0.03	0.02	0.01
Cash Flow to Interest Expenses	0.48	2.48	4.41	23.46	27.07	3.65

Table A-4 Financial Ratios Healthy Companies 7 and 8

	Company 7			**Company 8**		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	3.73	3.30	2.36	1.59	1.32	1.35
Current Ratio	5.82	5.18	4.09	1.59	1.32	1.35
Return on Assets Ratio	0.06	0.05	0.04	0.03	0.02	0.02
Return on Equity Ratio	0.21	0.18	0.16	0.15	0.16	0.15
Net Profit Margin Ratio	0.06	0.05	0.05	0.03	0.03	0.01
Gross Profit Margin Ratio	12.26	11.56	9.55	14.33	13.58	13.74
Return on Investment	0.06	0.05	0.05	0.03	0.02	0.02
Return on Sales Ratio	9.05	8.25	6.98	4.26	3.71	3.49
Debt to Assets Ratio	0.77	0.76	0.74	0.50	0.59	0.62
Equity to Assets Ratio	0.23	0.24	0.26	0.50	0.41	0.38
Debt to Equity Ratio	3.37	3.24	2.88	0.98	1.43	1.63
Times-Covered Ratio	9.35	7.74	6.47	-203.32	-82.55	-46.44
Interest Coverage Ratio	6.90	5.52	4.73	-60.52	-22.52	-11.81
Inventory to Turnover Ratio	2.28	2.53	2.76	N/A	N/A	N/A
Accounts Receivable Turnover Ratio	1.63	1.91	2.58	5.93	5.39	4.84
Total Assets Turnover Ratio	1.27	1.16	0.99	0.36	0.37	0.39
Net Working Capital Ratio	0.70	0.67	0.59	0.21	0.14	0.16
Retained Earnings to Total Assets Ratio	0.22	0.23	0.25	0.41	0.34	0.30
Net Income plus Tax Ratio	0.10	0.10	0.10	0.40	0.37	0.35
Sales to Total Assets Analysis Ratio	0.79	0.86	1.01	2.76	2.72	2.54
Equity to Debt Analysis Ratio	0.30	0.31	0.35	1.02	0.70	0.61
Cash Flow to Debt Analysis Ratio	0.07	0.07	0.07	0.20	0.15	0.13

Table A-4 Continued

Cash Flow to Total Assets Ratio	0.06	0.05	0.05	0.10	0.09	0.08
Cash Flow to Total Equity	0.25	0.22	0.19	0.19	0.21	0.21
Cash Flow to Total Sales	0.07	0.06	0.05	0.04	0.03	0.03
Cash Flow to Interest Expenses	5.60	4.08	3.26	-50.25	-19.32	-10.82

Table A-5 Financial Ratios Healthy Companies 9 and 10

	Company 9			Company 10		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	0.85	0.90	0.73	2.01	2.75	2.45
Current Ratio	0.85	0.91	0.73	2.30	3.25	2.88
Return on Assets Ratio	-0.06	-0.18	-0.10	-0.16	0.02	0.04
Return on Equity Ratio	0.18	0.67	11.09	-0.19	0.02	0.04
Net Profit Margin Ratio	-0.04	-0.10	-0.09	-0.16	0.02	0.05
Gross Profit Margin Ratio	9.47	3.88	6.24	21.88	23.97	27.69
Return on Investment	-0.06	-0.12	-0.09	-0.16	0.02	0.05
Return on Sales Ratio	-2.88	-9.62	-5.67	-11.57	3.00	6.01
Debt to Assets Ratio	1.35	1.27	1.01	0.29	0.20	0.21
Equity to Assets Ratio	-0.35	-0.27	-0.01	0.71	0.80	0.79
Debt to Equity Ratio	-3.87	-4.72	-113.74	0.42	0.24	0.26
Times-Covered Ratio	4.65	2.06	3.01	-80.07	-76.57	-34.96
Interest Coverage Ratio	-1.42	-5.10	-2.74	42.35	-9.57	-7.59
Inventory to Turnover Ratio	506.07	363.71	296.03	12.34	9.23	10.73
Accounts Receivable Turnover Ratio	6.83	5.14	2.30	4.01	3.73	4.43
Total Assets Turnover Ratio	0.66	0.83	1.00	1.16	1.28	1.24
Net Working Capital Ratio	-0.08	-0.05	-0.19	0.25	0.29	0.24
Retained Earnings to Total Assets Ratio	-0.32	-0.22	-0.03	0.59	0.69	0.69
Net Income plus Tax Ratio	0.14	0.05	0.06	0.19	0.19	0.22
Sales to Total Assets Analysis Ratio	1.52	1.21	1.00	0.86	0.78	0.81
Equity to Debt Analysis Ratio	-0.26	-0.21	-0.01	2.41	4.10	3.82
Cash Flow to Debt Analysis Ratio	-0.04	-0.13	-0.08	-0.17	0.46	0.52
Cash Flow to Total Assets Ratio	-0.05	-0.17	-0.08	-0.05	0.09	0.11
Cash Flow to Total Equity	0.14	0.62	9.20	-0.07	0.11	0.14
Cash Flow to Total Sales	-0.03	-0.14	-0.08	-0.06	0.11	0.13
Cash Flow to Interest Expenses	-1.57	-7.24	-3.95	21.18	-36.49	-16.79

Table A-6 Financial Ratios Healthy Companies 11 and 12

	Company 11			Company 12		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	3.59	6.22	3.48	1.58	1.68	1.71
Current Ratio	3.59	6.22	3.58	1.67	1.73	1.78
Return on Assets Ratio	0.01	0.03	0.06	0.05	0.05	0.08
Return on Equity Ratio	0.02	0.03	0.08	0.11	0.12	0.15
Net Profit Margin Ratio	0.03	0.01	0.0002	0.03	0.03	0.04
Gross Profit Margin Ratio	15.15	21.08	20.92	16.38	15.41	17.88
Return on Investment	0.02	0.01	0.06	0.05	0.05	0.08
Return on Sales Ratio	3.03	3.14	7.11	4.68	5.26	6.88
Debt to Assets Ratio	0.17	0.10	0.14	0.54	0.55	0.47
Equity to Assets Ratio	0.83	0.90	0.86	0.46	0.45	0.53
Debt to Equity Ratio	0.21	0.11	0.17	1.16	1.22	0.88
Times-Covered Ratio	185.19	167.86	102.04	31.54	27.02	26.93
Interest Coverage Ratio	37.04	25.00	34.69	9.00	9.23	10.36
Inventory to Turnover Ratio	N/A	N/A	63.00	49.19	66.47	66.30
Accounts Receivable Turnover Ratio	4.23	8.26	5.43	5.71	4.74	5.60
Total Assets Turnover Ratio	0.73	1.00	0.96	0.56	0.60	0.53
Net Working Capital Ratio	0.44	0.54	0.37	0.22	0.27	0.25
Retained Earnings to Total Assets Ratio	-0.02	-0.04	-0.07	0.40	0.40	0.46
Net Income plus Tax Ratio	0.21	0.21	0.22	0.29	0.26	0.34
Sales to Total Assets Analysis Ratio	1.37	1.00	1.04	1.79	1.67	1.90
Equity to Debt Analysis Ratio	4.88	8.74	5.94	0.86	0.82	1.13
Cash Flow to Debt Analysis Ratio	0.49	0.91	0.94	0.22	0.21	0.32
Cash Flow to Total Assets Ratio	0.08	0.09	0.14	0.12	0.11	0.15
Cash Flow to Total Equity	0.10	0.10	0.16	0.25	0.25	0.28
Cash Flow to Total Sales	0.06	0.09	0.13	0.06	0.07	0.08
Cash Flow to Interest Expenses	74.07	75.00	63.27	12.42	11.95	11.87

Table A-7 Financial Ratios Healthy Companies 13 and 14

	Company 13			Company 14		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	0.97	0.83	0.81	1.47	1.65	1.27
Current Ratio	0.97	0.83	0.82	1.70	1.92	1.46
Return on Assets Ratio	-0.04	-0.44	0.01	-0.08	0.06	0.04
Return on Equity Ratio	0.26	1.86	0.03	-0.28	0.17	0.13
Net Profit Margin Ratio	-0.04	0.45	0.01	-0.02	0.05	0.02
Gross Profit Margin Ratio	5.44	2.60	16.07	4.99	14.65	9.62
Return on Investment	-0.04	0.45	0.01	-0.02	0.04	0.02

Table A-7 Continued

Return on Sales Ratio	-3.46	44.09	4.63	-1.82	7.37	2.83
Debt to Assets Ratio	1.29	1.33	0.63	0.72	0.57	0.61
Equity to Assets Ratio	-0.29	-0.33	0.37	0.28	0.43	0.39
Debt to Equity Ratio	-4.44	-4.07	1.73	2.61	1.31	1.57
Times-Covered Ratio	-6.69	-3.00	-7.98	-5.52	-12.89	-7.82
Interest Coverage Ratio	4.25	-50.98	-2.30	2.02	-6.49	-2.29
Inventory to Turnover Ratio	N/A	2433.29	226.48	16.18	14.03	14.82
Accounts Receivable Turnover Ratio	7.23	3.99	7.76	3.84	3.16	3.08
Total Assets Turnover Ratio	0.53	0.73	1.07	1.03	0.85	0.85
Net Working Capital Ratio	-0.02	-0.12	-0.08	0.18	0.24	0.17
Retained Earnings to Total Assets Ratio	-0.82	-0.20	-0.11	0.24	0.39	0.37
Net Income plus Tax Ratio	0.10	0.04	0.15	0.05	0.17	0.11
Sales to Total Assets Analysis Ratio	1.87	1.37	0.94	0.97	1.18	1.17
Equity to Debt Analysis Ratio	-0.23	-0.25	0.58	0.38	0.76	0.64
Cash Flow to Debt Analysis Ratio	-0.03	-0.43	0.06	-0.05	0.22	0.16
Cash Flow to Total Assets Ratio	-0.04	-0.58	0.04	-0.04	0.12	0.10
Cash Flow to Total Equity	0.14	1.76	0.11	-0.14	0.28	0.26
Cash Flow to Total Sales	-0.02	-0.42	0.04	-0.04	0.10	0.08
Cash Flow to Interest Expenses	2.67	48.64	-2.08	4.36	-9.12	-6.88

Table A-8 Financial Ratios Healthy Companies 15 and 16

	Company 15			**Company 16**		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	1.59	1.48	1.57	1.12	0.96	0.87
Current Ratio	1.95	1.79	1.96	1.16	1.03	0.97
Return on Assets Ratio	0.05	0.05	0.06	0.001	0.005	-0.01
Return on Equity Ratio	0.12	0.11	0.14	0.01	0.06	-0.23
Net Profit Margin Ratio	0.08	0.07	0.07	0.001	0.01	-0.01
Gross Profit Margin Ratio	24.69	24.12	21.07	5.91	6.82	4.31
Return on Investment	0.05	0.05	0.06	0.001	0.01	-0.01
Return on Sales Ratio	11.97	11.55	11.43	0.13	0.66	-1.84
Debt to Assets Ratio	0.57	0.56	0.57	0.79	0.79	0.83
Equity to Assets Ratio	0.43	0.44	0.43	0.21	0.21	0.17
Debt to Equity Ratio	1.33	1.26	1.33	3.73	3.83	4.80
Times-Covered Ratio	11.00	10.88	10.21	-18.60	-23.33	-15.43
Interest Coverage Ratio	5.33	5.21	5.54	-0.41	-2.26	6.59
Inventory to Turnover Ratio	15.53	16.56	18.42	120.83	67.00	49.00
Accounts Receivable Turnover Ratio	6.58	6.24	7.80	5.88	6.54	8.14

Table A-8 Continued

Total Assets Turnover Ratio	1.44	1.45	1.18	0.36	0.37	0.36
Net Working Capital Ratio	0.09	0.08	0.09	0.09	0.01	-0.02
Retained Earnings to Total Assets Ratio	0.17	0.16	0.15	0.03	0.02	0.01
Net Income plus Tax Ratio	0.17	0.17	0.18	0.17	0.19	0.12
Sales to Total Assets Analysis Ratio	0.70	0.69	0.85	2.81	2.72	2.80
Equity to Debt Analysis Ratio	0.75	0.79	0.75	0.27	0.26	0.21
Cash Flow to Debt Analysis Ratio	0.19	0.19	0.20	0.06	0.08	0.01
Cash Flow to Total Assets Ratio	0.11	0.10	0.11	0.05	0.06	0.00
Cash Flow to Total Equity	0.25	0.24	0.26	0.24	0.30	0.03
Cash Flow to Total Sales	0.15	0.15	0.13	0.02	0.02	0.00
Cash Flow to Interest Expenses	6.89	6.81	6.44	-5.72	-7.93	-0.62

Table A-9 Financial Ratios Healthy Companies 17 and 18

	Company 17			**Company 18**		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	1.31	1.44	1.30	N/A	N/A	N/A
Current Ratio	1.31	1.44	1.30	2.13	1.79	1.78
Return on Assets Ratio	0.03	0.02	0.02	0.08	0.10	0.11
Return on Equity Ratio	0.36	0.27	0.33	0.14	0.19	0.21
Net Profit Margin Ratio	0.04	0.01	0.00	0.05	0.05	0.05
Gross Profit Margin Ratio	5.36	5.70	3.88	13.27	13.90	11.03
Return on Investment	0.03	0.02	0.02	0.08	0.10	0.11
Return on Sales Ratio	2.24	2.19	1.76	7.41	8.95	7.41
Debt to Assets Ratio	0.79	0.78	0.81	0.41	0.47	0.48
Equity to Assets Ratio	0.21	0.22	0.19	0.59	0.53	0.52
Debt to Equity Ratio	3.69	3.65	4.25	0.68	0.89	0.91
Times-Covered Ratio	73.38	41.62	30.01	0.55	0.58	0.77
Interest Coverage Ratio	30.71	16.03	13.61	0.31	0.37	0.52
Inventory to Turnover Ratio	N/A	N/A	N/A	N/A	N/A	N/A
Accounts Receivable Turnover Ratio	4.19	4.97	6.69	8.05	6.68	7.12
Total Assets Turnover Ratio	0.41	0.37	0.27	0.55	0.51	0.41
Net Working Capital Ratio	0.22	0.29	0.22	0.41	0.34	0.33
Retained Earnings to Total Assets Ratio	0.05	-0.03	N/A	0.86	0.87	0.95
Net Income plus Tax Ratio	0.13	0.15	0.14	0.24	0.27	0.27
Sales to Total Assets Analysis Ratio	2.43	2.70	3.73	1.82	1.97	2.43
Equity to Debt Analysis Ratio	0.27	0.27	0.24	1.47	1.13	1.10
Cash Flow to Debt Analysis Ratio	0.11	0.08	0.09	1.98	1.77	1.52
Cash Flow to Total Assets Ratio	0.08	0.07	0.07	0.80	0.83	0.72

Table A-9 Continued

Cash Flow to Total Equity	0.39	0.30	0.37	1.35	1.57	1.38
Cash Flow to Total Sales	0.03	0.02	0.02	0.44	0.42	0.30
Cash Flow to Interest Expenses	47.26	17.71	14.46	1.83	1.76	2.07

Table A-10 Financial Ratios Healthy Companies 19 and 20

	Company 19			**Company 20**		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	1.05	1.35	1.21	1.00	1.27	1.75
Current Ratio	1.19	1.49	1.41	1.08	1.37	1.91
Return on Assets Ratio	0.03	0.04	-0.04	0.01	0.03	0.04
Return on Equity Ratio	0.33	0.44	-0.43	0.03	0.14	0.10
Net Profit Margin Ratio	0.03	0.04	-0.04	0.01	0.06	0.01
Gross Profit Margin Ratio	5.25	3.23	-1.13	8.27	10.33	16.03
Return on Investment	0.03	0.04	-0.04	0.01	0.03	0.04
Return on Sales Ratio	4.29	2.58	-3.94	1.08	4.76	6.48
Debt to Assets Ratio	0.26	0.47	0.51	0.22	0.14	0.20
Equity to Assets Ratio	0.22	0.15	0.10	0.33	0.30	0.35
Debt to Equity Ratio	0.26	0.47	0.51	0.67	0.46	0.56
Times-Covered Ratio	4.30	1.64	-0.34	-8.54	-14.23	-15.73
Interest Coverage Ratio	3.52	1.31	-1.19	-1.11	-6.56	-6.36
Inventory to Turnover Ratio	33.29	38.57	16.24	35.50	28.72	14.18
Accounts Receivable Turnover Ratio	6.42	6.06	4.36	7.59	7.26	4.44
Total Assets Turnover Ratio	0.44	0.54	0.89	0.60	0.73	1.11
Net Working Capital Ratio	0.09	0.16	0.14	0.04	0.17	0.31
Retained Earnings to Total Assets Ratio	0.88	0.91	1.11	0.14	0.12	0.10
Net Income plus Tax Ratio	0.12	0.06	-0.01	0.14	0.14	0.14
Sales to Total Assets Analysis Ratio	2.25	1.85	1.12	1.66	1.38	0.90
Equity to Debt Analysis Ratio	3.79	2.12	1.96	1.49	2.19	1.77
Cash Flow to Debt Analysis Ratio	0.51	0.25	-0.03	0.15	0.40	0.30
Cash Flow to Total Assets Ratio	0.14	0.12	-0.02	0.03	0.06	0.06
Cash Flow to Total Equity	0.61	0.79	-0.15	0.10	0.18	0.17
Cash Flow to Total Sales	0.06	0.06	-0.01	0.02	0.04	0.07
Cash Flow to Interest Expenses	4.93	3.25	-0.42	-2.04	-5.51	-6.42

Table A-11 Financial Ratios Healthy Companies 21 and 22

	Company 21			Company 22		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	N/A	N/A	N/A	0.72	0.50	0.62
Current Ratio	1.86	2.37	2.57	0.88	0.61	0.84
Return on Assets Ratio	-0.09	0.05	0.05	0.07	0.06	0.03
Return on Equity Ratio	-0.18	0.08	0.08	0.10	0.13	0.07
Net Profit Margin Ratio	0.06	0.04	0.04	0.07	0.06	0.03
Gross Profit Margin Ratio	22.93	24.56	26.30	24.26	21.22	15.60
Return on Investment	0.07	0.05	0.05	0.07	0.06	0.03
Return on Sales Ratio	9.75	7.43	5.59	9.38	8.50	4.03
Debt to Assets Ratio	0.48	0.38	0.39	0.68	0.70	0.70
Equity to Assets Ratio	0.52	0.62	0.61	0.32	0.30	0.30
Debt to Equity Ratio	0.91	0.61	0.63	2.13	2.36	2.37
Times-Covered Ratio	19.43	19.48	19.93	5.09	4.88	4.07
Interest Coverage Ratio	8.26	5.89	4.24	1.97	1.95	1.05
Inventory to Turnover Ratio	N/A	N/A	N/A	13.26	16.74	12.38
Accounts Receivable Turnover Ratio	1.35	1.47	1.29	5.77	6.67	7.43
Total Assets Turnover Ratio	0.81	0.91	0.83	2.11	1.62	1.32
Net Working Capital Ratio	0.28	0.30	0.32	-0.02	-0.10	-0.04
Retained Earnings to Total Assets Ratio	0.19	0.29	0.27	0.17	0.18	0.17
Net Income plus Tax Ratio	0.28	0.27	0.32	0.11	0.13	0.12
Sales to Total Assets Analysis Ratio	1.24	1.10	1.20	0.47	0.62	0.76
Equity to Debt Analysis Ratio	1.10	1.63	1.58	0.47	0.42	0.42
Cash Flow to Debt Analysis Ratio	-0.14	0.22	0.22	0.11	0.11	0.09
Cash Flow to Total Assets Ratio	-0.07	0.08	0.09	0.07	0.08	0.07
Cash Flow to Total Equity	-0.13	0.13	0.14	0.22	0.27	0.22
Cash Flow to Total Sales	-0.06	0.07	0.07	0.15	0.13	0.09
Cash Flow to Interest Expenses	-4.71	5.92	5.42	3.17	2.98	2.25

Table A-12 Financial Ratios Healthy Companies 23 and 24

	Company 23			Company 24		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	1.86	1.69	1.87	1.50	1.53	1.59
Current Ratio	1.86	1.69	1.87	1.71	1.83	1.84
Return on Assets Ratio	-0.02	0.001	0.01	-0.02	0.04	0.07
Return on Equity Ratio	-0.14	0.01	0.13	-0.05	0.09	0.15
Net Profit Margin Ratio	-0.02	0.002	-0.00001	-0.02	0.03	0.05
Gross Profit Margin Ratio	13.13	11.32	12.31	32.07	38.58	37.62
Return on Investment	-0.02	0.001	-0.002	-0.02	0.04	0.07

Table A-12 Continued

Return on Sales Ratio	0.00	0.59	-1.22	-2.28	4.60	5.94
Debt to Assets Ratio	0.62	0.61	0.70	0.59	0.58	0.57
Equity to Assets Ratio	0.38	0.39	0.30	0.41	0.42	0.43
Debt to Equity Ratio	1.61	1.57	2.35	1.41	1.38	1.32
Times-Covered Ratio	45.18	37.93	18.49	27.52	30.49	22.62
Interest Coverage Ratio	0.00	1.97	-1.83	-1.95	3.64	3.57
Inventory to Turnover Ratio	N/A	N/A	N/A	10.53	7.08	8.75
Accounts Receivable Turnover Ratio	4.11	4.69	4.87	2.70	2.94	3.53
Total Assets Turnover Ratio	0.34	0.31	0.31	0.77	0.75	0.75
Net Working Capital Ratio	0.37	0.31	0.35	0.28	0.33	0.32
Retained Earnings to Total Assets Ratio	-0.67	-0.56	-0.61	0.00	0.02	-0.02
Net Income plus Tax Ratio	0.39	0.36	0.40	0.42	0.52	0.50
Sales to Total Assets Analysis Ratio	2.96	3.19	3.27	1.30	1.34	1.34
Equity to Debt Analysis Ratio	0.62	0.64	0.43	0.71	0.72	0.76
Cash Flow to Debt Analysis Ratio	-0.03	0.07	0.11	0.04	0.13	0.19
Cash Flow to Total Assets Ratio	-0.02	0.04	0.08	0.02	0.08	0.11
Cash Flow to Total Equity	-0.04	0.11	0.27	0.05	0.18	0.25
Cash Flow to Total Sales	-0.01	0.01	0.02	0.02	0.06	0.08
Cash Flow to Interest Expenses	-1.81	4.43	3.65	1.47	4.48	4.88

Table A-13 Financial Ratios Healthy Companies 25 and 26

	Company 25			**Company 26**		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	1.86	1.78	2.07	1.26	1.31	N/A
Current Ratio	1.91	1.82	2.14	1.26	1.31	1.30
Return on Assets Ratio	0.02	0.02	0.02	0.01	0.01	N/A
Return on Equity Ratio	0.08	0.09	0.18	0.13	0.14	N/A
Net Profit Margin Ratio	0.02	0.02	0.02	0.02	0.02	N/A
Gross Profit Margin Ratio	38.64	40.18	41.88	25.14	24.84	23.71
Return on Investment	0.02	0.02	0.02	0.01	0.01	N/A
Return on Sales Ratio	3.04	3.75	4.49	2.62	2.61	N/A
Total Debt to Total Assets Ratio	0.65	0.72	0.78	0.71	0.71	0.74
Total Equity to Total Assets Ratio	0.35	0.28	0.22	0.29	0.29	0.26
Total Debt to Total Equity Ratio	1.83	2.52	3.54	2.44	2.40	2.85
Times-Covered Ratio	14.73	17.51	14.81	N/A	N/A	N/A
Interest Coverage Ratio	1.16	1.64	1.59	N/A	N/A	N/A
Inventory to Turnover Ratio	N/A	N/A	N/A	N/A	N/A	N/A
Accounts Receivable Turnover Ratio	3.59	2.58	3.11	5.65	5.48	5.25

Table A-13 Continued

Total Assets Turnover Ratio	0.68	0.92	0.63	0.31	0.29	0.30
Net Working Capital Ratio	0.21	0.20	0.29	0.16	0.19	0.19
Retained Earnings to Total Assets Ratio	0.13	0.10	0.12	N/A	N/A	N/A
Net Income plus Tax Ratio	0.57	0.44	0.66	0.81	0.85	0.79
Sales to Total Assets Analysis Ratio	1.47	1.09	1.58	3.22	3.42	3.31
Equity to Debt Analysis Ratio	0.55	0.40	0.28	0.41	0.42	0.35
Cash Flow to Debt Analysis Ratio	0.08	0.06	0.09	N/A	N/A	N/A
Cash Flow to Total Assets Ratio	0.05	0.04	0.07	N/A	N/A	N/A
Cash Flow to Total Equity	0.14	0.15	0.32	N/A	N/A	N/A
Cash Flow to Total Sales	0.03	0.04	0.04	N/A	N/A	N/A
Cash Flow to Interest Expenses	1.29	1.66	1.58	N/A	N/A	N/A

Table A-14 Financial Ratios Healthy Companies 27 and 28

	Company 27			**Company 28**		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	0.74	0.52	0.59	0.48	0.45	0.51
Current Ratio	0.90	0.64	0.65	0.67	0.99	1.10
Return on Assets Ratio	0.02	-0.20	0.03	0.06	0.04	0.14
Return on Equity Ratio	0.27	-2.76	0.14	0.09	0.05	0.22
Net Profit Margin Ratio	0.05	0.05	0.02	0.08	0.05	0.15
Gross Profit Margin Ratio	28.48	29.61	7.62	51.96	68.52	70.05
Return on Investment	0.02	0.02	0.03	0.08	0.05	0.15
Return on Sales Ratio	6.81	7.50	3.25	11.78	7.70	22.99
Debt to Assets Ratio	0.92	0.93	0.78	0.74	0.79	0.82
Equity to Assets Ratio	0.08	0.07	0.22	0.26	0.21	0.18
Debt to Equity Ratio	11.14	12.81	3.47	2.85	3.75	4.43
Times-Covered Ratio	2.98	3.44	N/A	27.94	23.42	19.91
Interest Coverage Ratio	0.71	0.87	N/A	6.33	2.63	6.53
Inventory to Turnover Ratio	16.91	15.85	73.66	N/A	N/A	N/A
Accounts Receivable Turnover Ratio	9.46	8.63	21.51	9.67	6.56	5.62
Total Assets Turnover Ratio	2.19	2.48	0.66	2.55	3.89	3.49
Net Working Capital Ratio	-0.01	-0.06	-0.11	-0.05	-0.002	0.02
Retained Earnings to Total Assets Ratio	-0.03	-0.05	N/A	0.09	0.07	0.13
Net Income plus Tax Ratio	0.13	0.12	0.11	0.20	0.18	0.20
Sales to Total Assets Analysis Ratio	0.46	0.40	1.51	0.39	0.26	0.29
Equity to Debt Analysis Ratio	0.09	0.08	0.29	0.35	0.27	0.23
Cash Flow to Debt Analysis Ratio	0.07	-0.18	0.08	0.13	0.10	0.08
Cash Flow to Total Assets Ratio	0.06	-0.17	0.06	0.09	0.08	0.06

Table A-14 Continued

Cash Flow to Total Equity	0.73	-2.31	0.28	0.37	0.38	0.33
Cash Flow to Total Sales	0.13	-0.42	0.04	0.24	0.31	0.21
Cash Flow to Interest Expenses	1.37	-4.82	N/A	13.00	10.52	6.07

Table A-15 Financial Ratios Healthy Companies 29 and 30

	Company 29			**Company 30**		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	0.51	0.12	0.47	1.11	1.06	1.14
Current Ratio	4.93	5.24	5.98	1.40	1.36	1.46
Return on Assets Ratio	0.07	0.06	0.06	0.01	0.02	0.06
Return on Equity Ratio	0.21	0.18	0.21	0.03	0.05	0.19
Net Profit Margin Ratio	0.09	0.09	0.03	0.01	0.02	0.05
Gross Profit Margin Ratio	22.02	20.40	20.84	19.24	21.01	16.38
Return on Investment	0.07	0.06	0.06	0.01	0.02	0.06
Return on Sales Ratio	11.55	9.61	9.15	1.75	2.42	7.91
Debt to Assets Ratio	0.58	0.62	0.66	0.68	0.68	0.69
Equity to Assets Ratio	0.42	0.38	0.34	0.32	0.32	0.31
Debt to Equity Ratio	1.40	1.65	1.92	2.11	2.09	2.20
Times-Covered Ratio	152.56	119.51	65.84	-11.82	-11.54	-8.00
Interest Coverage Ratio	80.02	56.30	28.92	-1.08	-1.33	-3.86
Inventory to Turnover Ratio	1.34	1.24	1.26	14.40	13.12	14.44
Accounts Receivable Turnover Ratio	N/A	N/A	N/A	6.93	7.17	7.12
Total Assets Turnover Ratio	0.83	0.89	0.82	0.89	0.89	0.83
Net Working Capital Ratio	0.62	0.60	0.69	0.09	0.08	0.10
Retained Earnings to Total Assets Ratio	0.21	0.15	0.15	0.28	0.29	0.27
Net Income plus Tax Ratio	0.26	0.23	0.25	0.22	0.24	0.20
Sales to Total Assets Analysis Ratio	1.20	1.12	1.22	1.12	1.13	1.20
Equity to Debt Analysis Ratio	0.71	0.61	0.52	0.47	0.48	0.45
Cash Flow to Debt Analysis Ratio	0.16	0.12	0.12	0.06	0.07	0.14
Cash Flow to Total Assets Ratio	0.09	0.07	0.08	0.04	0.05	0.09
Cash Flow to Total Equity	0.22	0.20	0.23	0.12	0.16	0.30
Cash Flow to Total Sales	0.08	0.07	0.07	0.04	0.04	0.08
Cash Flow to Interest Expenses	53.32	38.73	20.78	-2.18	-2.44	-3.81

Table A-16 Financial Ratios Healthy Companies 31 and 32

	Company 31			Company 32		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	0.16	-1.27	0.04	2.31	1.05	1.34
Current Ratio	2.42	0.67	2.30	5.82	4.39	4.53
Return on Assets Ratio	0.07	0.06	0.06	0.07	0.10	0.09
Return on Equity Ratio	0.18	0.16	0.13	0.04	0.13	0.12
Net Profit Margin Ratio	0.07	0.06	0.06	0.07	0.10	0.09
Gross Profit Margin Ratio	10.57	9.59	8.87	12.30	15.27	14.17
Return on Investment	0.07	0.06	0.06	0.07	0.10	0.09
Return on Sales Ratio	11.00	9.75	9.13	12.01	15.49	14.28
Total Debt to Total Assets Ratio	0.57	0.60	0.60	0.52	0.61	0.65
Total Equity to Total Assets Ratio	0.43	0.40	0.40	0.48	0.39	0.35
Total Debt to Total Equity Ratio	1.34	1.49	1.51	1.08	1.58	1.84
Times-Covered Ratio	N/A	15.72	5.86	N/A	3.08	2.69
Interest Coverage Ratio	N/A	15.99	6.03	N/A	3.13	2.71
Inventory to Turnover Ratio	1.46	1.57	1.28	0.45	0.77	0.81
Accounts Receivable Turnover Ratio	N/A	N/A	N/A	30.84	60.67	93.33
Total Assets Turnover Ratio	0.89	0.92	1.06	3.64	1.96	2.08
Net Working Capital Ratio	0.43	-0.11	0.39	0.74	0.57	0.57
Retained Earnings to Total Assets Ratio	0.31	0.27	0.25	0.28	0.27	0.21
Net Income plus Tax Ratio	0.12	0.10	0.08	0.03	0.08	0.07
Sales to Total Assets Analysis Ratio	1.12	1.09	0.94	0.27	0.51	0.48
Equity to Debt Analysis Ratio	0.75	0.67	0.66	0.93	0.63	0.54
Cash Flow to Debt Analysis Ratio	0.14	0.12	0.10	0.06	0.10	0.09
Cash Flow to Total Assets Ratio	0.08	0.07	0.06	0.03	0.06	0.06
Cash Flow to Total Equity	0.19	0.18	0.15	0.07	0.16	0.16
Cash Flow to Total Sales	0.07	0.06	0.06	0.12	0.12	0.12
Cash Flow to Interest Expenses	N/A	10.61	4.10	N/A	2.44	2.26

Table A-17 Financial Ratios Healthy Companies 33 and 34

	Company 33			Company 34		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	0.62	1.05	0.68	3.27	2.38	2.29
Current Ratio	0.75	1.18	0.78	3.39	2.50	2.39
Return on Assets Ratio	0.02	0.02	0.02	-0.02	-0.35	0.04
Return on Equity Ratio	0.06	0.06	0.06	-0.05	-1.01	0.07
Net Profit Margin Ratio	0.05	0.05	0.04	-0.02	-0.10	0.04
Gross Profit Margin Ratio	33.03	33.50	23.59	16.00	16.98	23.19
Return on Investment	0.02	0.02	0.02	-0.02	-0.10	0.04

Table A-17 Continued

Return on Sales Ratio	7.79	7.44	5.92	-3.23	-11.08	7.79
Debt to Assets Ratio	0.66	0.66	0.68	0.55	0.55	0.41
Equity to Assets Ratio	0.34	0.34	0.32	0.45	0.45	0.59
Debt to Equity Ratio	1.93	1.94	2.13	1.21	1.23	0.69
Times-Covered Ratio	4.45	4.08	4.19	7.33	8.24	18.17
Interest Coverage Ratio	1.05	0.91	1.05	-1.48	-5.38	6.10
Inventory to Turnover Ratio	19.61	22.60	28.55	57.99	56.77	61.66
Accounts Receivable Turnover Ratio	6.94	6.11	7.28	4.50	4.77	4.46
Total Assets Turnover Ratio	2.28	2.36	1.64	0.89	0.78	1.01
Net Working Capital Ratio	-0.03	0.02	-0.03	0.33	0.23	0.16
Retained Earnings to Total Assets Ratio	0.01	0.01	0.01	-0.24	0.20	0.09
Net Income plus Tax Ratio	0.15	0.14	0.14	0.18	0.22	0.23
Sales to Total Assets Analysis Ratio	0.44	0.42	0.61	1.12	1.28	0.99
Equity to Debt Analysis Ratio	0.52	0.52	0.47	0.83	0.81	1.44
Cash Flow to Debt Analysis Ratio	0.09	0.09	0.09	0.03	-0.72	0.17
Cash Flow to Total Assets Ratio	0.06	0.06	0.06	0.02	-0.40	0.07
Cash Flow to Total Equity	0.18	0.18	0.18	0.04	-0.88	0.12
Cash Flow to Total Sales	0.14	0.14	0.10	0.02	-0.31	0.07
Cash Flow to Interest Expenses	1.90	1.77	1.71	0.71	-14.97	5.57

APPENDIX B
FINANCIAL RATIOS-UNHEALTHY COMPANIES

Table B-1 Financial Ratios Unhealthy Companies 1 and 2

	Company 1			Company 2		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	0.74	1.08	1.14	0.47	1.84	4.05
Current Ratio	0.8	1.38	1.41	0.47	1.85	4.05
Return on Assets Ratio	-32.85	4.04	4.76	-18.5	4.91	-13.25
Return on Equity Ratio	187.66	11.98	10.12	-52.56	10.63	-17.58
Net Profit Margin Ratio	-0.28	0.02	0.02	-0.13	0.04	-0.12
Gross Profit Margin Ratio	-2.63	5.26	4.65	0.68	0.79	0.88
Return on Investment	-125.82	48.02	6903.13	9.3	30.66	14.08
Return on Sales Ratio	-44.60	3.79	3.62	-10.01	4.27	-17.57
Debt to Assets Ratio	0.74	0.32	0.38	0.65	N/A	N/A
Equity to Assets Ratio	-0.18	0.34	0.47	0.35	0.46	0.75
Debt to Equity Ratio	-1.5	0.25	N/A	0.32	N/A	N/A
Times-Covered Ratio	-2.12	15.47	99.59	13.50	98.95	98.22
Interest Coverage Ratio	-2.12	15.47	99.59	13.50	98.95	98.22
Inventory to Turnover Ratio	20575	20096	N/A	N/A	N/A	N/A
Accounts Receivable Turnover Ratio	23.80	-48.64	158.32	N/A	N/A	N/A
Total Assets Turnover Ratio	1.17	1.88	2.36	1.46	1.26	1.14
Net Working Capital Ratio	-0.15	0.12	0.16	-0.28	0.46	0.75
Retained Earnings to Total Assets Ratio	-0.26	0.15	0.17	-0.14	0.06	0.02
Net Income plus Tax Ratio	-0.03	0.10	0.11	0.31	0.35	0.30
Sales to Total Assets Analysis Ratio	1.17	1.88	2.36	1.46	1.26	1.14
Equity to Debt Analysis Ratio	-0.24	1.05	1.22	0.54	N/A	N/A
Cash Flow to Debt Analysis Ratio	-0.41	0.19	0.19	-0.28	N/A	N/A
Cash Flow to Total Assets Ratio	-0.31	0.06	0.07	-0.18	N/A	N/A
Cash Flow to Total Equity	1.75	0.18	0.16	-0.52	N/A	N/A
Cash Flow to Total Sales	-0.26	0.03	0.03	-0.13	N/A	N/A
Cash Flow to Interest Expenses	-21.12	9.58	66.83	-7.92	N/A	N/A

Table B-2 Financial Ratios Unhealthy Companies 3 and 4

	Company 3			Company 4		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	0.7	0.88	1.2	0.49	1.06	0.78
Current Ratio	1.02	1.16	1.53	0.63	1.23	1.04
Return on Assets Ratio	-9.19	-2.14	2.1	-12.47	-3.08	11.22
Return on Equity Ratio	-63.05	-11.54	5.99	-48.87	-12.42	41.37
Net Profit Margin Ratio	-0.04	-0.02	0.01	-0.15	-0.06	0.09
Gross Profit Margin Ratio	102.28	101.11	99.42	-3.63	1.11	23.30
Return on Investment	60.40	157.73	10,383	-69.32	-10.29	76.53

Table B-2 Continued

Return on Sales Ratio	-2.70	-0.77	2.51	-17.52	-10.00	14.62
Debt to Assets Ratio	0.69	0.66	0.46	N/A	0.72	0.62
Equity to Assets Ratio	0.15	0.19	0.35	0.26	0.25	0.27
Debt to Equity Ratio	0.37	0.11	N/A	1.06	1.26	0.73
Times-Covered Ratio	111.32	174.26	381.38	-0.78	0.58	40.04
Interest Coverage Ratio	-2.94	-1.33	9.62	-3.75	-5.23	25.12
Inventory to Turnover Ratio	10.90	7.49	10.94	17.72	10.481	N/A
Accounts Receivable Turnover Ratio	-39.70	13.97	14.43	12.46	13.391	-19.99
Total Assets Turnover Ratio	2.34	1.37	1.62	0.86	0.48	1.22
Net Working Capital Ratio	0.01	0.1	0.25	-0.15	0.12	0.16
Retained Earnings to Total Assets Ratio	-0.13	-0.02	-0.01	-0.11	0.02	0.16
Net Income plus Tax Ratio	2.39	1.38	1.61	-0.03	0.01	0.28
Sales to Total Assets Analysis Ratio	2.34	1.37	1.62	0.86	0.48	1.22
Equity to Debt Analysis Ratio	0.21	0.28	0.75	N/A	0.3447	0.435
Cash Flow to Debt Analysis Ratio	0.03	0.05	0.21	N/A	-0.041	0.21
Cash Flow to Total Assets Ratio	0.02	0.03	0.10	-0.12	-0.029	0.131
Cash Flow to Total Equity	0.14	0.17	0.27	-0.47	-0.118	0.483
Cash Flow to Total Sales	0.01	0.02	0.06	-0.14	-0.061	0.107
Cash Flow to Interest Expenses	0.98	3.93	22.74	-2.99	-3.189	18.48

Table B-3 Financial Ratios Unhealthy Companies 5 and 6

	Company 5			**Company 6**		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	N/A	N/A	N/A	0.72	0.98	0.85
Current Ratio	0.83	1.38	N/A	1.15	1.15	1.12
Return on Assets Ratio	0.06	0.05	N/A	0.35	10.14	3.78
Return on Equity Ratio	0.17	0.10	N/A	0.97	27.08	12.01
Net Profit Margin Ratio	0.04	0.03	0.01	-0.07	0.06	0.03
Gross Profit Margin Ratio	0.15	8.76	4.72	30.99	18.95	22.71
Return on Investment	N/A	N/A	N/A	0.61	16.01	5.51
Return on Sales Ratio	5.84	3.84	2.52	0.17	8.92	2.77
Debt to Assets Ratio	0.57	0.40	N/A	0.64	0.6256	0.685
Equity to Assets Ratio	0.35	0.47	N/A	0.36	0.37	0.32
Debt to Equity Ratio	1.62	0.86	N/A	60.41	69.11	117.8
Times-Covered Ratio	N/A	N/A	N/A	6.16	9.25	7.89
Interest Coverage Ratio	17.89	29.22	4.36	1.03	5.35	1.96
Inventory to Turnover Ratio	0.45	66.63	8.17	30.63	65.21	49.07
Accounts Receivable Turnover Ratio	4.52	7.35	N/A	3.64	9.59	7.43

Table B-3 Continued

Total Assets Turnover Ratio	1.50	1.79	N/A	0.76	1.70	1.30
Net Working Capital Ratio	0.470	0.553	N/A	0.043	0.0353	0.026
Retained Earnings to Total Assets Ratio	0.44	0.57	N/A	0.28	0.31	0.26
Net Income plus Tax Ratio	0.00	0.16	N/A	0.24	0.32	0.30
Sales to Total Assets Analysis Ratio	1.50	1.79	N/A	0.76	1.70	1.30
Equity to Debt Analysis Ratio	0.62	1.16	N/A	0.56	0.5985	0.46
Cash Flow to Debt Analysis Ratio	0.51	0.67	N/A	0.34	0.5439	0.413
Cash Flow to Total Assets Ratio	0.29	0.27	N/A	0.22	0.3403	0.283
Cash Flow to Total Equity	0.82	0.58	N/A	0.61	0.9087	0.898
Cash Flow to Total Sales	0.19	0.15	N/A	0.29	0.2007	0.218
Cash Flow to Interest Expenses	58.94	114.36	N/A	5.68	9.7951	7.569

Table B-4 Financial Ratios Unhealthy Companies 7 and 8

	Company 7			**Company 8**		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	1.19	1.22	1.28	0.64	0.83	1.02
Current Ratio	1.51	1.49	1.39	1.00	1.40	1.43
Return on Assets Ratio	2.36	3.34	4.54	-36.56	1.89	1.54
Return on Equity Ratio	N/A	N/A	N/A	-4544.38	5.62	4.32
Net Profit Margin Ratio	2.78	3.88	5.48	-23.79	1.07	0.87
Gross Profit Margin Ratio	11.10	14.21	17.90	-6.72	10.45	10.99
Return on Investment	3.31	4.65	6.55	-3175.83	5.55	4.23
Return on Sales Ratio	5.20	7.48	11.25	-25.55	1.45	1.14
Debt to Assets Ratio	14.68	13.23	17.23	44.04	13.05	1.18
Equity to Assets Ratio	N/A	N/A	N/A	0.01	0.34	0.36
Debt to Equity Ratio	0.77	4.69	11.04	43.09	1.36	2.30
Times-Covered Ratio	N/A	N/A	N/A	-3.74	29.13	50.93
Interest Coverage Ratio	N/A	N/A	N/A	-14.21	4.05	5.28
Inventory to Turnover Ratio	72	69	64	7.00	12.08	20.32
Accounts Receivable Turnover Ratio	3.36	2.86	2.74	2.91	3.96	5.86
Total Assets Turnover Ratio	0.84	0.82	0.82	1.46	1.87	1.92
Net Working Capital Ratio	0.005	0.004	0.011	0.00	0.25	0.26
Retained Earnings to Total Assets Ratio	0.02	0.02	0.05	-0.05	0.28	0.29
Net Income plus Tax Ratio	0.00	0.00	0.01	-0.10	0.18	0.20
Sales to Total Assets Analysis Ratio	0.85	0.86	0.83	1.54	1.77	1.78
Equity to Debt Analysis Ratio	N/A	N/A	N/A	0.01	0.51	0.55
Cash Flow to Debt Analysis Ratio	2.75	2.31	1.74	-0.32	0.06	0.07

Table B-4 Continued

Cash Flow to Total Assets Ratio	0.80	0.73	0.65	-0.32	0.04	0.04
Cash Flow to Total Equity	N/A	N/A	N/A	-39.94	0.11	0.12
Cash Flow to Total Sales	0.94	0.84	0.79	-0.21	0.02	0.02
Cash Flow to Interest Expenses	N/A	N/A	N/A	-11.64	5.78	11.42

Table B-5 Financial Ratios Unhealthy Companies 9 and 10

	Company 9			**Company 10**		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	1.31	1.08	1.20	0.07	0.27	0.51
Current Ratio	1.67	1.50	1.51	0.10	0.34	0.64
Return on Assets Ratio	1.38	0.29	2.44	-46.61	-44.91	3.49
Return on Equity Ratio	3.62	0.85	7.79	27.25	72.06	-28.99
Net Profit Margin Ratio	0.77	0.17	1.27	-59.76	-12.55	2.00
Gross Profit Margin Ratio	7.51	7.77	7.50	-22.22	1.82	11.45
Return on Investment	2.96	0.64	5.51	27.77	82.05	-666.67
Return on Sales Ratio	1.30	0.69	2.41	-60.19	-12.51	1.96
Debt to Assets Ratio	13.91	14.81	18.44	132.18	71.82	57.73
Equity to Assets Ratio	0.38	0.34	0.31	-1.71	-0.62	-0.12
Debt to Equity Ratio	22.26	33.75	41.55	-1.90	-12.17	-95.65
Times-Covered Ratio	2.09	0.90	3.28	-0.65	0.43	4.03
Interest Coverage Ratio	3.09	1.90	4.28	-1.76	-2.95	0.69
Inventory to Turnover Ratio	9.33	9.25	11.98	18.32	129.49	109.32
Accounts Receivable Turnover Ratio	4.50	4.27	5.19	1.85	7.21	7.39
Total Assets Turnover Ratio	1.74	1.64	1.86	0.52	2.92	2.78
Net Working Capital Ratio	0.34	0.26	0.27	-2.16	-0.94	-0.32
Retained Earnings to Total Assets Ratio	0.17	0.12	0.13	-3.41	-1.48	-0.71
Net Income plus Tax Ratio	0.14	0.13	0.14	-0.17	0.06	0.29
Sales to Total Assets Analysis Ratio	1.80	1.72	1.92	0.78	3.58	2.54
Equity to Debt Analysis Ratio	0.61	0.51	0.46	-0.63	-0.39	-0.11
Cash Flow to Debt Analysis Ratio	0.10	0.04	0.07	0.63	0.67	0.94
Cash Flow to Total Assets Ratio	0.06	0.03	0.05	1.70	1.08	1.05
Cash Flow to Total Equity	0.16	0.08	0.14	-1.00	-1.73	-8.77
Cash Flow to Total Sales	0.03	0.01	0.02	2.19	0.30	0.41
Cash Flow to Interest Expenses	5.35	1.93	3.20	6.38	7.12	14.52

Table B-6 Financial Ratios Unhealthy Companies 11 and 12

	Company 11			Company 12		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	0.95	1.02	1.07	1.06	0.86	0.87
Current Ratio	1.44	1.48	1.45	1.90	1.41	1.36
Return on Assets Ratio	3.26	4.14	3.97	1.34	1.45	1.09
Return on Equity Ratio	7.72	11.91	11.39	14.79	15.48	6.81
Net Profit Margin Ratio	1.67	2.42	2.41	1.24	1.49	1.24
Gross Profit Margin Ratio	8.25	10.39	11.12	29.30	30.87	25.65
Return on Investment	6.04	7.20	6.70	1.90	2.36	1.85
Return on Sales Ratio	2.68	4.12	4.48	2.97	3.71	2.80
Debt to Assets Ratio	13.45	27.03	26.01	75.45	72.44	58.09
Equity to Assets Ratio	0.42	0.35	0.35	0.09	0.09	0.16
Debt to Equity Ratio	27.40	65.07	69.53	677.91	556.93	267.35
Times-Covered Ratio	8.50	8.44	7.23	6.64	5.30	6.88
Interest Coverage Ratio	2.76	3.35	2.91	0.67	0.64	0.75
Inventory to Turnover Ratio	13.46	14.55	15.33	4.33	4.27	4.62
Accounts Receivable Turnover Ratio	5.82	5.54	5.58	3.42	2.76	3.29
Total Assets Turnover Ratio	2.00	1.82	1.72	0.95	0.80	0.84
Net Working Capital Ratio	0.18	0.18	0.16	0.26	0.16	0.14
Retained Earnings to Total Assets Ratio	0.29	0.26	0.25	-0.36	-0.26	-0.09
Net Income plus Tax Ratio	0.16	0.18	0.18	0.32	0.30	0.23
Sales to Total Assets Analysis Ratio	1.95	1.72	1.65	1.08	0.98	0.88
Equity to Debt Analysis Ratio	0.73	0.53	0.53	0.10	0.10	0.32
Cash Flow to Debt Analysis Ratio	0.09	0.08	0.08	0.01	-0.12	-0.29
Cash Flow to Total Assets Ratio	0.05	0.05	0.05	0.01	-0.11	-0.15
Cash Flow to Total Equity	0.12	0.16	0.14	0.08	-1.15	-0.92
Cash Flow to Total Sales	0.03	0.03	0.03	0.01	-0.11	-0.17
Cash Flow to Interest Expenses	2.63	2.56	1.97	0.16	-1.90	-4.47

Table B-7 Financial Ratios Unhealthy Companies 13 and 14

	Company 13			Company 14		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	0.86	0.68	0.96	1.80	1.50	2.46
Current Ratio	1.41	1.25	1.53	2.89	2.27	3.36
Return on Assets Ratio	1.18	2.74	2.93	3.85	-9.18	2.12
Return on Equity Ratio	3.16	7.54	7.23	5.68	-16.39	2.87
Net Profit Margin Ratio	0.60	1.78	1.86	2.77	-7.98	1.33
Gross Profit Margin Ratio	8.34	10.93	13.11	25.78	15.53	19.33
Return on Investment	1.73	4.13	4.17	4.96	-13.43	2.81

Table B-7 Continued

Return on Sales Ratio	1.04	3.01	3.53	4.94	-13.88	2.21
Debt to Assets Ratio	35.44	39.18	37.69	14.08	17.85	1.64
Equity to Assets Ratio	0.37	0.36	0.41	0.68	0.56	0.74
Debt to Equity Ratio	82.40	82.70	73.47	14.48	22.06	2.02
Times-Covered Ratio	3.51	4.62	8.52	28.56	133.00	189.07
Interest Coverage Ratio	0.44	1.27	2.30	5.47	-118.85	21.57
Inventory to Turnover Ratio	24.09	21.41	19.33	7.23	6.90	7.52
Accounts Receivable Turnover Ratio	9.61	7.98	6.89	4.42	4.04	3.97
Total Assets Turnover Ratio	1.92	1.62	1.67	1.30	1.22	1.46
Net Working Capital Ratio	0.11	0.08	0.14	0.43	0.40	0.58
Retained Earnings to Total Assets Ratio	0.32	0.31	0.35	0.19	0.13	0.26
Net Income plus Tax Ratio	0.16	0.17	0.21	0.36	0.18	0.31
Sales to Total Assets Analysis Ratio	1.97	1.54	1.58	1.39	1.15	1.59
Equity to Debt Analysis Ratio	0.60	0.57	0.68	2.10	1.27	2.82
Cash Flow to Debt Analysis Ratio	0.09	0.09	0.13	0.22	-0.17	0.16
Cash Flow to Total Assets Ratio	0.05	0.05	0.08	0.07	-0.08	0.04
Cash Flow to Total Equity	0.14	0.15	0.19	0.10	-0.14	0.06
Cash Flow to Total Sales	0.03	0.04	0.05	0.05	-0.07	0.03
Cash Flow to Interest Expenses	1.15	1.50	3.12	5.57	-56.62	26.21

Table B-8 Financial Ratios Unhealthy Companies 15 and 16

	Company 15			**Company 16**		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	2.05	1.99	1.77	1.59	1.40	N/A
Current Ratio	2.64	2.55	2.04	1.63	1.44	N/A
Return on Assets Ratio	6.60	5.96	4.88	1.30	5.42	N/A
Return on Equity Ratio	13.24	11.60	10.17	2.56	10.44	N/A
Net Profit Margin Ratio	7.29	6.96	4.68	0.89	3.39	N/A
Gross Profit Margin Ratio	38.29	36.75	27.02	2.31	5.36	N/A
Return on Investment	9.17	8.27	6.92	2.20	9.78	N/A
Return on Sales Ratio	16.14	15.49	9.14	1.08	5.93	N/A
Debt to Assets Ratio	18.56	18.99	20.71	10.09	4.49	N/A
Equity to Assets Ratio	0.50	0.51	0.48	0.51	0.52	N/A
Debt to Equity Ratio	34.22	32.76	40.37	16.56	6.69	N/A
Times-Covered Ratio	14.52	12.52	14.46	4.23	16.76	N/A
Interest Coverage Ratio	6.12	5.28	4.89	1.98	18.55	N/A
Inventory to Turnover Ratio	25.17	23.75	24.53	234.70	N/A	N/A
Accounts Receivable Turnover Ratio	5.84	3.84	4.09	5.00	N/A	N/A

Table B-8 Continued

Total Assets Turnover Ratio	0.89	0.86	1.14	1.48	N/A	N/A
Net Working Capital Ratio	0.24	0.24	0.21	0.19	0.16	N/A
Retained Earnings to Total Assets Ratio	0.47	0.48	0.44	0.44	0.45	N/A
Net Income plus Tax Ratio	0.35	0.31	0.28	0.03	0.09	N/A
Sales to Total Assets Analysis Ratio	0.91	0.86	1.04	1.46	1.60	N/A
Equity to Debt Analysis Ratio	0.99	1.06	0.92	1.04	1.08	N/A
Cash Flow to Debt Analysis Ratio	0.34	0.31	0.26	0.18	0.25	N/A
Cash Flow to Total Assets Ratio	0.17	0.15	0.14	0.09	0.12	N/A
Cash Flow to Total Equity	0.34	0.30	0.28	0.17	0.24	N/A
Cash Flow to Total Sales	0.19	0.18	0.13	0.06	0.08	N/A
Cash Flow to Interest Expenses	7.12	6.04	6.99	10.92	23.94	N/A

Table B-9 Financial Ratios Unhealthy Companies 17 and 18

	Company 17			**Company 18**		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	1.08	0.26	N/A	0.03	0.07	0.19
Current Ratio	1.16	0.65	N/A	0.03	0.08	0.21
Return on Assets Ratio	15.82	6.81	N/A	-72.82	-54.69	-24.46
Return on Equity Ratio	63.65	35.92	N/A	8.57	30.18	26.43
Net Profit Margin Ratio	24.07	10.18	N/A	-35.17	-99.45	-41.30
Gross Profit Margin Ratio	50.60	39.53	N/A	15.97	10.64	-2.73
Return on Investment	24.88	9.71	N/A	10.22	67.46	1227.53
Return on Sales Ratio	41.08	11.11	N/A	-35.19	-99.44	-41.29
Debt to Assets Ratio	44.64	67.55	N/A	581.21	194.69	131.75
Equity to Assets Ratio	0.25	0.19	N/A	-8.49	-1.81	-0.93
Debt to Equity Ratio	155.85	270.04	N/A	-16.15	-55.26	-97.85
Times-Covered Ratio	14.68	3.36	N/A	0.36	0.28	-0.19
Interest Coverage Ratio	11.91	0.95	N/A	-0.80	-2.66	-2.82
Inventory to Turnover Ratio	42.73	N/A	N/A	35.00	24.84	18.82
Accounts Receivable Turnover Ratio	22.85	N/A	N/A	5.82	3.03	2.28
Total Assets Turnover Ratio	1.10	N/A	N/A	0.78	0.47	0.54
Net Working Capital Ratio	0.035	-0.099	N/A	-7.72	-1.62	-0.81
Retained Earnings to Total Assets Ratio	0.18	-0.31	N/A	-13.14	-2.90	-1.72
Net Income plus Tax Ratio	0.33	0.26	N/A	0.33	0.06	-0.02
Sales to Total Assets Analysis Ratio	0.65	0.67	N/A	2.07	0.55	0.59
Equity to Debt Analysis Ratio	0.33	0.23	N/A	-0.89	-0.64	-0.48
Cash Flow to Debt Analysis Ratio	0.24	0.21	N/A	-0.06	-0.18	-0.11
Cash Flow to Total Assets Ratio	0.18	0.17	N/A	-0.61	-0.51	-0.21

Table B-9 Continued

Cash Flow to Total Equity	0.74	0.89	N/A	0.07	0.28	0.23
Cash Flow to Total Sales	0.28	0.25	N/A	-0.29	-0.93	-0.36
Cash Flow to Interest Expenses	8.10	2.15	N/A	-0.66	-2.49	-2.45

Table B-10 Financial Ratios Unhealthy Companies 19 and 20

	Company 19			**Company 20**		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	0.65	0.61	0.69	1.05	1.04	1.12
Current Ratio	1.39	1.22	1.29	1.21	1.29	1.33
Return on Assets Ratio	7.21	5.10	3.37	2.46	3.84	1.86
Return on Equity Ratio	21.23	15.67	9.24	7.47	10.81	4.60
Net Profit Margin Ratio	2.93	2.47	1.64	0.74	1.45	0.94
Gross Profit Margin Ratio	10.06	9.18	7.98	7.85	11.05	13.06
Return on Investment	N/A	11.97	7.07	5.80	7.71	3.62
Return on Sales Ratio	4.77	3.86	2.35	1.29	2.32	1.39
Debt to Assets Ratio	22.46	15.46	14.27	13.02	21.18	13.22
Equity to Assets Ratio	0.34	0.33	0.37	0.33	0.35	0.41
Debt to Equity Ratio	55.81	28.81	28.79	30.12	39.97	26.80
Times-Covered Ratio	10.45	9.80	12.55	10.62	11.78	10.32
Interest Coverage Ratio	4.96	4.12	3.70	1.75	2.47	1.10
Inventory to Turnover Ratio	8.72	7.09	7.39	98.25	89.58	81.66
Accounts Receivable Turnover Ratio	10.78	10.11	9.25	7.80	6.89	5.10
Total Assets Turnover Ratio	2.50	2.31	2.09	3.60	2.95	2.09
Net Working Capital Ratio	0.18	0.12	0.15	0.12	0.13	0.15
Retained Earnings to Total Assets Ratio	0.23	0.22	0.23	0.21	0.24	0.28
Net Income plus Tax Ratio	0.25	0.19	0.16	0.26	0.29	0.26
Sales to Total Assets Analysis Ratio	2.46	2.06	2.06	3.30	2.64	1.99
Equity to Debt Analysis Ratio	0.51	0.48	0.58	0.49	0.55	0.68
Cash Flow to Debt Analysis Ratio	0.09	0.10	0.08	0.09	0.12	0.10
Cash Flow to Total Assets Ratio	0.06	0.07	0.05	0.06	0.08	0.06
Cash Flow to Total Equity	0.17	0.21	0.14	0.19	0.21	0.14
Cash Flow to Total Sales	0.02	0.03	0.03	0.02	0.03	0.03
Cash Flow to Interest Expenses	2.42	3.54	3.98	2.54	3.06	2.30

Table B-11 Financial Ratios Unhealthy Companies 21 and 22

	Company 21			Company 22		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	1.38	1.34	1.29	0.05	0.20	0.17
Current Ratio	1.43	1.16	1.43	0.05	0.20	0.20
Return on Assets Ratio	2.89	0.69	-0.27	29.41	8.78	-50.96
Return on Equity Ratio	11.39	2.36	-0.93	167.47	-17.55	72.97
Net Profit Margin Ratio	1.56	0.43	-0.14	75.00	38.44	-137.81
Gross Profit Margin Ratio	14.38	10.22	8.45	98.80	21.85	-57.75
Return on Investment	9.82	1.80	-0.71	86.63	-23.93	89.89
Return on Sales Ratio	5.77	0.27	-1.70	155.69	115.97	-137.56
Debt to Assets Ratio	4.30	10.86	15.94	49.37	105.15	119.16
Equity to Assets Ratio	0.25	0.29	0.29	0.18	-0.50	-0.70
Debt to Equity Ratio	16.00	21.33	23.00	-52.72	-14.88	-12.57
Times-Covered Ratio	50.57	12.42	16.13	9.17	0.60	-7.24
Interest Coverage Ratio	20.29	0.33	-3.25	14.44	3.21	-17.24
Inventory to Turnover Ratio	73.58	30.36	32.36	N/A	13.72	11.86
Accounts Receivable Turnover Ratio	3.50	2.47	2.76	2.31	0.82	1.68
Total Assets Turnover Ratio	2.21	1.69	1.87	0.35	0.22	0.35
Net Working Capital Ratio	0.27	0.27	0.26	-0.49	-1.09	-1.25
Retained Earnings to Total Assets Ratio	0.21	0.23	0.22	-1.02	-1.42	-1.53
Net Income plus Tax Ratio	0.27	0.17	0.16	0.39	0.05	-0.21
Sales to Total Assets Analysis Ratio	1.85	1.61	1.86	0.39	0.23	0.37
Equity to Debt Analysis Ratio	0.34	0.41	0.41	0.21	-0.33	-0.41
Cash Flow to Debt Analysis Ratio	0.09	0.03	0.02	0.79	0.21	-0.25
Cash Flow to Total Assets Ratio	0.07	0.02	0.01	0.65	0.31	-0.42
Cash Flow to Total Equity	0.27	0.08	0.05	3.68	-0.63	0.60
Cash Flow to Total Sales	0.04	0.01	0.01	1.65	1.38	-1.14
Cash Flow to Interest Expenses	13.00	1.75	1.50	15.33	3.81	-14.24

Table B-12 Financial Ratios Unhealthy Companies 23 and 24

	Company 23			Company 24		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	1.15	1.04	1.00	0.42	0.25	2.65
Current Ratio	1.17	1.17	1.04	0.7	0.83	2.75
Return on Assets Ratio	9.32	7.48	4.82	-0.62	-0.89	0.24
Return on Equity Ratio	28.20	19.21	13.43	N/A	N/A	N/A
Net Profit Margin Ratio	5.92	4.32	3.20	-0.88	-1.43	0.43
Gross Profit Margin Ratio	19.59	16.85	14.36	21.71	22.11	23.39
Return on Investment	19.90	17.16	11.33	-1.69	N/A	N/A

Table B-12 Continued

Return on Sales Ratio	11.87	9.10	6.30	-0.90	-1.43	0.43
Debt to Assets Ratio	18.41	13.20	20.43	67.62	N/A	N/A
Equity to Assets Ratio	0.33	0.39	0.36	N/A	N/A	N/A
Debt to Equity Ratio	41.66	11.95	18.54	289.93	N/A	N/A
Times-Covered Ratio	31.36	25.00	13.90	3.07	3.09	3.59
Interest Coverage Ratio	19.00	13.50	6.10	-0.13	-0.20	0.07
Inventory to Turnover Ratio	N/A	N/A	N/A	3.77	5.56	32.86
Accounts Receivable Turnover Ratio	4.80	4.55	4.15	4.00	1.49	0.71
Total Assets Turnover Ratio	1.95	1.79	1.62	0.69	0.63	0.54
Net Working Capital Ratio	0.08	0.09	0.02	-0.19	-0.06	0.50
Retained Earnings to Total Assets Ratio	0.20	0.17	0.10	-0.15	N/A	N/A
Net Income plus Tax Ratio	0.31	0.29	0.22	0.15	0.14	0.13
Sales to Total Assets Analysis Ratio	1.57	1.73	1.50	0.70	0.62	0.54
Equity to Debt Analysis Ratio	0.49	0.64	0.56	N/A	N/A	N/A
Cash Flow to Debt Analysis Ratio	0.21	0.22	0.16	0.01	-0.004	0.01
Cash Flow to Total Assets Ratio	0.14	0.13	0.11	0.01	-0.004	0.01
Cash Flow to Total Equity	0.43	0.34	0.29	N/A	N/A	N/A
Cash Flow to Total Sales	0.09	0.08	0.07	0.01	-0.006	0.02
Cash Flow to Interest Expenses	14.55	11.50	6.80	0.20	-0.084	0.29

Table B-13 Financial Ratios Unhealthy Companies 25 and 26

	Company 25			**Company 26**		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	0.72	0.73	0.69	1.12	1.13	0.59
Current Ratio	0.72	0.73	0.69	1.41	1.33	0.82
Return on Assets Ratio	-1.49	6.56	9.73	3.49	2.94	0.85
Return on Equity Ratio	-24.37	86.12	-11000.00	8.12	10.06	4.77
Net Profit Margin Ratio	N/A	114.05	5.74	3.54	2.50	0.57
Gross Profit Margin Ratio	N/A	100.00	8.35	14.16	14.98	14.86
Return on Investment	-24.37	86.12	-11000.00	5.26	5.34	1.55
Return on Sales Ratio	N/A	110.53	5.74	6.20	4.63	1.54
Total Debt to Total Assets Ratio	17.90	17.90	18.22	24.14	26.44	37.84
Total Equity to Total Assets Ratio	0.06	0.08	0.00	0.43	0.29	0.18
Total Debt to Total Equity Ratio	0.00	0.00	0.00	54.38	95.86	207.32
Times-Covered Ratio	N/A	N/A	N/A	7.65	14.98	11.84
Interest Coverage Ratio	N/A	N/A	N/A	3.35	4.63	1.23

Table B-13 Continued

Inventory to Turnover Ratio	N/A	N/A	40.36	16.89	18.84	14.01
Accounts Receivable Turnover Ratio	0.00	0.08	1.83	8.41	9.81	8.58
Total Assets Turnover Ratio	0.00	0.06	1.29	0.99	1.18	1.50
Net Working Capital Ratio	-0.26	-0.25	-0.31	0.10	0.12	-0.07
Retained Earnings to Total Assets Ratio	-2.74	-2.73	-2.66	0.03	0.03	N/A
Net Income plus Tax Ratio	0.00	0.06	0.14	0.14	0.18	0.22
Sales to Total Assets Analysis Ratio	0.00	0.06	1.70	0.99	1.18	1.50
Equity to Debt Analysis Ratio	0.07	0.08	0.00	0.75	0.41	0.22
Cash Flow to Debt Analysis Ratio	-0.02	0.08	0.45	0.08	0.06	0.04
Cash Flow to Total Assets Ratio	-0.02	0.08	0.45	0.05	0.05	0.03
Cash Flow to Total Equity	-0.25	1.00	N/A	0.11	0.15	0.18
Cash Flow to Total Sales	N/A	1.32	0.26	0.05	0.04	0.02
Cash Flow to Interest Expenses	N/A	N/A	N/A	2.65	3.83	1.71

Table B-14 Financial Ratios Unhealthy Companies 27 and 28

	Company 27			**Company 28**		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	0.74	1.31	2.47	0.10	0.32	0.30
Current Ratio	0.82	1.50	2.66	0.90	1.16	2.86
Return on Assets Ratio	-62.95	-122.09	-76.83	-40.87	-33.84	-7.97
Return on Equity Ratio	-212.91	-186.80	-100.58	-125.38	-67.60	-14.86
Net Profit Margin Ratio	-183.46	-639.32	-364.85	-59.56	-62.86	-48.30
Gross Profit Margin Ratio	25.55	47.69	33.33	6.68	22.81	44.04
Return on Investment	-205.75	-181.04	-97.37	-82.83	-53.62	-9.70
Return on Sales Ratio	-183.21	-640.00	-364.91	-59.54	-62.88	-48.93
Debt to Assets Ratio	6.61	4..87	5.33	40.34	36.93	35.92
Equity to Assets Ratio	0.30	0.65	0.76	0.33	0.50	0.54
Debt to Equity Ratio	3.64	3.99	4.21	51.37	26.08	53.18
Times-Covered Ratio	35.00	31.00	3.80	0.71	2.06	4.50
Interest Coverage Ratio	-251.00	-416.00	-41.60	-6.37	-5.68	-5.00
Inventory to Turnover Ratio	14.23	13.02	56.90	1.69	1.42	0.73
Accounts Receivable Turnover Ratio	1.16	0.62	0.69	9.50	9.36	4.93
Total Assets Turnover Ratio	0.37	0.21	0.21	0.59	0.54	0.22
Net Working Capital Ratio	-0.12	0.16	0.35	-0.05	0.06	0.33
Retained Earnings to Total Assets Ratio	-5.05	-5.13	-5.00	-1.14	-0.55	-0.22
Net Income plus Tax Ratio	0.09	0.09	0.07	0.05	0.12	0.07
Sales to Total Assets Analysis Ratio	0.34	0.19	0.21	0.69	0.54	0.16
Equity to Debt Analysis Ratio	0.42	1.89	3.22	0.48	1.00	1.16

Table B-14 Continued

Cash Flow to Debt Analysis Ratio	-0.86	-3.43	-2.98	-0.53	-0.62	-0.11
Cash Flow to Total Assets Ratio	-0.61	-1.19	-0.71	-0.36	-0.31	-0.05
Cash Flow to Total Equity	-2.04	-1.82	-0.93	-1.10	-0.61	-0.09
Cash Flow to Total Sales	-1.76	-6.23	-3.35	-0.52	-0.57	-0.30
Cash Flow to Interest Expenses	-241.00	-405.00	-38.20	-5.59	-5.16	-3.09

Table B-15 Financial Ratios Unhealthy Companies 29 and 30

	Company 29			**Company 30**		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	0.27	1.06	0.35	8.38	1.30	0.07
Current Ratio	0.29	1.09	0.39	8.38	1.59	0.27
Return on Assets Ratio	-11.68	-17.89	0.4	73.04	155.73	-27.87
Return on Equity Ratio	-53.19	-45.49	0.91	111.06	-3892.66	19.17
Net Profit Margin Ratio	-50.97	-84.35	2.59	8489.56	2673.68	-61.58
Gross Profit Margin Ratio	15.27	24.37	31.41	95.35	21.34	-6.17
Return on Investment	-40.83	-30.25	0.55	111.06	-3892.66	19.17
Return on Sales Ratio	-51.07	-96.14	6.72	2562.79	3770.12	-61.58
Debt to Assets Ratio	58.71	45.09	38.72	0.01	19.76	163.80
Equity to Assets Ratio	0.22	0.39	0.44	0.66	-0.04	-1.45
Debt to Equity Ratio	19.98	48.96	63.14	0.00	0.00	0.00
Times-Covered Ratio	0.33	0.53	0.45	N/A	0.05	-0.13
Interest Coverage Ratio	-1.10	-2.07	0.10	N/A	9.11	-1.33
Inventory to Turnover Ratio	29	30	N/A	N/A	72.90	303.65
Accounts Receivable Turnover Ratio	1.26	1.21	N/A	0.52	1.71	3.63
Total Assets Turnover Ratio	0.25	0.21	N/A	0.01	0.06	0.38
Net Working Capital Ratio	-0.49	0.03	-0.11	0.84	0.37	-1.64
Retained Earnings to Total Assets Ratio	-0.13	-0.02	N/A	-3.81	-2.69	-0.15
Net Income plus Tax Ratio	0.03	0.05	0.05	0.01	0.01	-0.03
Sales to Total Assets Analysis Ratio	0.23	0.21	0.15	0.01	0.06	0.45
Equity to Debt Analysis Ratio	0.28	0.65	0.78	1.92	-0.04	-0.59
Cash Flow to Debt Analysis Ratio	-0.13	-0.26	0.03	2.14	1.51	-0.11
Cash Flow to Total Assets Ratio	-0.10	-0.16	0.02	0.73	1.57	-0.26
Cash Flow to Total Equity	-0.47	-0.41	0.04	1.11	-39.19	0.18
Cash Flow to Total Sales	-0.45	-0.75	0.12	85.16	26.92	-0.58
Cash Flow to Interest Expenses	-0.98	-1.62	0.18	N/A	6.51	-1.26

Table B-16 Financial Ratios Unhealthy Companies 31 and 32

	Company 31			Company 32		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	0.71	1.03	1.28	N/A	N/A	N/A
Current Ratio	0.86	1.22	1.69	N/A	N/A	N/A
Return on Assets Ratio	-10.74	-0.65	-3.63	4.12	3.93	6.02
Return on Equity Ratio	-83.80	-3.11	-17.05	24.14	21.72	29.57
Net Profit Margin Ratio	-9.77	-0.71	-3.32	4.48	3.64	5.30
Gross Profit Margin Ratio	13.59	11.54	11.33	18.71	18.51	15.27
Return on Investment	-70.34	-1.58	-6.88	19.93	17.45	26.05
Return on Sales Ratio	-8.47	1.58	-0.70	6.48	5.05	6.16
Total Debt to Total Assets Ratio	30.42	44.43	46.81	5.19	5.14	3.95
Total Equity to Total Assets Ratio	0.13	0.21	0.21	0.17	0.18	0.20
Total Debt to Total Equity Ratio	9.63	89.57	128.26	21.52	24.47	13.51
Times-Covered Ratio	1.59	1.63	1.82	33.19	49.24	57.82
Interest Coverage Ratio	-0.99	0.22	-0.11	11.49	13.43	23.33
Inventory to Turnover Ratio	12.22	7.19	N/A	52.78	67.54	77.92
Accounts Receivable Turnover Ratio	1.96	1.83	N/A	1.84	2.18	2.91
Total Assets Turnover Ratio	1.04	0.96	N/A	0.95	1.11	1.27
Net Working Capital Ratio	-0.14	0.13	0.32	N/A	N/A	N/A
Retained Earnings to Total Assets Ratio	-0.17	-0.06	-0.07	0.16	0.16	N/A
Net Income plus Tax Ratio	0.15	0.11	0.12	0.17	0.20	0.17
Sales to Total Assets Analysis Ratio	1.10	0.91	1.09	0.92	1.08	1.14
Equity to Debt Analysis Ratio	0.15	0.26	0.27	0.36	0.72	1.23
Cash Flow to Debt Analysis Ratio	-0.09	0.03	0.01	0.14	0.27	0.51
Cash Flow to Total Assets Ratio	-0.08	0.03	0.00	0.06	0.07	0.08
Cash Flow to Total Equity	-0.59	0.13	0.02	0.38	0.37	0.42
Cash Flow to Total Sales	-0.07	0.03	0.00	0.07	0.06	0.07
Cash Flow to Interest Expenses	-0.81	0.42	0.07	12.49	16.68	28.30

Table B-17 Financial Ratios Unhealthy Company 33

	Company 33			Company		
Financial Ratios	1yr	2 yr	3 yr	1yr	2 yr	3 yr
Quick Ratio	1.95	1.46	1.62			
Current Ratio	2.27	1.76	1.90			
Return on Assets Ratio	-27.27	-9.69	3.51			
Return on Equity Ratio	228.47	-70.58	14.78			
Net Profit Margin Ratio	-22.91	-9.77	4.29			
Gross Profit Margin Ratio	7.29	22.22	23.94			
Return on Investment	236.48	-13.54	4.89			

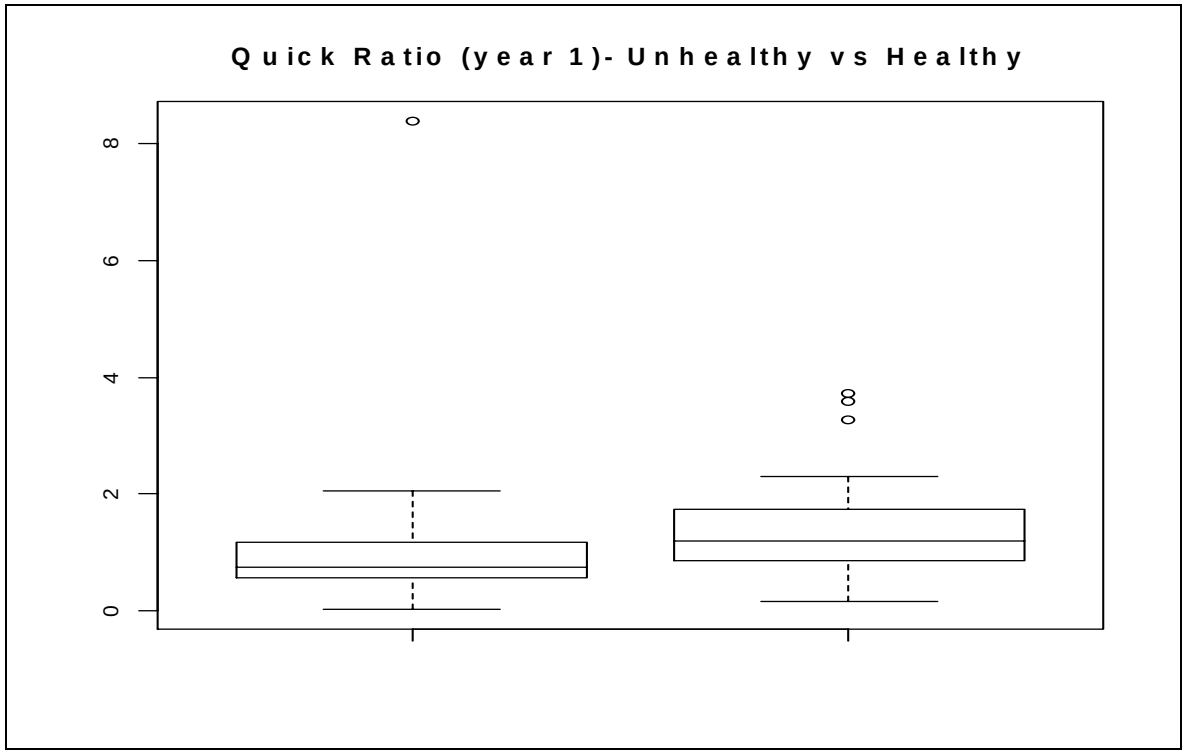
Table B-17 Continued

Return on Sales Ratio	-22.33	-9.30	6.65			
Debt to Assets Ratio	8.66	64.26	51.50			
Equity to Assets Ratio	-0.12	0.14	0.24			
Debt to Equity Ratio	-0.56	421.42	202.18			
Times-Covered Ratio	1.40	3.60	5.59			
Interest Coverage Ratio	-4.30	-1.51	1.55			
Inventory to Turnover Ratio	22.81	22.31	28.50			
Accounts Receivable Turnover Ratio	2.81	2.83	3.01			
Total Assets Turnover Ratio	1.08	1.03	1.17			
Net Working Capital Ratio	0.27	0.19	0.21			
Retained Earnings to Total Assets Ratio	-0.37	-0.08	0.02			
Net Income plus Tax Ratio	0.09	0.22	0.20			
Sales to Total Assets Analysis Ratio	1.19	0.99	0.82			
Equity to Debt Analysis Ratio	-0.11	0.16	0.31			
Cash Flow to Debt Analysis Ratio	-0.21	-0.07	0.08			
Cash Flow to Total Assets Ratio	-0.23	-0.06	0.06			
Cash Flow to Total Equity	1.94	-0.44	0.24			
Cash Flow to Total Sales	-0.19	-0.06	0.07			
Cash Flow to Interest Expenses	-3.75	-0.98	1.65			

APPENDIX C
BOXPLOTS YEAR 1

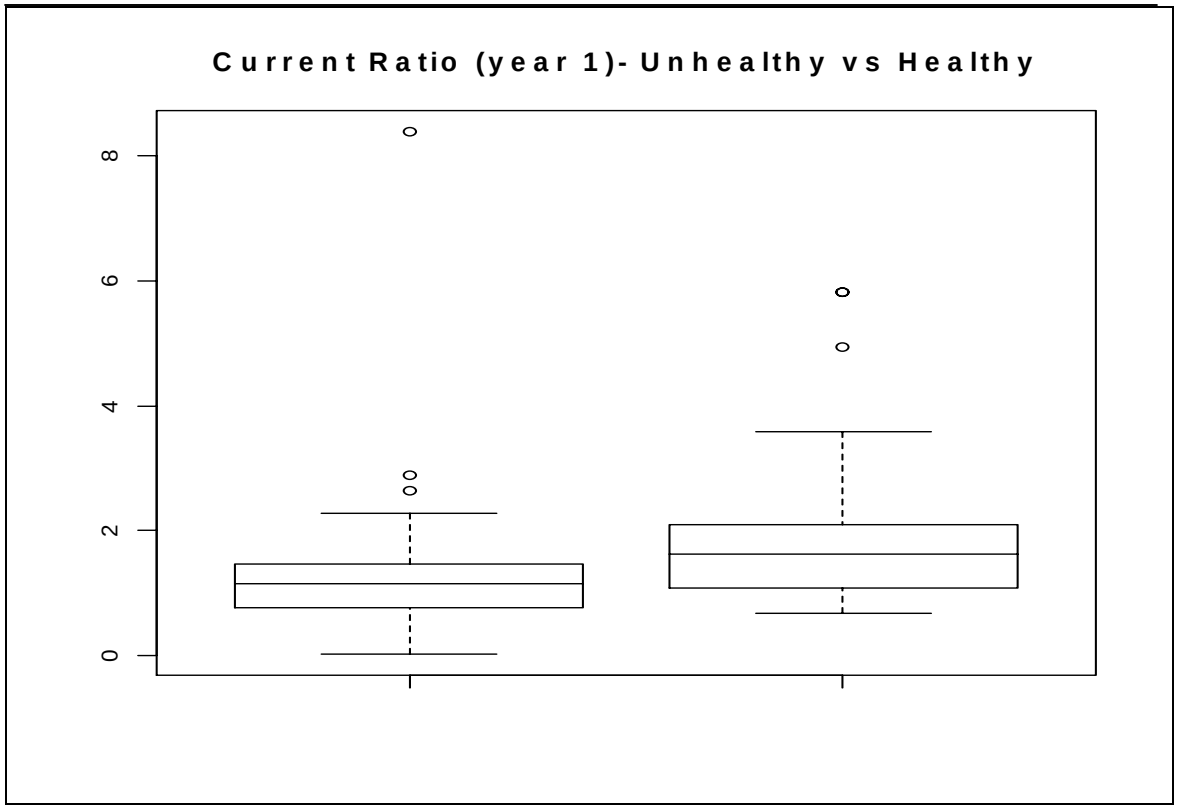
Appendix C shows the complete set of Boxplots of the data one year before bankruptcy. Also, it shows the R-language commands used to calculate the figures mentioned before.

```
## Vectors creation
## un: Unhealthy and he: Healthy
## Financial ratios will be ordered as on the tables of variables.
unrat1yr1 <- c(0.74, 0.47, 0.7, 0.49, NA, 0.72, 1.19, 0.64, 1.31, 0.07, 0.95, 1.06, 0.86,
1.80, 2.05, 1.59, 1.08, 0.03, 0.65, 1.05, 1.38, 0.05, 1.15, 0.42, 0.72, 1.12, 0.74, 0.10, 0.27,
8.38, 0.71, NA, 1.95)
## I am going to compare the first variable. Then, if it works, I will introduce first the
data from the unhealthy companies and then the data from the healthy companies.
herat1yr1 <- c(0.95, 1.64, 0.96, 1.93, 0.87, 0.76, 3.73, 1.59, 0.85, 2.01, 3.59, 1.58, 0.97,
1.47, 1.59, 1.12, 1.31, NA, 1.05, 1.00, NA, 0.72, 1.86, 1.50, 1.86, 1.26, 0.74, 0.48, 0.51,
1.11, 0.16, 2.31, 0.62, 3.27)
boxplot(unrat1yr1, herat1yr1,main="Quick Ratio (year 1)- Unhealthy vs Healthy")
```

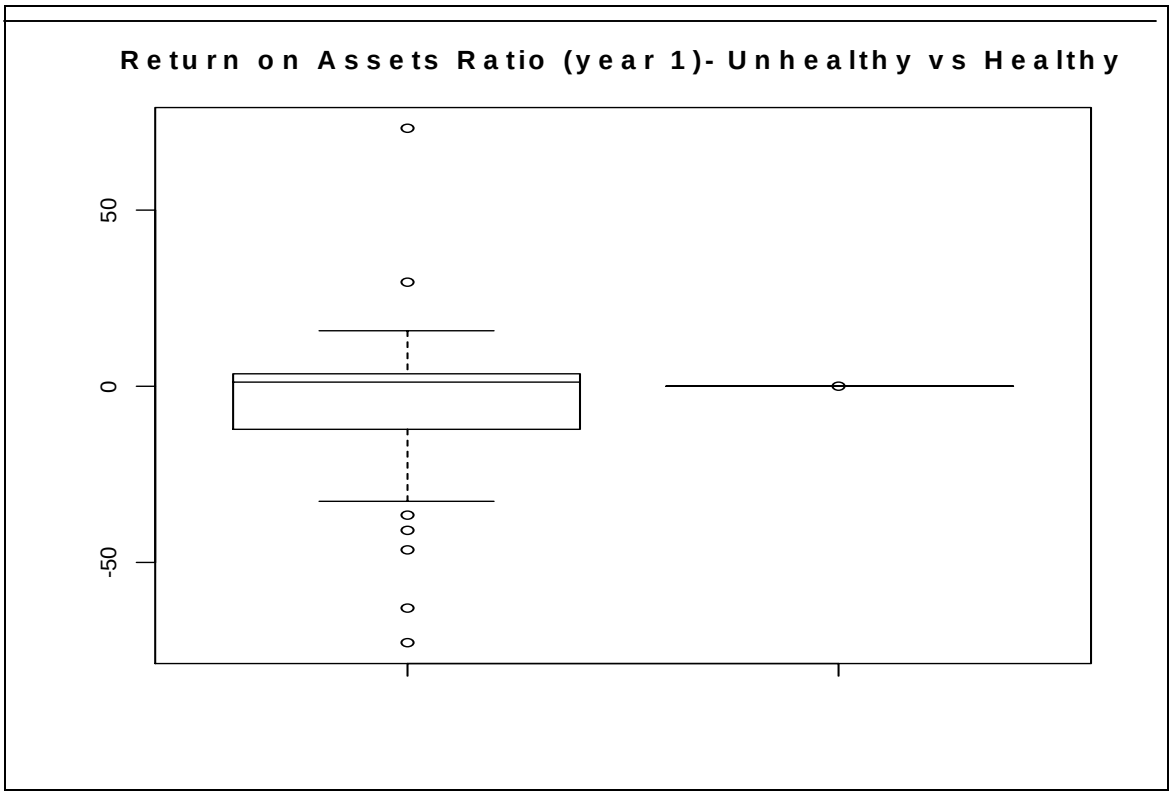



```
## Current Ratio
unrat2yr1 <- c(0.8, 0.47, 1.02, 0.63, 0.83, 1.15, 1.51, 1.00, 1.67, 0.10, 1.44, 1.90, 1.41,
2.89, 2.64, 1.63, 1.16, 0.03, 1.39, 1.21, 1.43, 0.05, 1.17, 0.7, 0.72, 1.41, 0.82, 0.90, 0.29,
8.38, 0.86, NA, 2.27)
herat2yr1 <- c(1.08, 1.64, 1.21, 2.09, 1.02, 1.21, 5.82, 1.59, 0.85, 2.30, 3.59, 1.67, 0.97,
1.70, 1.95, 1.16, 1.31, 2.13, 1.19, 1.08, 1.86, 0.88, 1.86, 1.71, 1.91, 1.26, 0.90, 0.67, 4.93,
1.40, 2.42, 5.82, 0.75, 3.39)
```

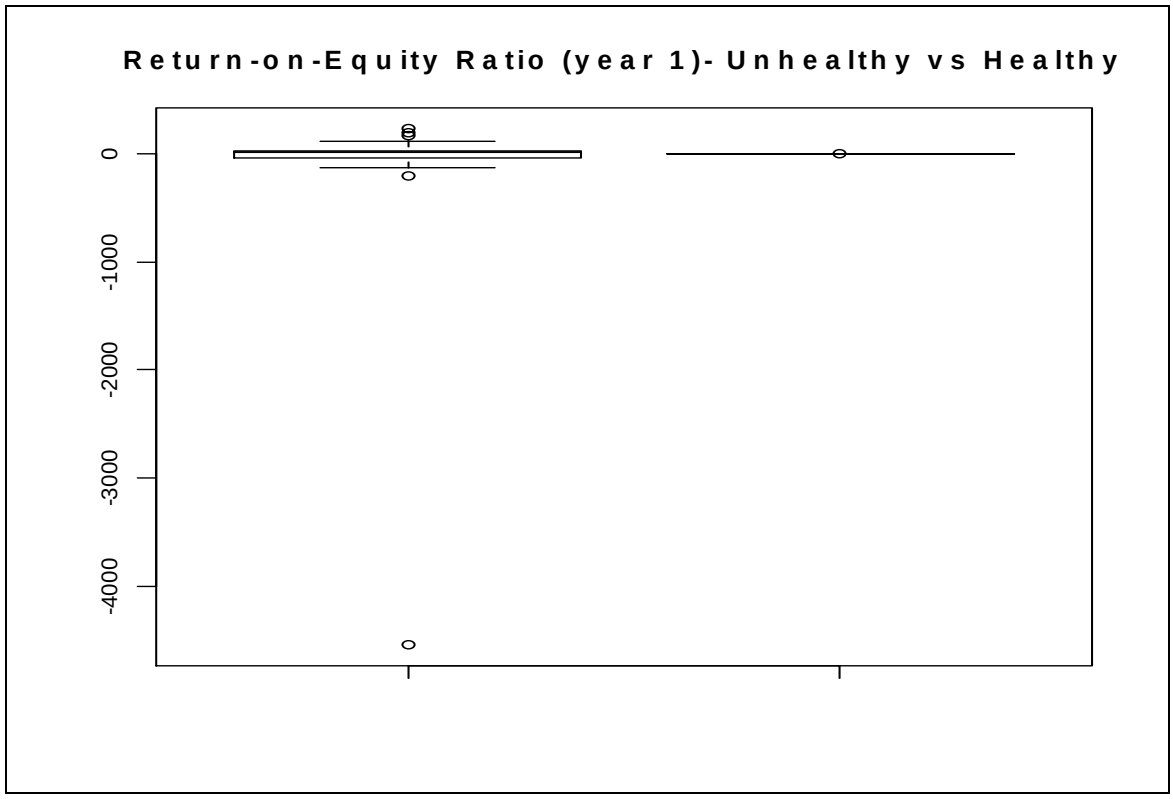
boxplot(unrat2yr1, herat2yr1,main="Current Ratio (year 1)- Unhealthy vs Healthy")



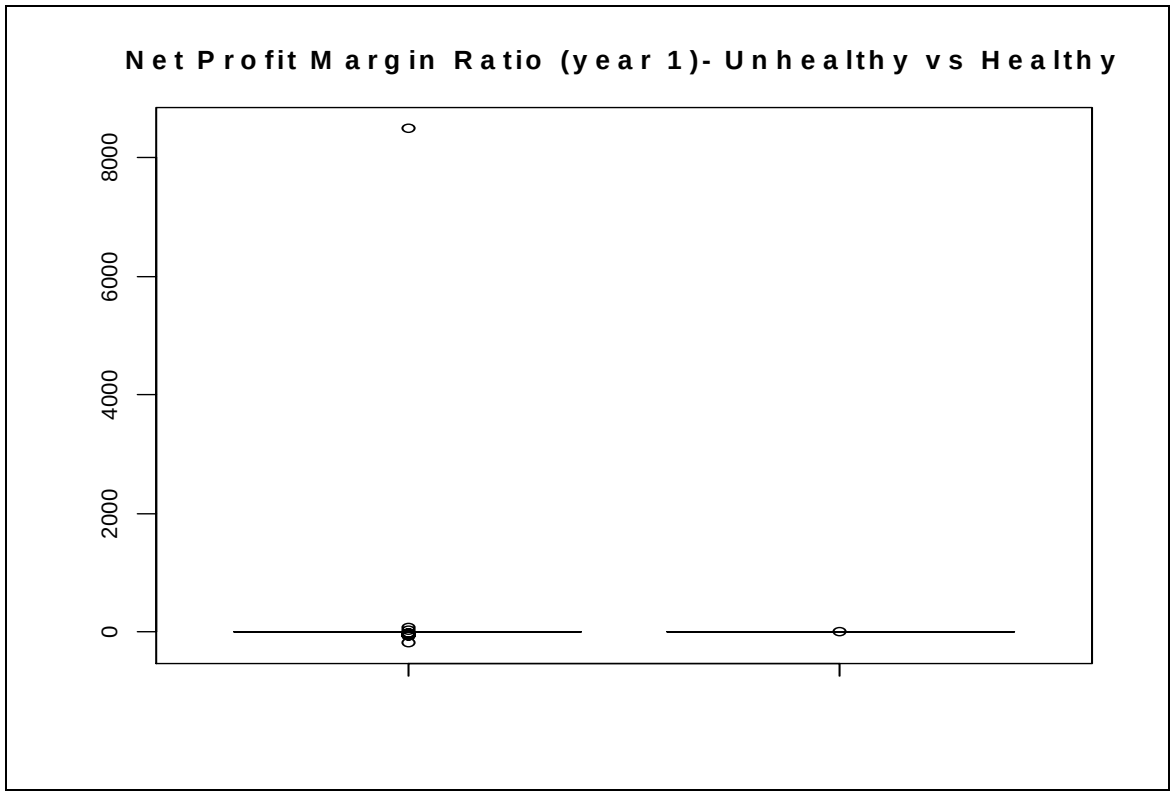
```
## Return on Assets Ratio
unrat3yr1 <- c(-32.85, -18.5, -9.19, -12.47, 0.06, 0.35, 2.36, -36.56, 1.38, -46.61, 3.26,
1.34, 1.18, 3.85, 6.60, 1.30, 15.82, -72.82, 7.21, 2.46, 2.89, 29.41, 9.32, -0.62, -1.49, 3.49,
-62.95, -40.87, -11.68, 73.04, -10.74, 4.12, -27.27)
herat3yr1 <- c(-0.04, -0.01, 0.03, 0.05, -0.06, 0.05, 0.06, 0.03, -0.06, -0.16, 0.01, 0.05, -
0.04, -0.08, 0.05, 0.001, 0.03, 0.08, 0.03, 0.01, -0.09, 0.07, -0.02, -0.02, 0.02, 0.01, 0.02,
0.06, 0.07, 0.01, 0.07, 0.07, 0.02, -0.02)
boxplot(unrat3yr1, herat3yr1,main="Return on Assets Ratio (year 1)- Unhealthy vs
Healthy")
```



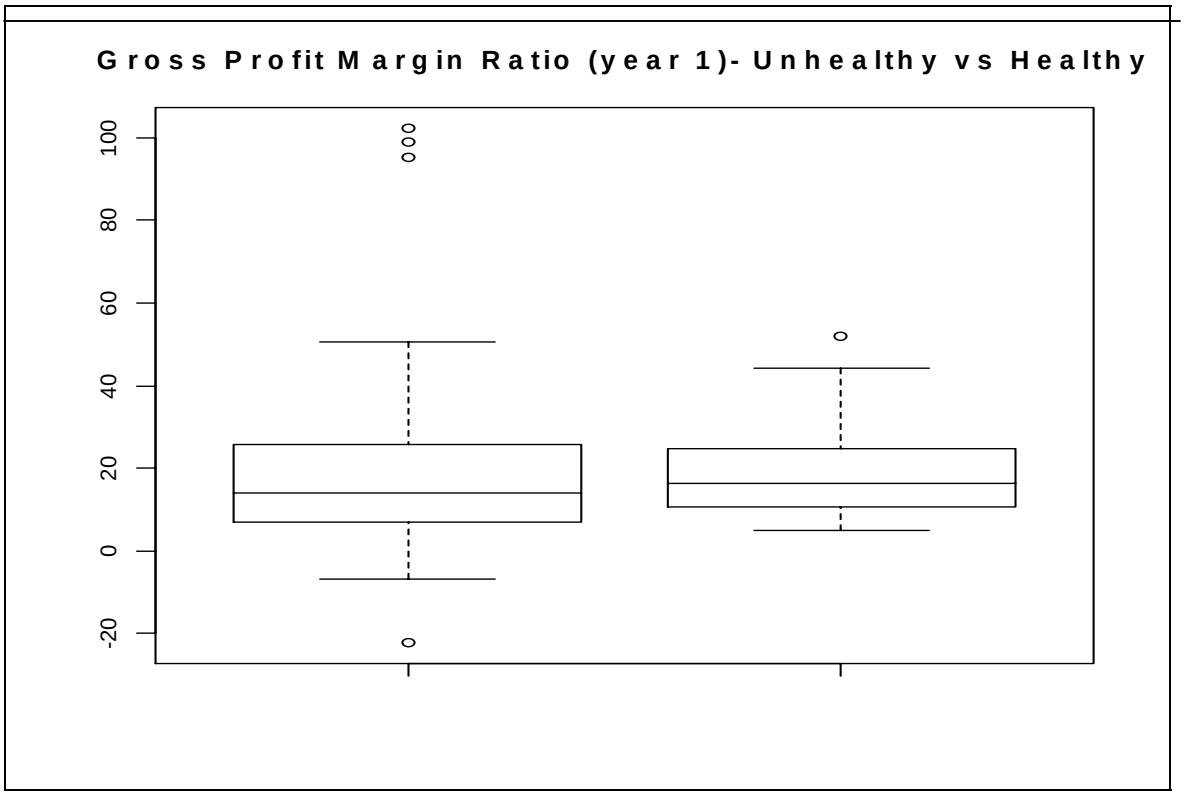
```
## Return-on-Equity Ratio
unrat4yr1 <- c(187.66, -52.56, -63.05, -48.87, 0.17, 0.97, NA, -4544.38, 3.62, 27.25,
7.72, 14.79, 3.16, 5.68, 13.24, 2.56, 63.65, 8.57, 21.23, 7.47, 11.39, 167.47, 28.20, NA, -
24.37, 8.12, -212.91, -125.38, -53.19, 111.06, -83.80, 24.14, 228.47)
herat4yr1 <- c(-0.77, -0.05, 0.09, 0.09, -0.10, 0.15, 0.21, 0.15, 0.18, -0.19, 0.02, 0.11,
0.26, -0.28, 0.12, 0.01, 0.36, 0.14, 0.33, 0.03, -0.18, 0.10, -0.14, -0.05, 0.08, 0.13, 0.27,
0.09, 0.21, 0.03, 0.18, 0.04, 0.06, -0.05)
boxplot(unrat4yr1, herat4yr1,main="Return-on-Equity Ratio (year 1)- Unhealthy vs
Healthy")
```



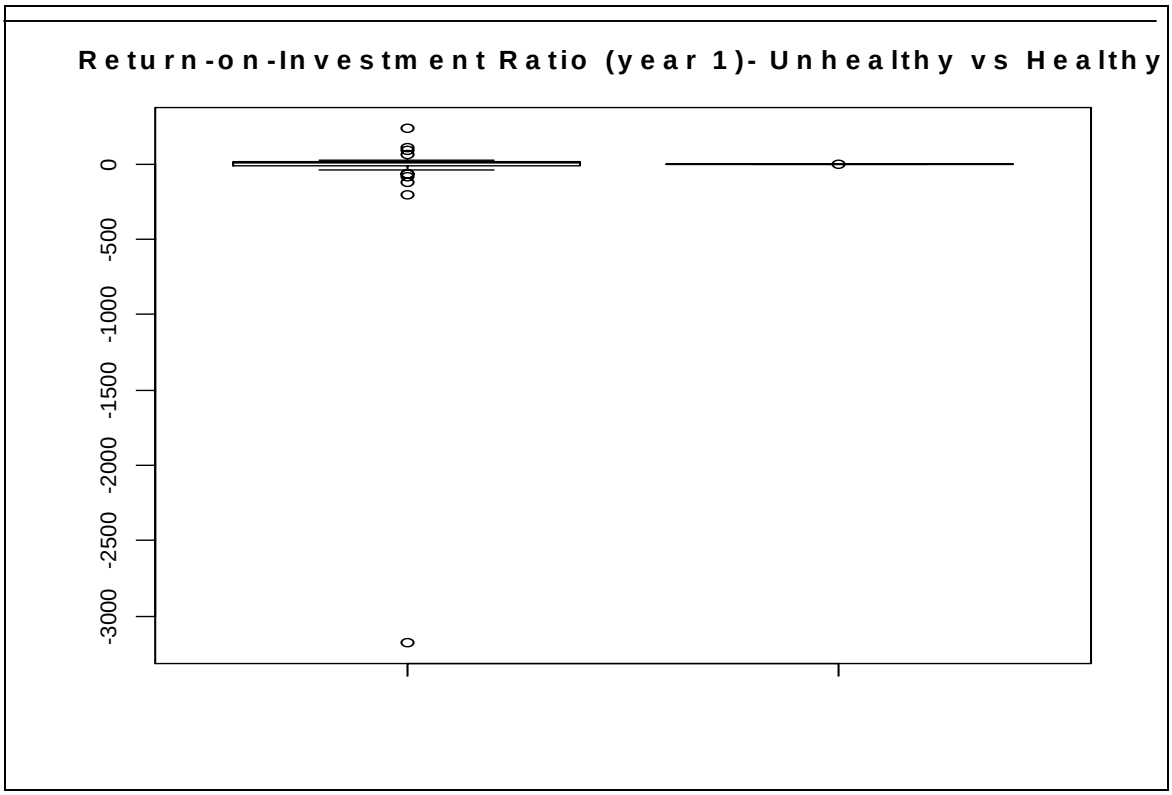
```
## Net Profit Margin Ratio
unrat5yr1 <- c(-0.28, -0.13, -0.04, -0.15, 0.04, -0.07, 2.78, -23.79, 0.77, -59.76, 1.67,
1.24, 0.60, 2.77, 7.29, 0.89, 24.07, -35.17, 2.93, 0.74, 1.56, 75.00, 5.92, -0.88, NA, 3.54, -
183.46, -59.56, -50.97, 8489.56, -9.77, 4.48, -22.91)
herat5yr1 <- c(0.01, -0.02, 0.10, 0.05, -0.06, 0.02, 0.06, 0.03, -0.04, -0.16, 0.03, 0.03, -
0.04, -0.02, 0.08, 0.001, 0.04, 0.05, 0.03, 0.01, 0.06, 0.07, -0.02, -0.02, 0.02, 0.02, 0.05,
0.08, 0.09, 0.01, 0.07, 0.07, 0.05, -0.02)
boxplot(unrat5yr1, herat5yr1,main="Net Profit Margin Ratio (year 1)- Unhealthy vs
Healthy")
```



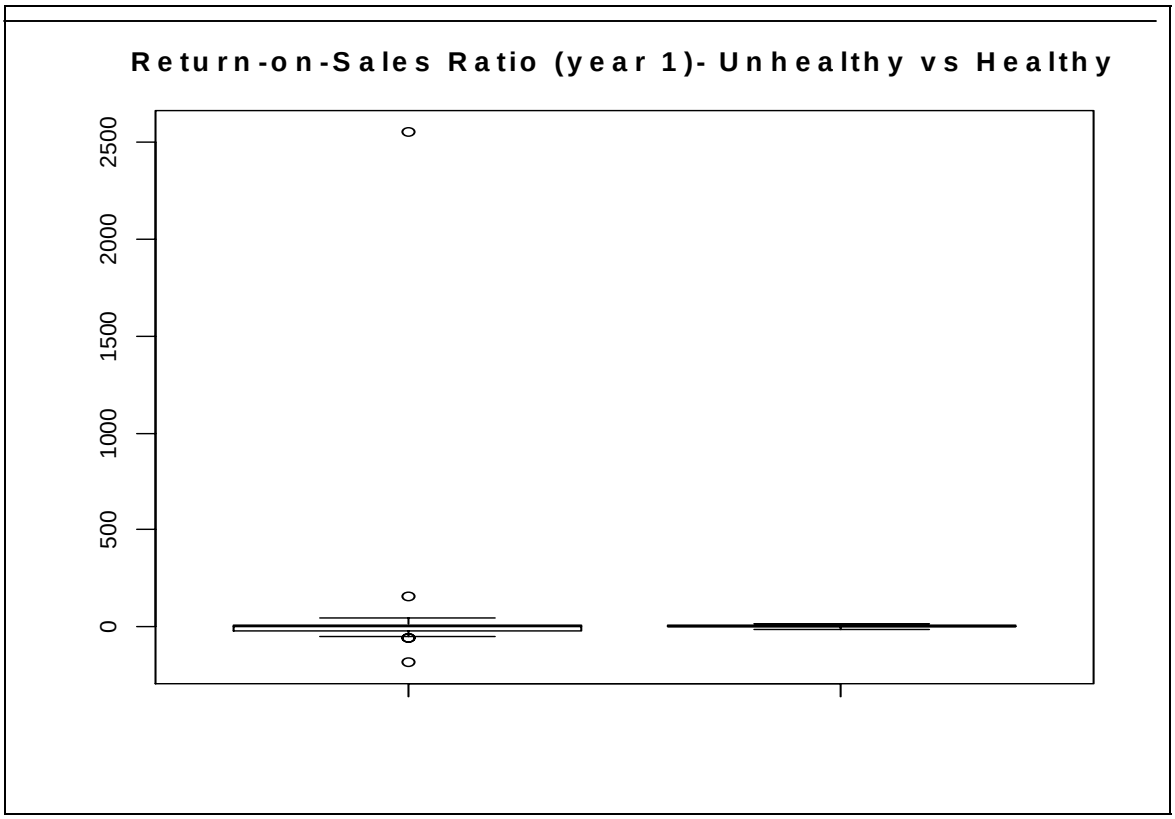
```
## Gross Profit Margin Ratio
unrat6yr1 <- c(-2.63, 0.68, 102.28, -3.63, 0.15, 30.99, 11.10, -6.72, 7.51, -22.22, 8.25,
29.30, 8.34, 25.78, 38.29, 2.31, 50.60, 15.97, 10.06, 7.85, 14.38, 98.80, 19.59, 21.71, NA,
14.16, 25.55, 6.68, 15.27, 95.35, 13.59, 18.71, 7.29)
herat6yr1 <- c(27.85, 14.05, 44.16, 16.56, 22.63, 5.52, 12.26, 14.33, 9.47, 21.88, 15.15,
16.38, 5.44, 4.99, 24.69, 5.91, 5.36, 13.27, 5.25, 8.27, 22.93, 24.26, 13.13, 32.07, 38.64,
25.14, 28.48, 51.96, 22.02, 19.24, 10.57, 12.30, 33.03, 16.00)
boxplot(unrat6yr1, herat6yr1,main="Gross Profit Margin Ratio (year 1)- Unhealthy vs
Healthy")
```



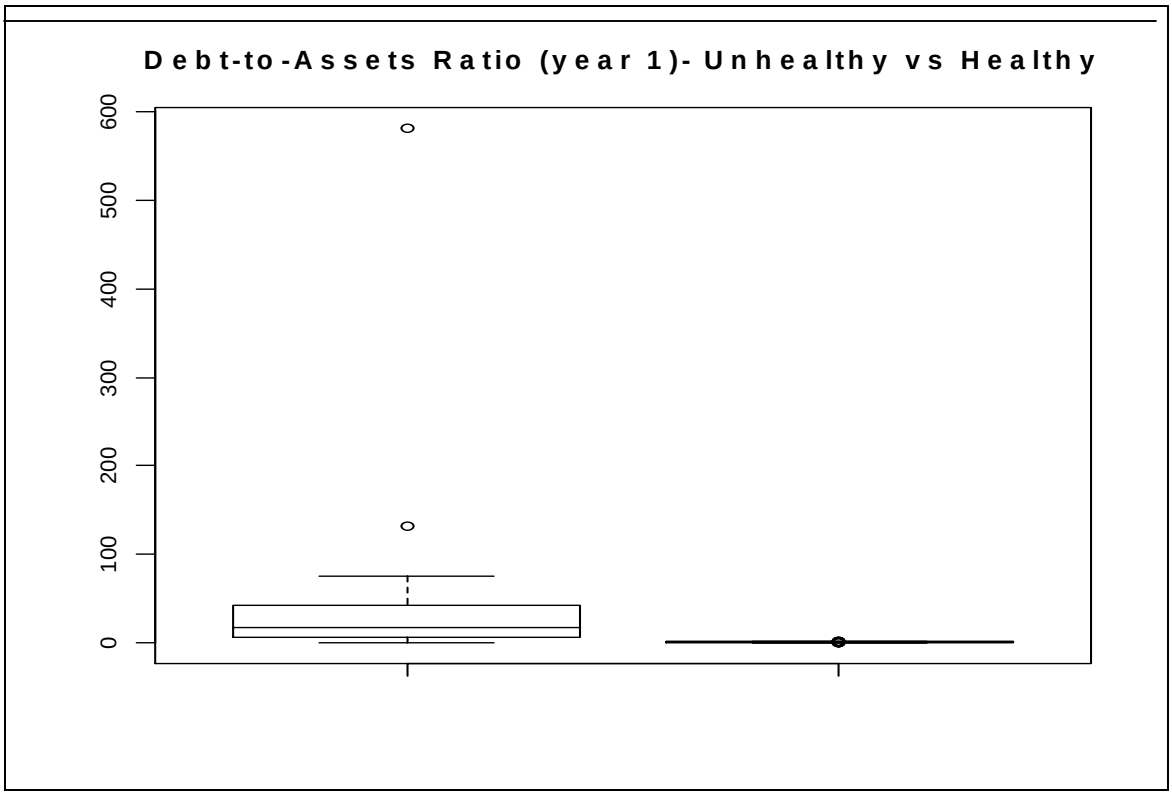
```
## Return on Investment Ratio
unrat7yr1 <- c(-125.82, 9.3, 60.40, -69.32, NA, 0.61, 3.31, -3175.83, 2.96, 27.77, 6.04,
1.90, 1.73, 4.96, 9.17, 2.20, 24.88, 10.22, NA, 5.80, 9.82, 86.63, 19.90, -1.69, -24.37,
5.26, -205.75, -82.83, -40.83, 111.06, -70.34, 19.93, 236.48)
herat7yr1 <- c(0.01, -0.02, 0.03, 0.05, -0.04, 0.052, 0.06, 0.03, -0.06, -0.16, 0.02, 0.05, -
0.04, -0.02, 0.05, 0.001, 0.03, 0.08, 0.03, 0.01, 0.07, 0.07, -0.02, -0.02, 0.02, 0.01, 0.02,
0.08, 0.07, 0.01, 0.07, 0.07, 0.02, -0.02)
boxplot(unrat7yr1, herat7yr1,main="Return-on-Investment Ratio (year 1)- Unhealthy vs
Healthy")
```



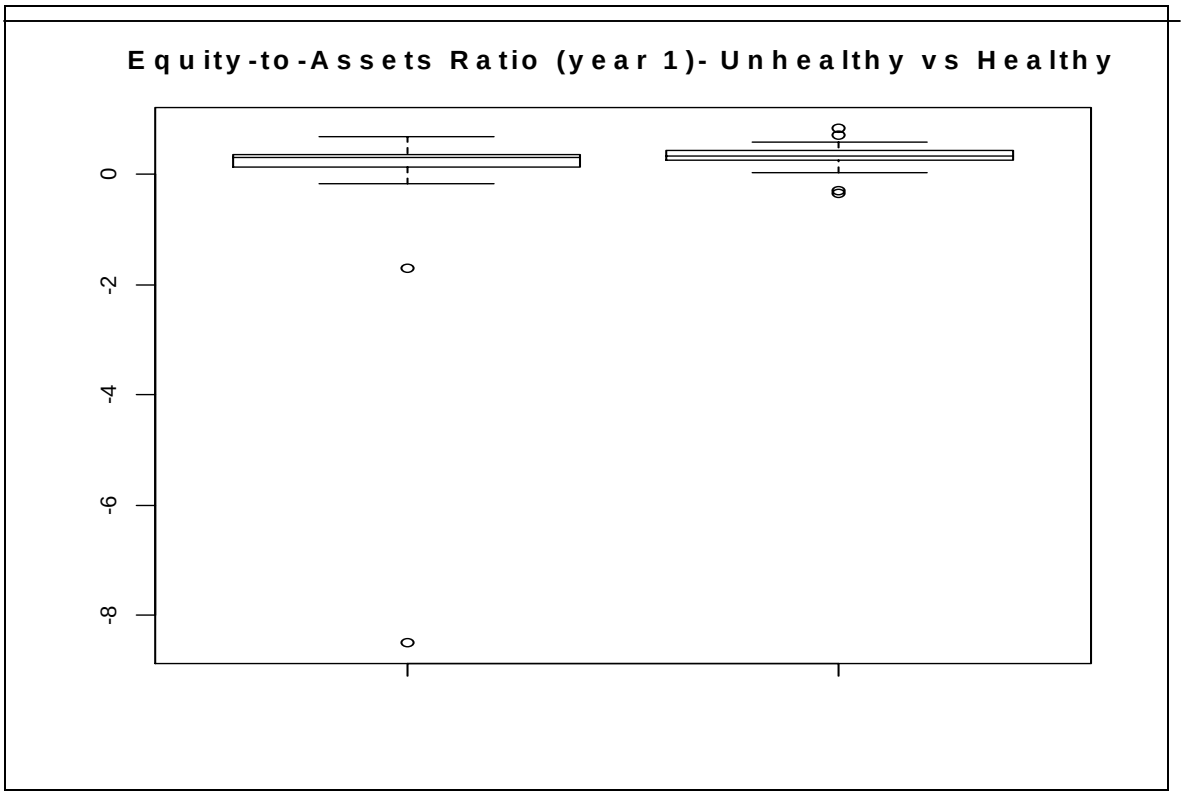
```
## Return on Sales Ratio
unrat8yr1 <- c(-44.60, -10.01, -2.70, -17.52, 5.84, 0.17, 5.20, -25.55, 1.30, -60.19, 2.68,
2.97, 1.04, 4.94, 16.14, 1.08, 41.08, -35.19, 4.77, 1.29, 5.77, 155.69, 11.87, -0.90, NA,
6.20, -183.21, -59.54, -51.07, 2562.79-8.47, 6.48, -22.33)
herat8yr1 <- c(1.37, -3.65, 16.14, 9.22, -7.32, 3.04, 9.05, 4.26, -2.88, -11.57, 3.03, 4.68, -
3.46, -1.82, 11.97, 0.13, 2.24, 7.41, 4.29, 1.08, 9.75, 9.38, 0, -2.28, 3.04, 2.62, 6.81,
11.78, 11.55, 1.75, 11.00, 12.01, 7.79, -3.23)
boxplot(unrat8yr1, herat8yr1,main="Return-on-Sales Ratio (year 1)- Unhealthy vs
Healthy")
```



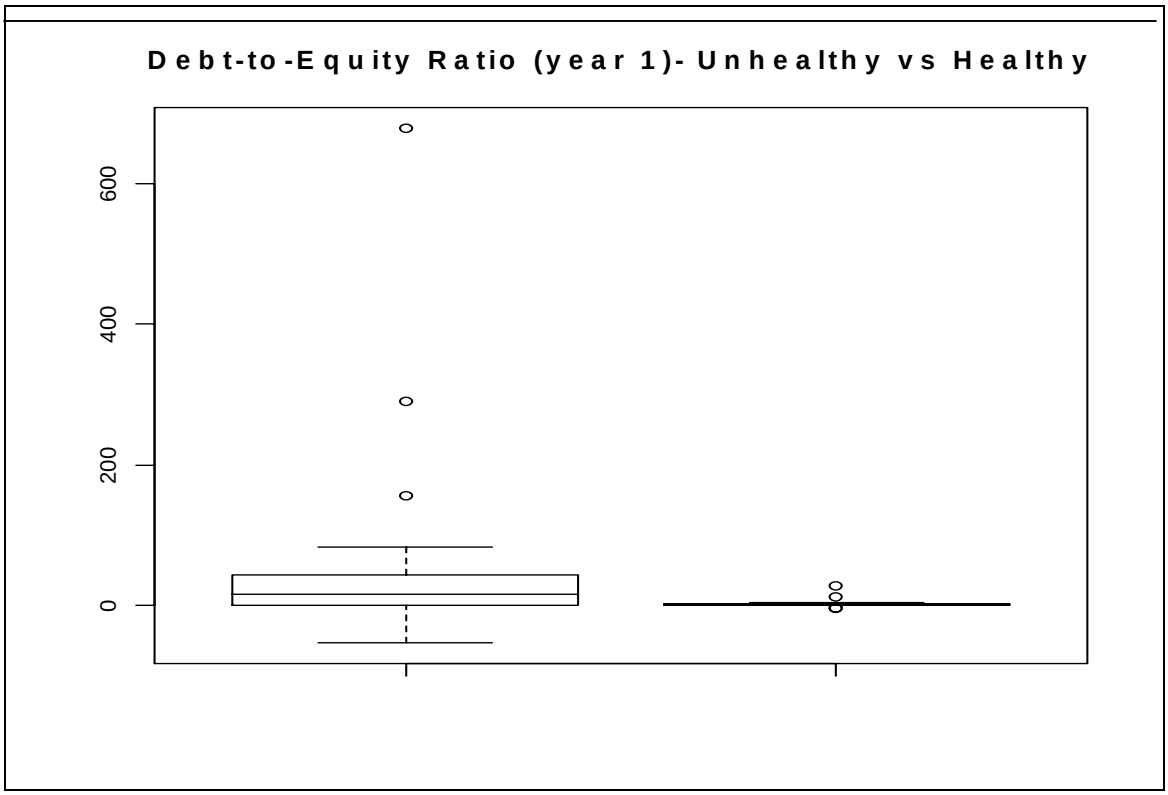
```
## Debt to Assets Ratio
unrat9yr1 <- c(0.74, 0.65, 0.69, NA, 0.57, 0.64, 14.68, 44.04, 13.91, 132.18, 13.45,
75.45, 35.44, 14.08, 18.56, 10.09, 44.64, 581.21, 22.46, 13.02, 4.30, 49.37, 18.41, 67.62,
17.90, 24.14, 6.61, 40.34, 58.71, 0.01, 30.42, 5.19, 8.66)
herat9yr1 <- c(0.97, 0.71, 0.65, 0.61, 0.75, 0.69, 0.77, 0.50, 1.35, 0.29, 0.17, 0.54, 1.29,
0.72, 0.57, 0.79, 0.79, 0.41, 0.26, 0.22, 0.49, 0.68, 0.62, 0.59, 0.65, 0.71, 0.92, 0.74, 0.58,
0.68, 0.57, 0.52, 0.66, 0.55)
boxplot(unrat9yr1, herat9yr1,main="Debt-to-Assets Ratio (year 1)- Unhealthy vs
Healthy")
```



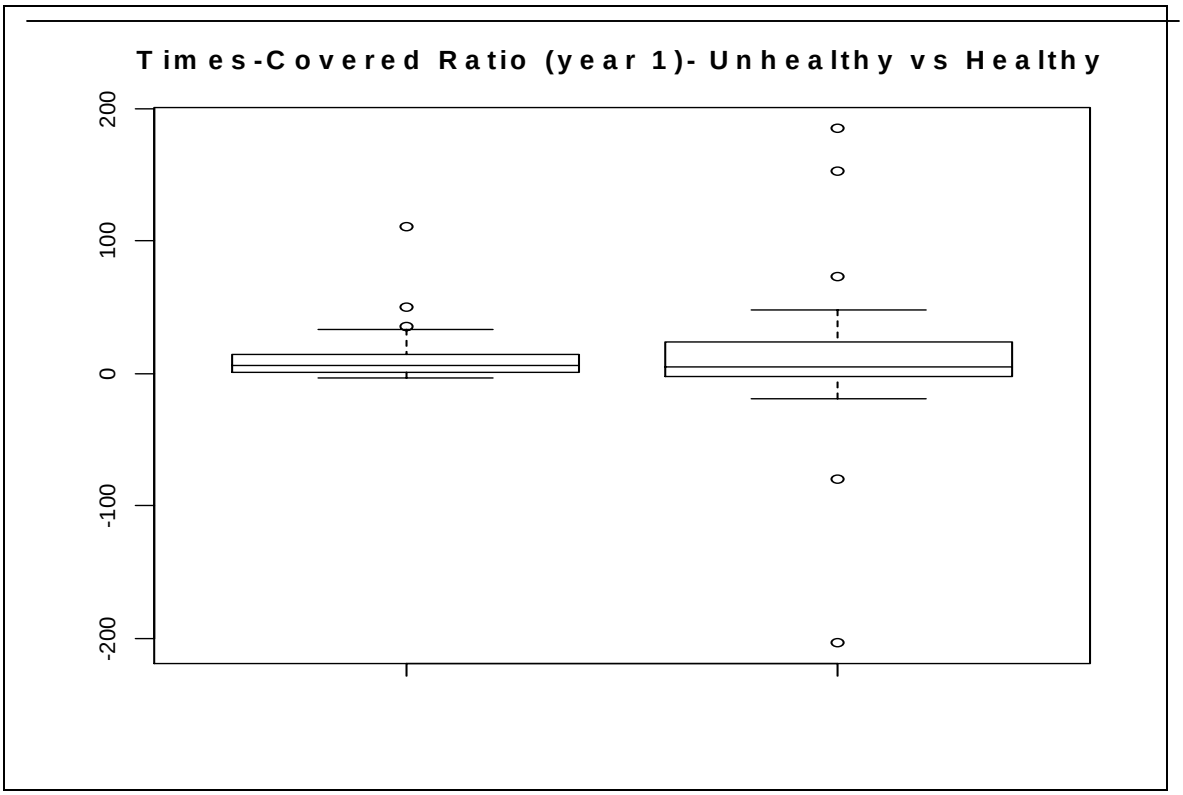
```
## Equity to Assets Ratio
unrat10yr1 <- c(-0.18, 0.35, 0.15, 0.26, 0.35, 0.36, NA, 0.01, 0.38, -1.71, 0.42, 0.09, 0.37,
0.68, 0.50, 0.51, 0.25, -8.49, 0.34, 0.33, 0.25, 0.18, 0.33, NA, 0.06, 0.43, 0.30, 0.33, 0.22,
0.66, 0.13, 0.17, -0.12)
herat10yr1 <- c(0.03, 0.29, 0.35, 0.39, 0.25, 0.31, 0.23, 0.50, -0.35, 0.71, 0.83, 0.46, -
0.29, 0.28, 0.43, 0.21, 0.21, 0.59, 0.22, 0.33, 0.52, 0.32, 0.38, 0.41, 0.35, 0.29, 0.08, 0.26,
0.42, 0.32, 0.43, 0.48, 0.34, 0.45)
boxplot(unrat10yr1, herat10yr1,main="Equity-to-Assets Ratio (year 1)- Unhealthy vs
Healthy")
```



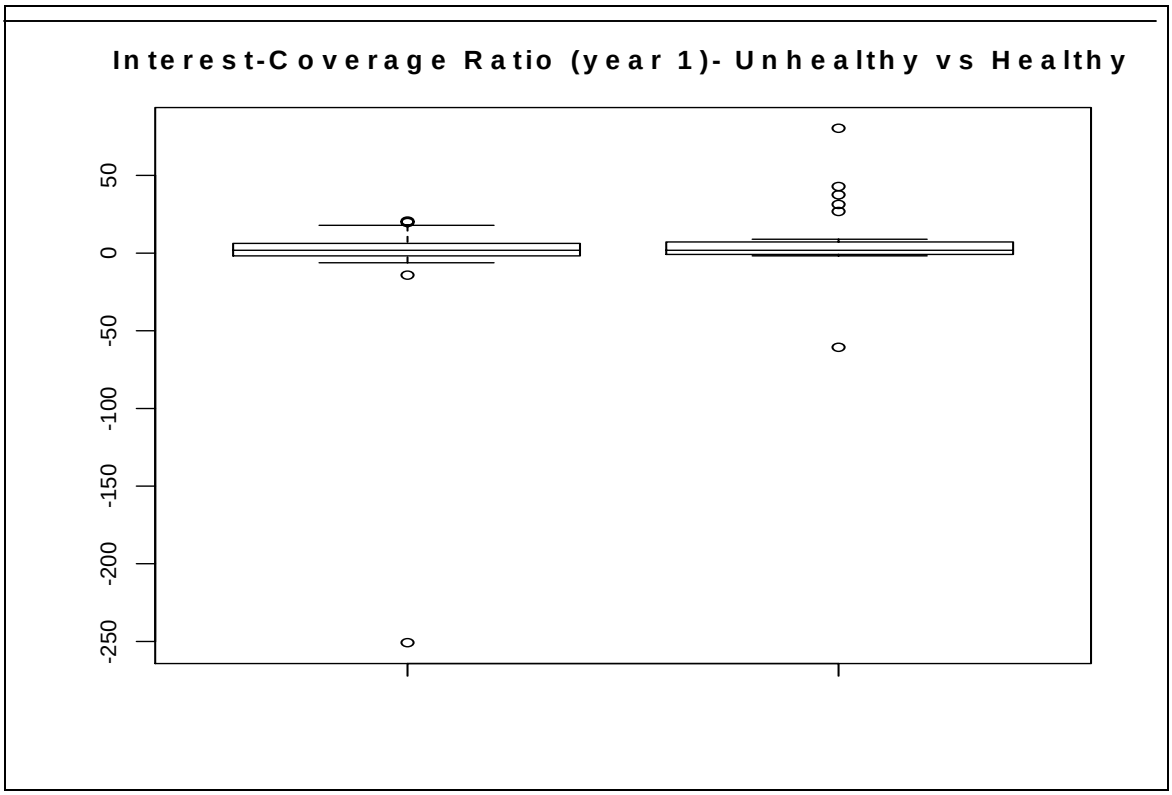
```
## Debt to Equity Ratio
unrat11yr1 <- c(-1.5, 0.32, 0.37, 1.06, 1.62, 60.41, 0.77, 43.09, 22.26, -1.90, 27.40,
677.91, 82.40, 14.48, 34.22, 16.56, 155.85, -16.15, 55.81, 30.12, 16.00, -52.72, 41.66,
289.93, 0, 54.38, 3.64, 51.37, 19.98, 0, 9.63, 21.52, -0.56)
herat11yr1 <- c(28.15, 2.46, 1.85, 1.57, 3.05, 2.19, 3.37, 0.98, -3.87, 0.42, 0.21, 1.16, -
4.44, 2.61, 1.33, 3.73, 3.69, 0.68, 0.26, 0.67, 0.91, 2.13, 1.61, 1.41, 1.83, 2.44, 11.14,
2.85, 1.40, 2.11, 1.34, 1.08, 1.93, 1.21)
boxplot(unrat11yr1, herat11yr1,main="Debt-to-Equity Ratio (year 1)- Unhealthy vs
Healthy")
```



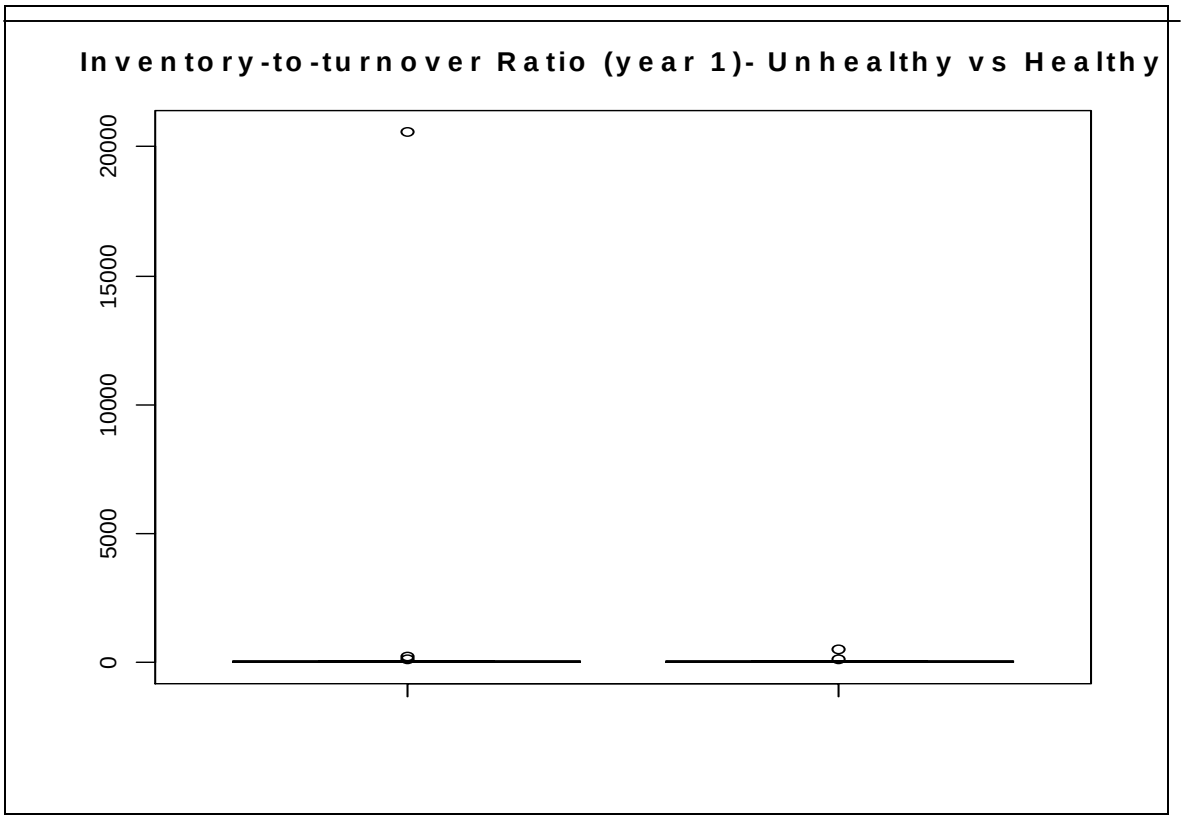
```
## Times-Covered Ratio
unrat12yr1 <- c(-2.12, 13.50, 111.32, -0.78, NA, 6.16, NA, -3.74, 2.09, -0.65, 8.50, 6.64,
3.51, 28.56, 14.52, 4.23, 14.68, 0.36, 10.45, 10.62, 50.57, 9.17, 31.36, 3.07, NA, 7.65,
35.00, 0.71, 0.33, NA, 1.59, 33.19, 1.40)
herat12yr1 <- c(-9.20, 3.51, 5.89, 6.08, 3.69, 48.07, 9.35, -203.32, 4.65, -80.07, 185.19,
31.54, -6.69, -5.52, 11.00, -18.60, 73.38, 0.55, 4.30, -8.54, 19.43, 5.09, 45.18, 27.52,
14.73, NA, 2.98, 27.94, 152.56, -11.82, NA, NA, 4.45, 7.33)
boxplot(unrat12yr1, herat12yr1,main="Times-Covered Ratio (year 1)- Unhealthy vs
Healthy")
```



Interest-Coverage Ratio
unrat13yr1 <- c(-2.12, 13.50, -2.94, -3.75, 17.89, 1.03, NA, -14.21, 3.09, -1.76, 2.76, 0.67, 0.44, 5.47, 6.12, 1.98, 11.91, -0.80, 4.96, 1.75, 20.29, 14.44, 19.00, -0.13, NA, 3.35, -251.00, -6.37, -1.10, NA, -0.99, 11.49, -4.30)
herat13yr1 <- c(-0.45, -0.91, 2.15, 3.39, -1.19, 26.50, 6.90, -60.52, -1.42, 42.35, 37.04, 9.00, 4.25, 2.02, 5.33, -0.41, 30.71, 0.31, 3.52, -1.11, 8.26, 1.97, 0, -1.95, 1.16, NA, 0.71, 6.33, 80.02, -1.08, NA, NA, 1.05, -1.48)
boxplot(unrat13yr1, herat13yr1,main="Interest-Coverage Ratio (year 1)- Unhealthy vs Healthy")

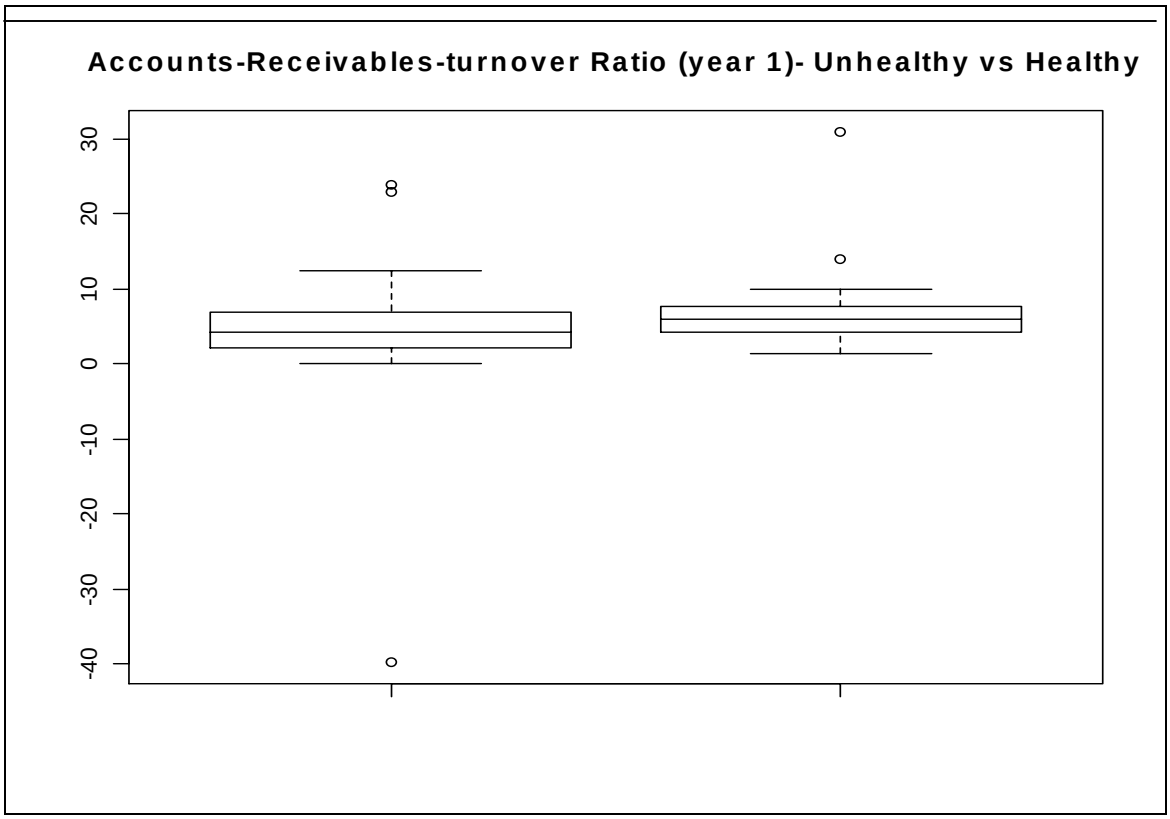


```
## Inventory-to-turover Ratio
unrat14yr1 <- c(20575, NA, 10.90, 17.92, 0.45, 30.63, 72, 7.00, 9.33, 18.32, 13.46, 4.33,
24.09, 7.23, 25.17, 234.70, 42.73, 35.00, 8.72, 98.25, 73.58, NA, NA, 3.77, NA, 16.89,
14.23, 1.69, 29, NA, 12.22, 52.78, 22.81)
herat14yr1 <- c(5.55, NA, 7.17, 33.99, 15.08, 10.06, 2.28, NA, 506.07, 12.34, NA, 49.19,
NA, 16.18, 15.53, 120.83, NA, NA, 33.29, 35.50, NA, 13.26, NA, 10.53, NA, NA, 16.91,
NA, 1.34, 14.40, 1.46, 0.45, 19.61, 57.99)
boxplot(unrat14yr1, herat14yr1,main="Inventory-to-turnover Ratio (year 1)- Unhealthy
vs Healthy")
```

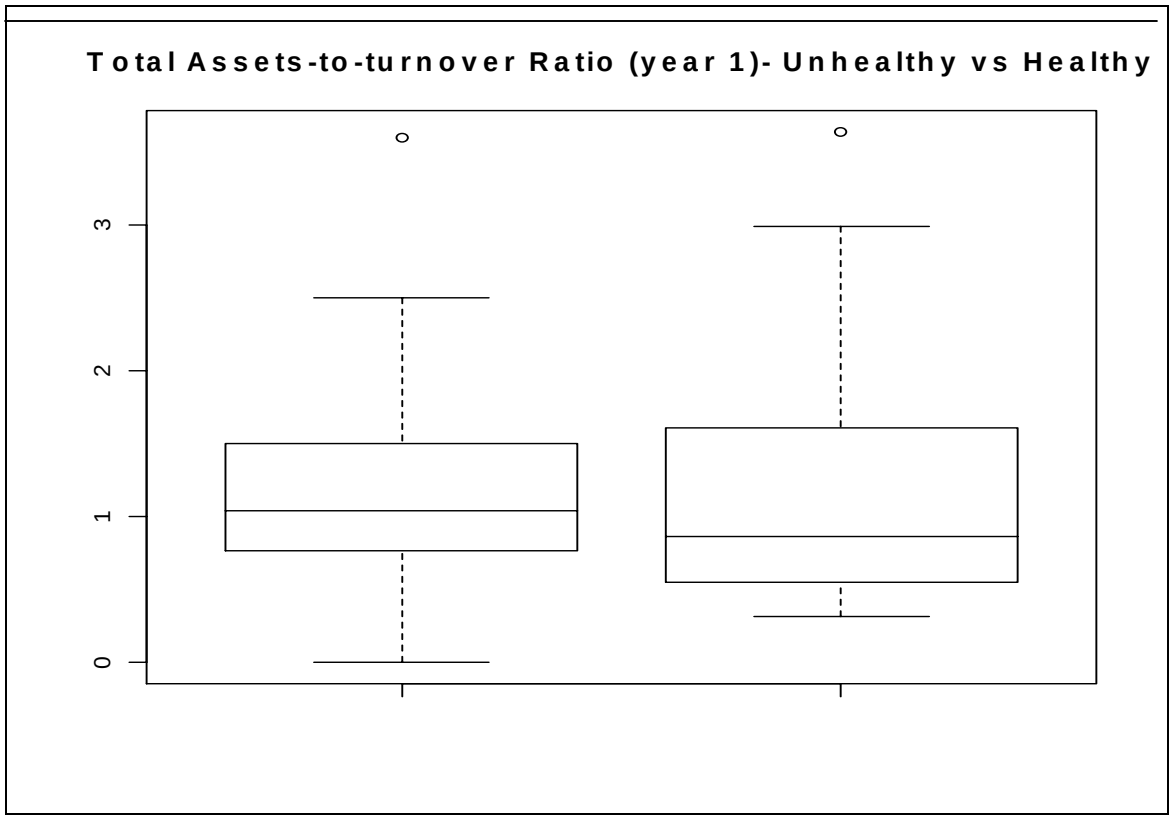


Accounts-Receivables-Turnover Ratio

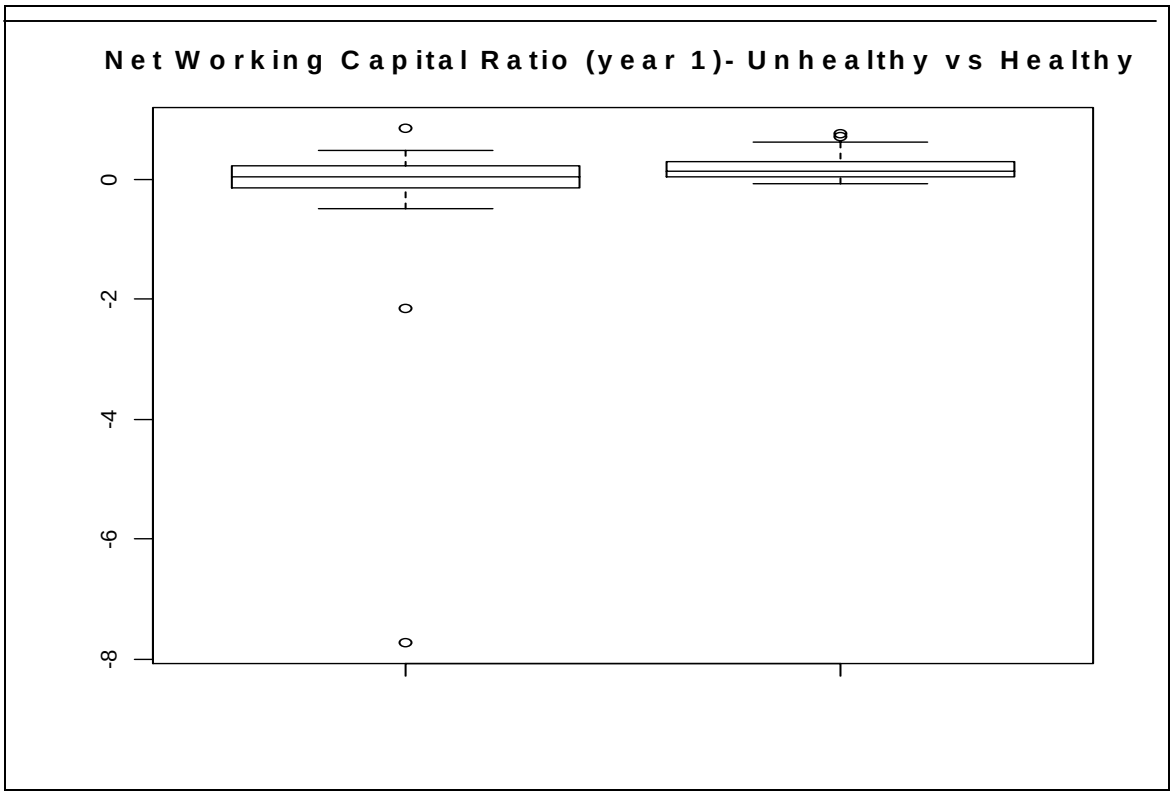
```
unrat15yr1 <- c(23.80, NA, -39.70, 12.46, 4.52, 3.64, 3.36, 2.91, 4.50, 1.85, 5.82, 3.42,
9.61, 4.42, 5.84, 5.00, 22.85, 5.82, 10.78, 7.80, 3.50, 2.31, 4.80, 4.00, 0, 8.41, 1.16, 9.50,
1.26, 0.52, 1.96, 1.84, 2.81)
herat15yr1 <- c(2.55, 5.87, 8.69, 9.95, 7.80, 13.84, 1.63, 5.93, 6.83, 4.01, 4.23, 5.71,
7.23, 3.84, 6.58, 5.88, 4.19, 8.05, 6.42, 7.59, 1.35, 5.77, 4.11, 2.70, 3.59, 5.65, 9.46, 9.67,
NA, 6.93, NA, 30.84, 6.94, 4.50)
boxplot(unrat15yr1, herat15yr1,main="Accounts-Receivables-turnover Ratio (year 1)-
Unhealthy vs Healthy")
```



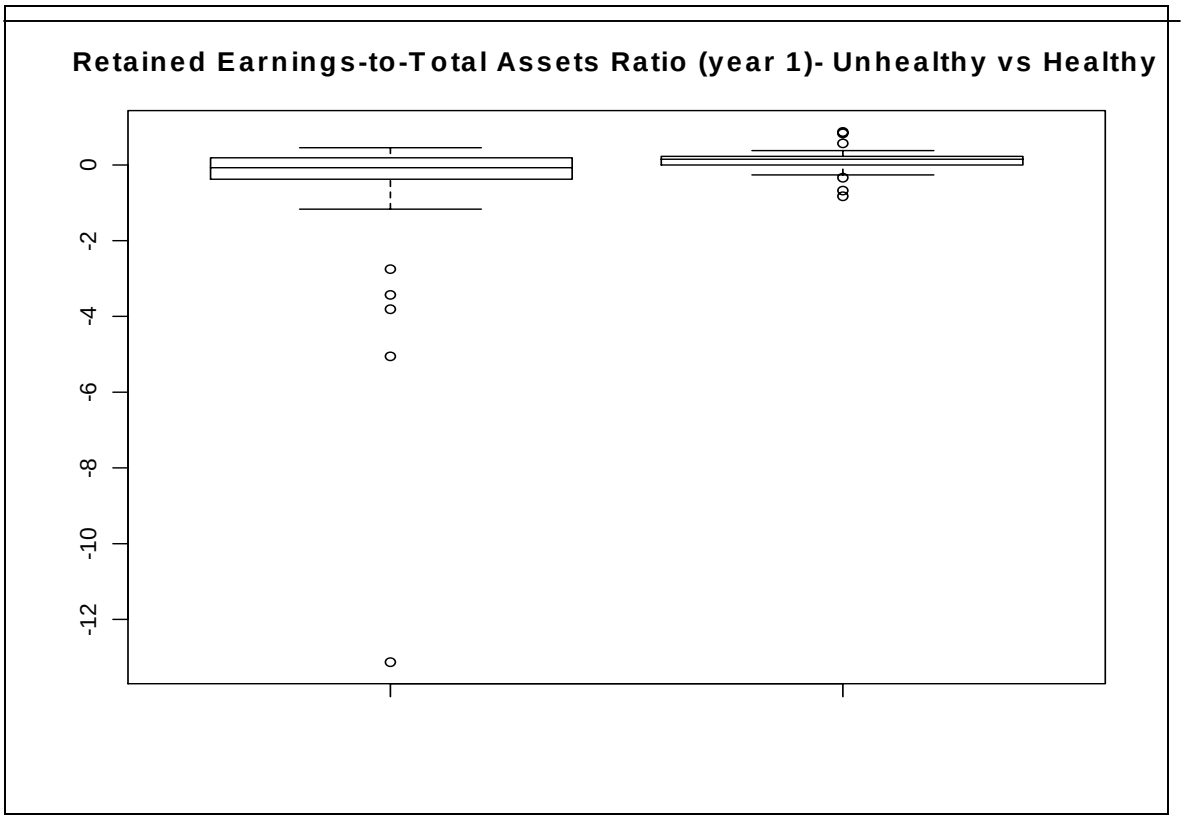
```
## Total Assets-to-Turnover Ratio
unrat16yr1 <- c(1.17, 1.46, 2.34, 0.86, 1.50, 0.76, 0.84, 1.46, 1.74, 0.52, 2.00, 0.95, 1.92,
1.30, 0.89, 1.48, 1.10, 0.78, 2.50, 3.60, 2.21, 0.35, 1.95, 0.69, 0, 0.99, 0.37, 0.59, 0.25,
0.01, 1.04, 0.95, 1.08)
herat16yr1 <- c(1.61, 1.00, 2.99, 1.61, 2.49, 0.39, 1.27, 0.36, 0.66, 1.16, 0.73, 0.56, 0.53,
1.03, 1.44, 0.36, 0.41, 0.55, 0.44, 0.60, 0.81, 2.11, 0.34, 0.77, 0.68, 0.31, 2.19, 2.55, 0.83,
0.89, 0.89, 3.64, 2.28, 0.89)
boxplot(unrat16yr1, herat16yr1,main="Total Assets-to-turnover Ratio (year 1)-
Unhealthy vs Healthy")
```



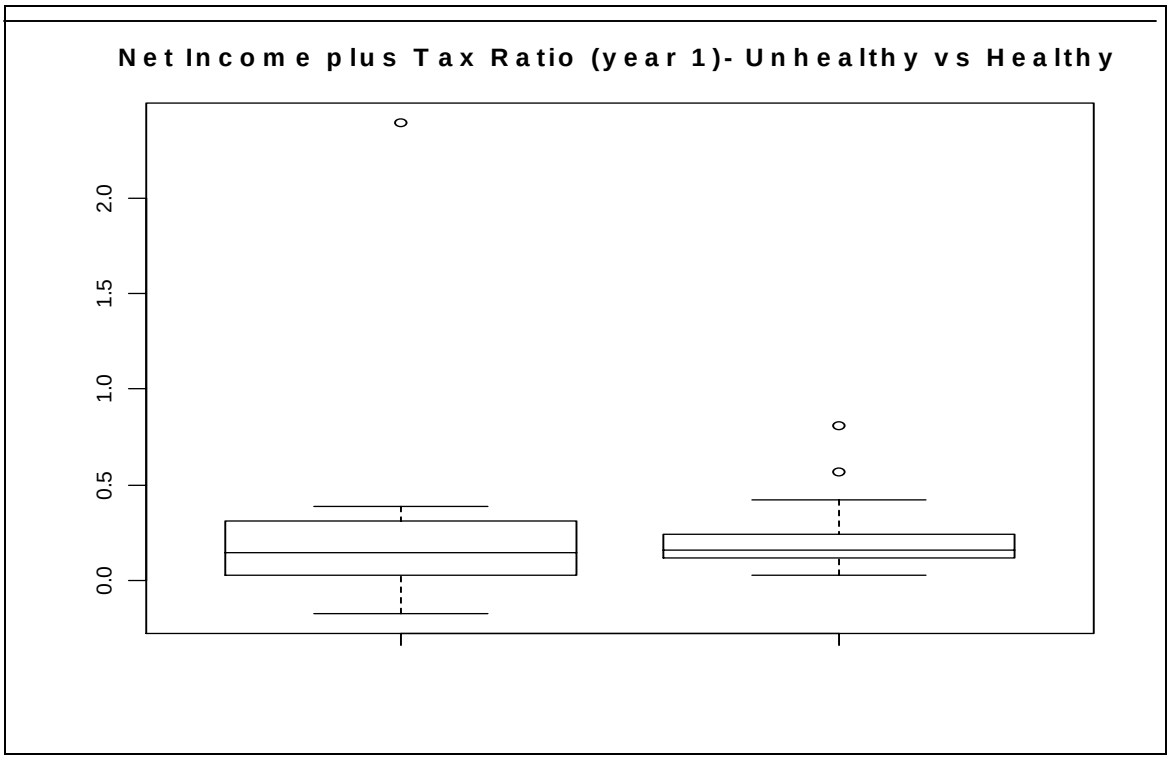
Net Working Capital Ratio
unrat17yr1 <- c(-0.15, -0.28, 0.01, -0.15, 0.47, 0.04, 0.005, 0, 0.34, -2.16, 0.18, 0.26, 0.11, 0.43, 0.24, 0.19, 0.035, -7.72, 0.18, 0.12, 0.27, -0.49, 0.08, -0.19, -0.26, 0.10, -0.12, -0.05, -0.49, 0.84, -0.14, NA, 0.27)
herat17yr1 <- c(0.05, 0.10, 0.02, 0.10, 0.003, 0.11, 0.70, 0.21, -0.08, 0.25, 0.44, 0.22, -0.02, 0.18, 0.09, 0.09, 0.22, 0.41, 0.09, 0.04, 0.28, -0.02, 0.37, 0.28, 0.21, 0.16, -0.01, -0.05, 0.62, 0.09, 0.43, 0.74, -0.03, 0.33)
boxplot(unrat17yr1, herat17yr1,main="Net Working Capital Ratio (year 1)- Unhealthy vs Healthy")



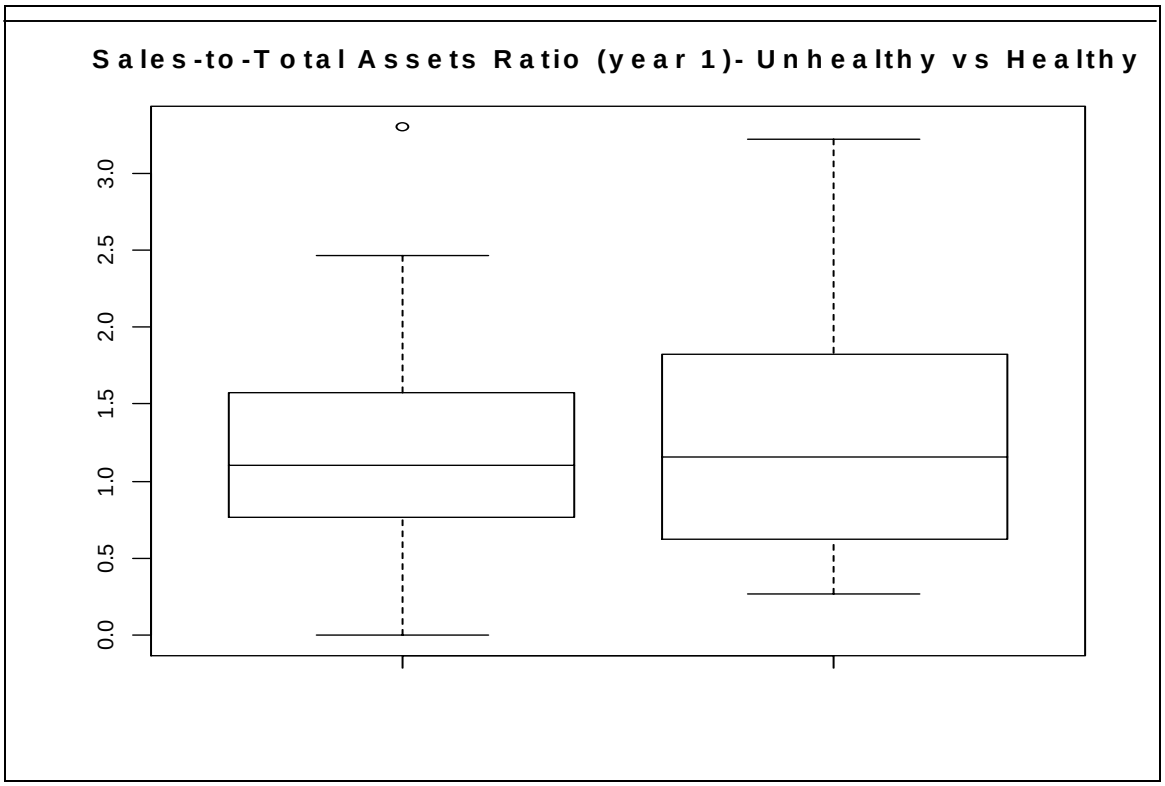
```
## Retained Earnings to Total Assets Ratio
unrat18yr1 <- c(-0.26, -0.14, -0.13, -0.11, 0.44, 0.28, 0.02, -0.05, 0.17, -3.41, 0.29, -0.36,
0.32, 0.19, 0.47, 0.44, 0.18, -13.14, 0.23, 0.21, 0.21, -1.02, 0.20, -0.15, -2.74, 0.03, -5.05,
-1.14, -0.13, -3.81, -0.17, 0.16, -0.37)
herat18yr1 <- c(0.06, 0.23, 0.16, 0.14, 0.07, 0.21, 0.22, 0.41, -0.32, 0.59, -0.02, 0.40, -
0.82, 0.24, 0.17, 0.03, 0.05, 0.86, 0.88, 0.14, 0.19, 0.17, -0.67, 0, 0.13, NA, -0.03, 0.09,
0.21, 0.28, 0.31, 0.28, 0.01, -0.24)
boxplot(unrat18yr1, herat18yr1,main="Retained Earnings-to-Total Assets Ratio (year 1)-
Unhealthy vs Healthy")
```



Net Income plus Tax Ratio
unrat19yr1 <- c(-0.03, 0.31, 2.39, -0.03, 0, 0.24, 0, -0.10, 0.14, -0.17, 0.16, 0.32, 0.16, 0.36, 0.35, 0.03, 0.33, 0.33, 0.25, 0.26, 0.27, 0.39, 0.31, 0.15, 0, 0.14, 0.09, 0.05, 0.03, 0.01, 0.15, 0.17, 0.09)
herat19yr1 <- c(0.17, 0.14, 0.15, 0.10, 0.09, 0.14, 0.10, 0.40, 0.14, 0.19, 0.21, 0.29, 0.10, 0.05, 0.17, 0.17, 0.13, 0.24, 0.12, 0.14, 0.28, 0.11, 0.39, 0.42, 0.57, 0.81, 0.13, 0.20, 0.26, 0.22, 0.12, 0.03, 0.15, 0.18)
boxplot(unrat19yr1, herat19yr1,main="Net Income plus Tax Ratio (year 1)- Unhealthy vs Healthy")

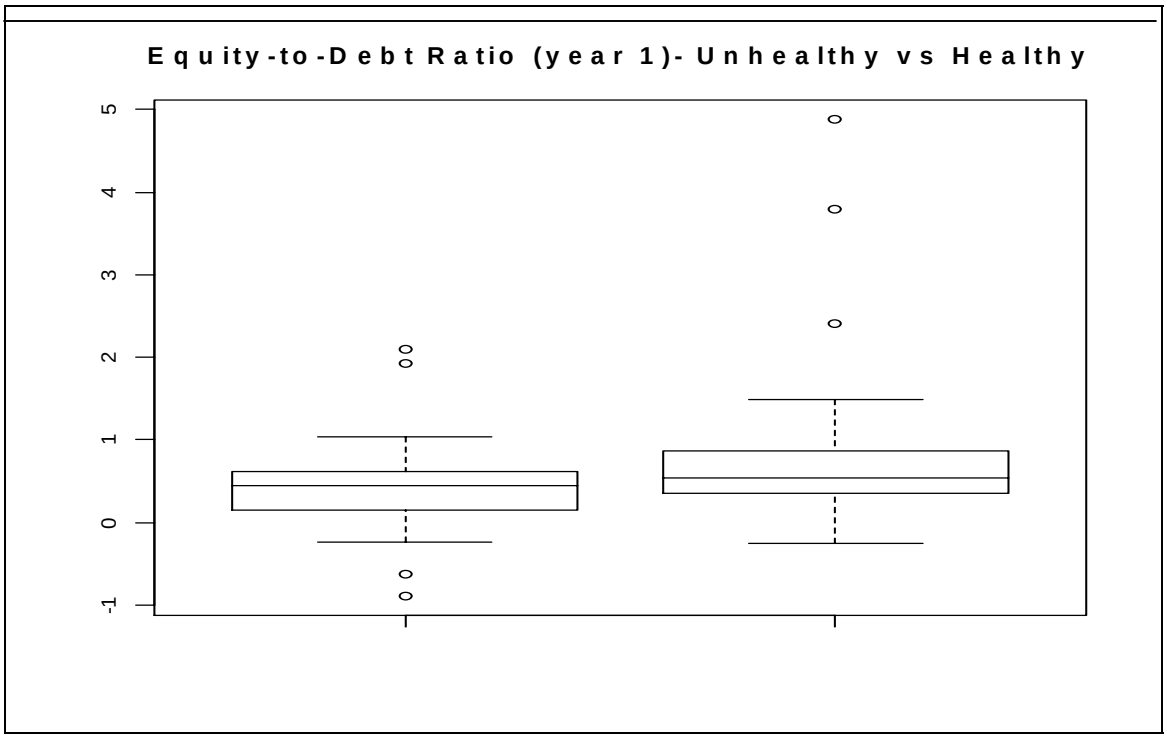


```
## Sales-to-Total Assets Ratio
unrat20yr1 <- c(1.17, 1.46, 2.34, 0.86, 1.50, 0.76, 0.85, 1.54, 1.80, 0.78, 1.95, 1.08, 1.97,
1.39, 0.91, 1.46, 0.65, 2.07, 2.46, 3.30, 1.85, 0.39, 1.57, 0.70, 0, 0.99, 0.34, 0.69, 0.23,
0.01, 1.10, 0.92, 1.19)
herat20yr1 <- c(0.62, 1.00, 0.33, 0.62, 0.40, 2.55, 0.79, 2.76, 1.52, 0.86, 1.37, 1.79, 1.87,
0.97, 0.70, 2.81, 2.43, 1.82, 2.25, 1.66, 1.24, 0.47, 2.96, 1.30, 1.47, 3.22, 0.46, 0.39, 1.20,
1.12, 1.12, 0.27, 0.44, 1.12)
boxplot(unrat20yr1, herat20yr1,main="Sales-to-Total Assets Ratio (year 1)- Unhealthy
vs Healthy")
```



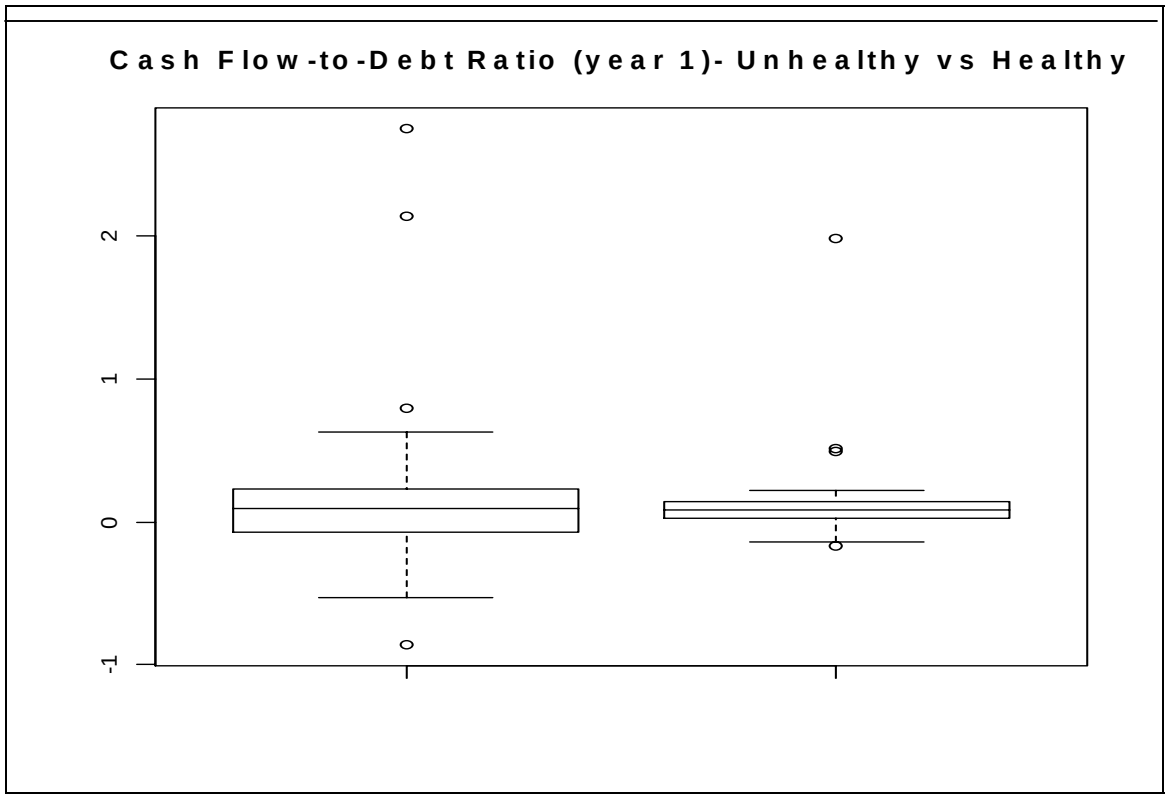
Equity-to-Debt Ratio

```
unrat21yr1 <- c(-0.24, 0.54, 0.21, NA, 0.62, 0.56, NA, 0.01, 0.61, -0.63, 0.73, 0.10, 0.60, 2.10, 0.99, 1.04, 0.33, -0.89, 0.51, 0.49, 0.34, 0.21, 0.49, NA, 0.07, 0.75, 0.42, 0.48, 0.28, 1.92, 0.15, 0.36, -0.11)
herat21yr1 <- c(0.04, 0.41, 0.54, 0.64, 0.33, 0.46, 0.30, 1.02, -0.26, 2.41, 4.88, 0.86, -0.23, 0.38, 0.75, 0.27, 0.27, 1.47, 3.79, 1.49, 1.10, 0.47, 0.62, 0.71, 0.55, 0.41, 0.09, 0.35, 0.71, 0.47, 0.75, 0.93, 0.52, 0.83)
boxplot(unrat21yr1, herat21yr1,main="Equity-to-Debt Ratio (year 1)- Unhealthy vs Healthy")
```

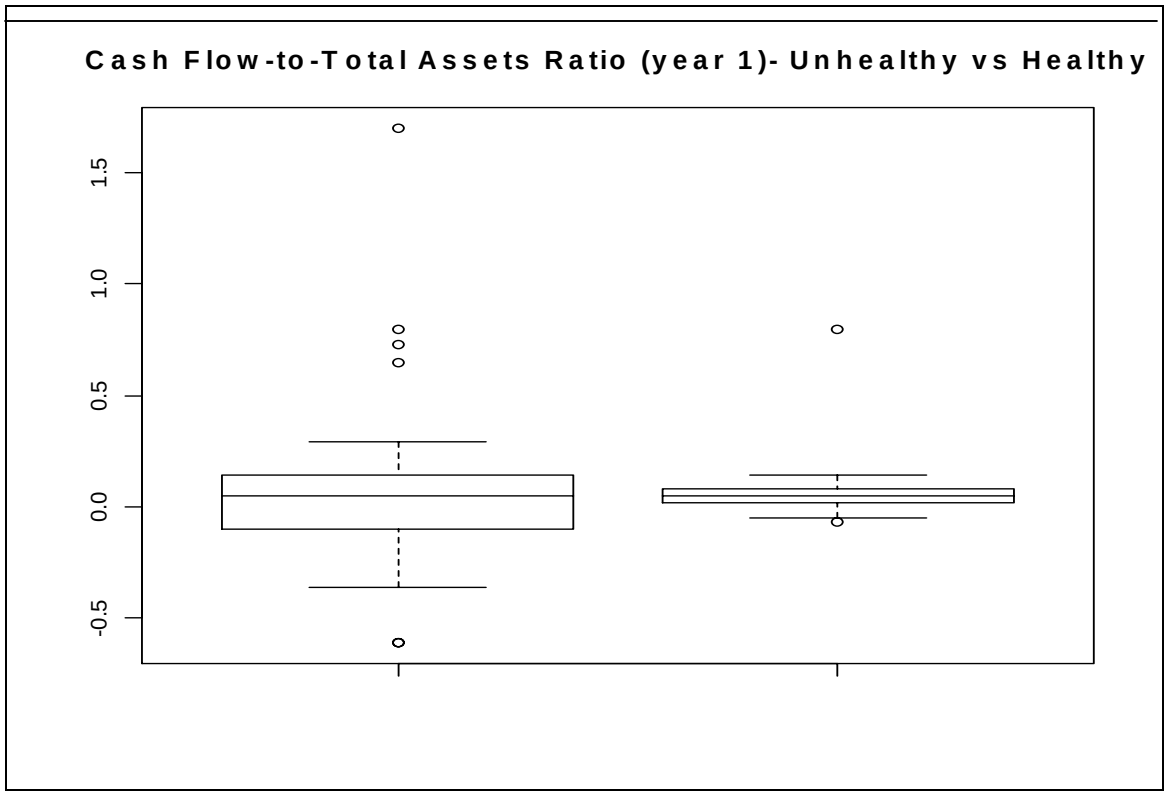


Cash Flow-to-Debt Ratio

```
unrat22yr1 <- c(-0.41, -0.28, 0.03, NA, 0.51, 0.34, 2.75, -0.32, 0.10, 0.63, 0.09, 0.01,
0.09, 0.22, 0.34, 0.18, 0.24, -0.06, 0.09, 0.09, 0.09, 0.79, 0.21, 0.01, -0.02, 0.08, -0.86, -
0.53, -0.13, 2.14, -0.09, 0.14, -0.21)
herat22yr1 <- c(-0.01, 0.02, 0.11, 0.09, 0.02, 0.10, 0.07, 0.20, -0.04, -0.17, 0.49, 0.22, -
0.03, -0.05, 0.19, 0.06, 0.11, 1.98, 0.51, 0.15, -0.14, 0.11, -0.03, 0.04, 0.08, NA, 0.07,
0.13, 0.16, 0.06, 0.14, 0.06, 0.09, 0.03)
boxplot(unrat22yr1, herat22yr1,main="Cash Flow-to-Debt Ratio (year 1)- Unhealthy vs
Healthy")
```

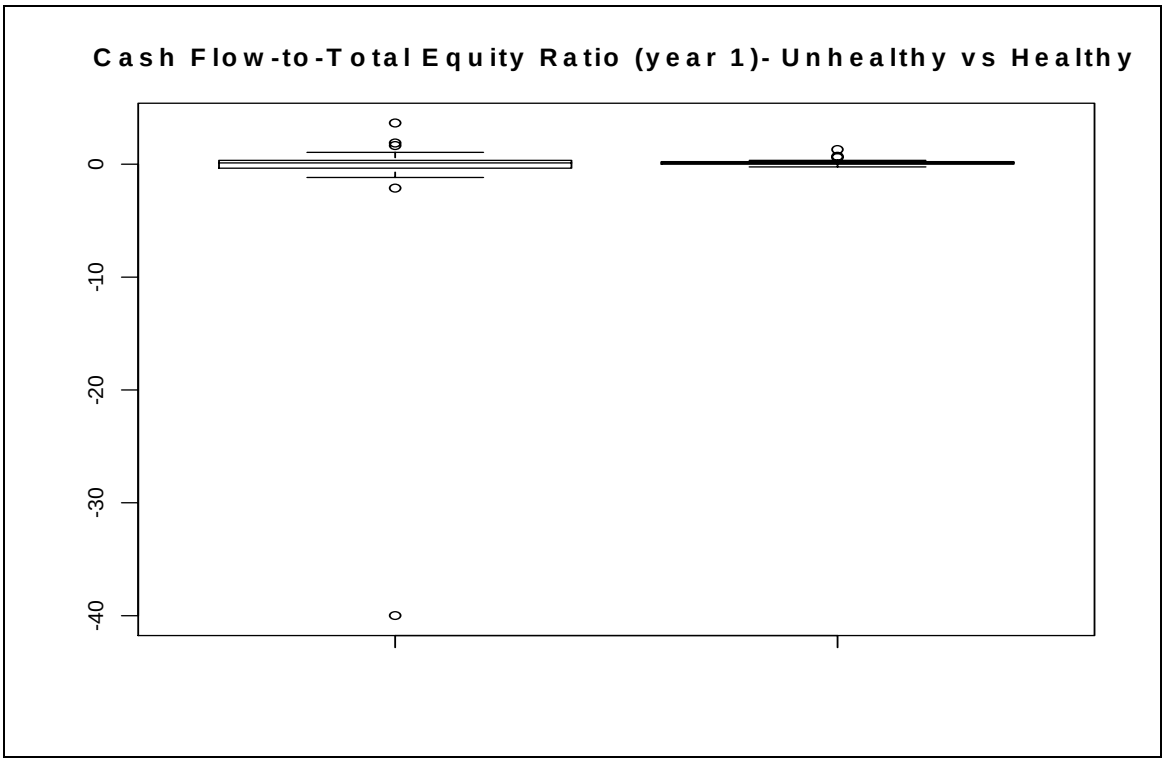


```
## Cash Flow-to-Total Assets Ratio
unrat23yr1 <- c(-0.31, -0.18, 0.02, -0.12, 0.29, 0.22, 0.80, -0.32, 0.06, 1.70, 0.05, 0.01,
0.05, 0.07, 0.17, 0.09, 0.18, -0.61, 0.06, 0.06, 0.07, 0.65, 0.14, 0.01, -0.02, 0.05, -0.61, -
0.36, -0.10, 0.73, -0.08, 0.06, -0.23)
herat23yr1 <- c(-0.01, 0.02, 0.07, 0.05, 0.01, 0.07, 0.06, 0.10, -0.05, -0.05, 0.08, 0.12, -
0.04, -0.04, 0.11, 0.05, 0.08, 0.80, 0.14, 0.03, -0.07, 0.07, -0.02, 0.02, 0.05, NA, 0.06,
0.09, 0.09, 0.04, 0.08, 0.03, 0.06, 0.02)
boxplot(unrat23yr1, herat23yr1,main="Cash Flow-to-Total Assets Ratio (year 1)-
Unhealthy vs Healthy")
```

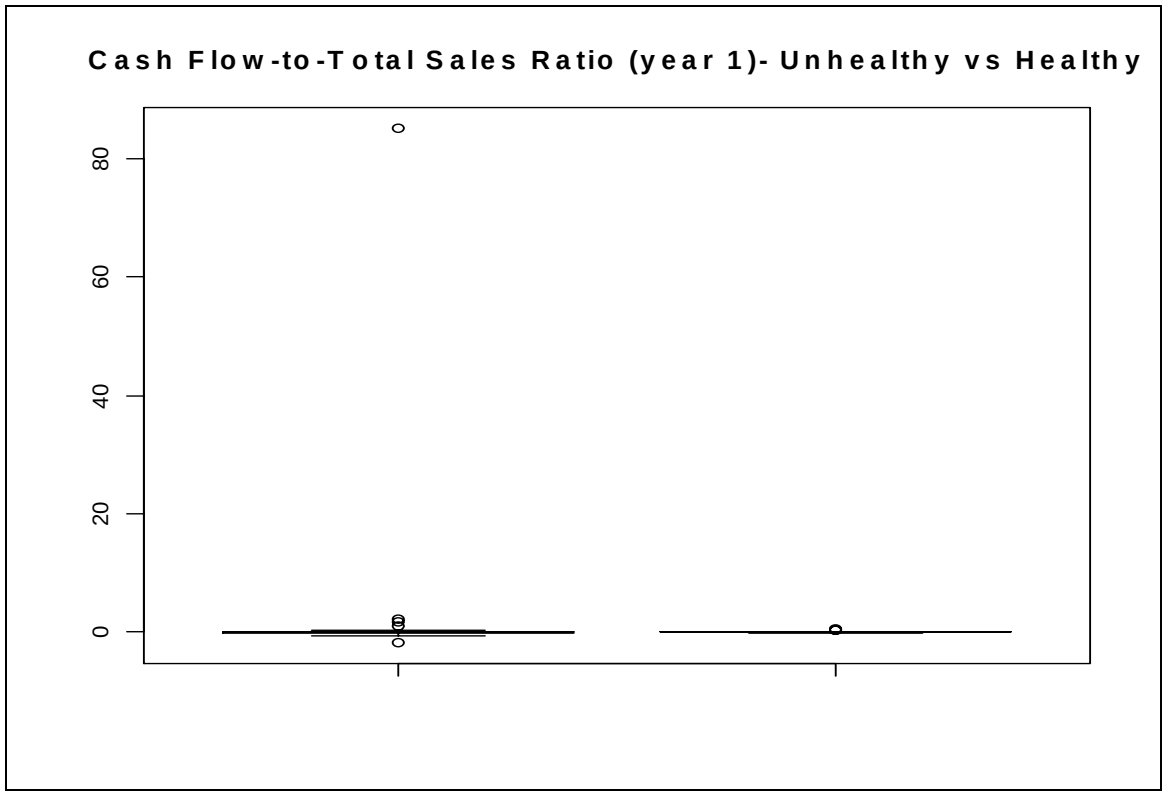


Cash Flow-to-Total Equity

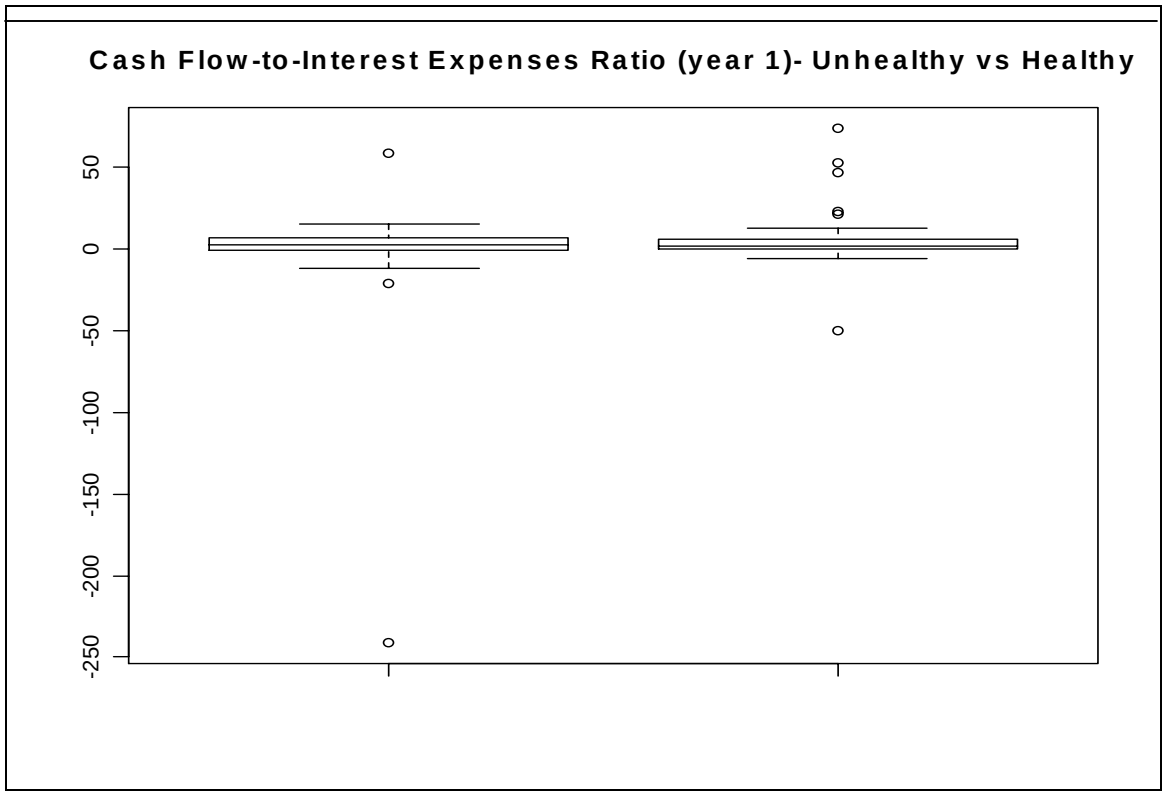
```
unrat24yr1 <- c(1.75, -0.52, 0.14, -0.47, 0.82, 0.61, NA, -39.94, 0.16, -1.00, 0.12, 0.08,
0.14, 0.10, 0.34, 0.17, 0.74, 0.07, 0.17, 0.19, 0.27, 3.68, 0.43, NA, -0.25, 0.11, -2.04, -
1.10, -0.47, 1.11, -0.59, 0.38, 1.94)
herat24yr1 <- c(-0.17, 0.06, 0.21, 0.14, 0.05, 0.22, 0.25, 0.19, 0.14, -0.07, 0.10, 0.25,
0.14, -0.14, 0.25, 0.24, 0.39, 1.35, 0.61, 0.10, -0.13, 0.22, -0.04, 0.05, 0.14, NA, 0.73,
0.37, 0.22, 0.12, 0.19, 0.07, 0.18, 0.04)
boxplot(unrat24yr1, herat24yr1,main="Cash Flow-to-Total Equity Ratio (year 1)-
Unhealthy vs Healthy")
```



```
## Cash Flow-to-Total Sales
unrat25yr1 <- c(-0.26, -0.13, 0.01, -0.14, 0.19, 0.29, 0.94, -0.21, 0.03, 2.19, 0.03, 0.01,
0.03, 0.05, 0.19, 0.06, 0.28, -0.29, 0.02, 0.02, 0.04, 1.65, 0.09, 0.01, NA, 0.05, -1.76, -
0.52, -0.45, 85.16, -0.07, 0.07, -0.19)
herat25yr1 <- c(-0.01, 0.02, 0.22, 0.09, 0.03, 0.03, 0.07, 0.04, -0.03, -0.06, 0.06, 0.06, -
0.02, -0.04, 0.15, 0.02, 0.03, 0.44, 0.06, 0.02, -0.06, 0.15, -0.01, 0.02, 0.03, NA, 0.13,
0.24, 0.08, 0.04, 0.07, 0.12, 0.14, 0.02)
boxplot(unrat25yr1, herat25yr1,main="Cash Flow-to-Total Sales Ratio (year 1)-
Unhealthy vs Healthy")
```



Cash Flow-to-Interest Expenses
unrat26yr1 <- c(-21.12, -7.92, 0.98, -2.99, 58.94, 5.68, NA, -11.64, 5.35, 6.38, 2.63, 0.16, 1.15, 5.57, 7.12, 10.92, 8.10, -0.66, 2.42, 2.54, 13.00, 15.33, 14.55, 0.20, NA, 2.65, -241.00, -5.59, -0.98, NA, -0.81, 12.49, -3.75)
herat26yr1 <- c(0.31, 0.40, 2.95, 3.16, 0.48, 23.46, 5.60, -50.25, -1.57, 21.18, 74.07, 12.42, 2.67, 4.36, 6.89, -5.72, 47.26, 1.83, 4.93, -2.04, -4.71, 3.17, -1.81, 1.47, 1.29, NA, 1.37, 13.00, 53.32, -2.18, NA, NA, 1.90, 0.71)
boxplot(unrat26yr1, herat26yr1,main="Cash Flow-to-Interest Expenses Ratio (year 1)- Unhealthy vs Healthy")



Because there are considerable differences among the data, data from each one of the financial ratios was standardized as mentioned in chapter 5. The new vectors are:

Boxplots Ratios Standarized
First I am going to introduce the vectors and then plot the boxplots using 6 plots per sheet.
unrat1yr1s <- c(-0.44, -0.67, -0.48, -0.66, NA, -0.46, -0.06, -0.53, 0.04, -1.01, -0.27, -0.17, -0.34, 0.45, 0.66, 0.27, -0.16, -1.04, -0.52, -0.18, 0.10, -1.03, -0.10, -0.71, -0.46, -0.12, -0.44, -0.98, -0.84, 6.00, -0.47, NA, 0.58)
herat1yr1s <- c(-0.27, 0.31, -0.26, 0.56, -0.33, -0.43, 2.08, 0.27, -0.35, 0.63, 1.96, 0.26, -0.25, 0.17, 0.27, -0.12, 0.04, NA, -0.18, -0.23, NA, -0.46, 0.50, 0.20, 0.50, -0.01, -0.44, -0.66, -0.64, -0.13, -0.93, 0.88, -0.55, 1.69)

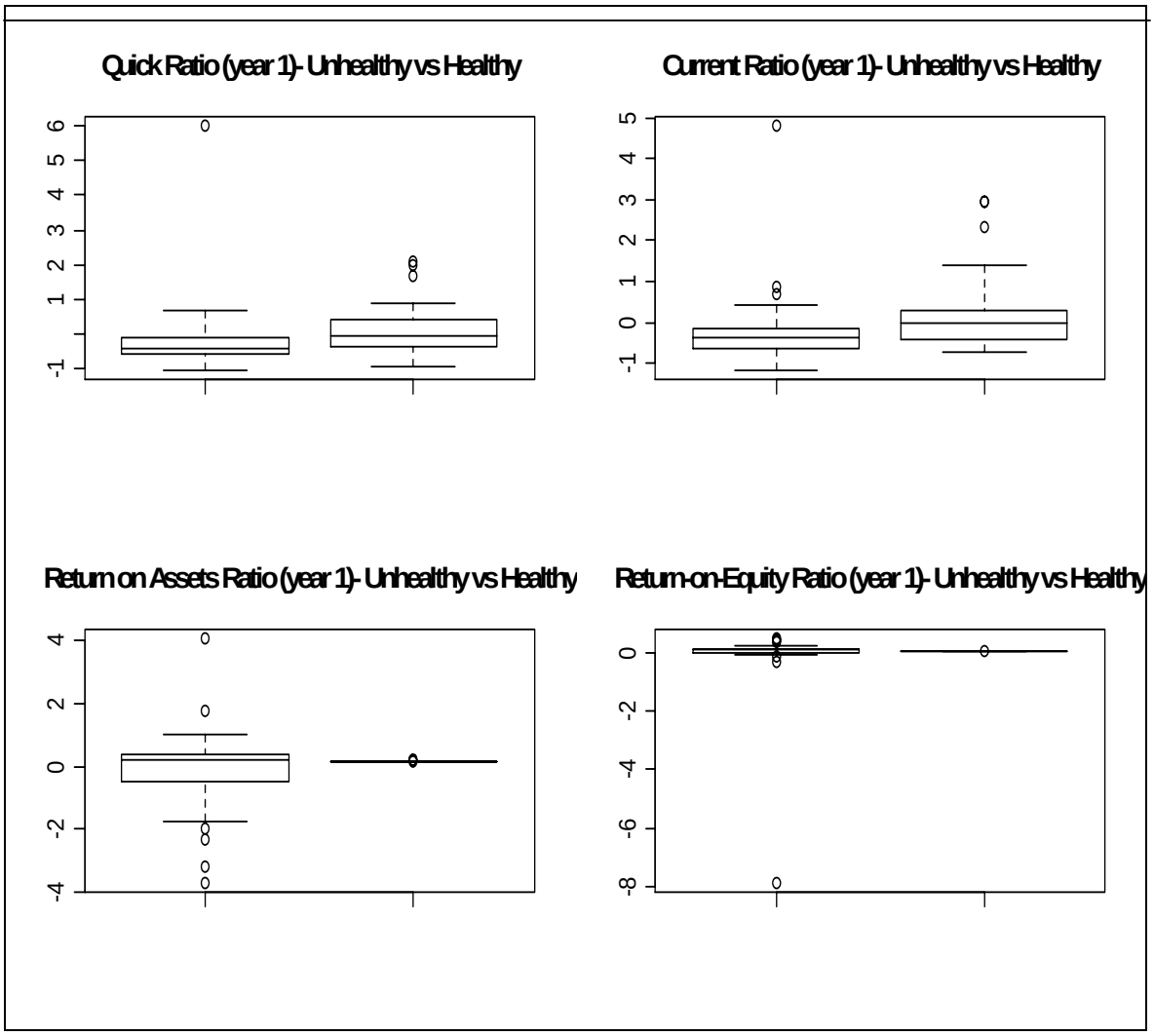
```
unrat2yr1s <- c(-0.61, -0.85, -0.45, -0.73, -0.59, -0.36, -0.10, -0.47, 0.01, -1.11, -0.15,
0.18, -0.17, 0.88, 0.70, -0.02, -0.35, -1.16, -0.19, -0.32, -0.16, -1.15, -0.35, -0.68, -0.67, -
0.17, -0.60, -0.54, -0.97, 4.80, -0.57, NA, 0.44)
herat2yr1s <- c(-0.41, -0.01, -0.32, 0.31, -0.45, -0.32, 2.97, -0.05, -0.57, 0.46, 1.38, 0.01,
-0.49, 0.03, 0.21, -0.35, -0.25, 0.34, -0.33, -0.41, 0.15, -0.55, 0.15, 0.04, 0.18, -0.28, -
0.54, -0.70, 2.34, -0.18, 0.55, 2.97, -0.65, 1.24)
unrat3yr1s <- c(-1.58, -0.82, -0.32, -0.50, 0.17, 0.19, 0.30, -1.78, 0.24, -2.32, 0.35, 0.24,
0.23, 0.38, 0.52, 0.24, 1.02, -3.72, 0.56, 0.30, 0.33, 1.74, 0.67, 0.14, 0.09, 0.36, -3.19, -
2.01, -0.45, 4.07, -0.40, 0.39, -1.29)
herat3yr1s <- c(0.17, 0.17, 0.19, 0.17, 0.17, 0.17, 0.17, 0.17, 0.17, 0.16, 0.17, 0.17, 0.17,
0.17, 0.17, 0.17, 0.17, 0.18, 0.17, 0.17, 0.17, 0.17, 0.17, 0.17, 0.17, 0.17, 0.17, 0.17, 0.17,
0.17, 0.17, 0.17, 0.17, 0.17)
unrat4yr1s <- c(0.45, 0.02, 0.00, 0.03, 0.12, 0.12, NA, -7.90, 0.12, 0.16, 0.13, 0.14, 0.12,
0.13, 0.14, 0.12, 0.23, 0.13, 0.15, 0.13, 0.14, 0.41, 0.17, NA, 0.07, 0.13, -0.26, -0.11,
0.02, 0.31, -0.03, 0.16, 0.52)
herat4yr1s <- c(0.11, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12,
0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12,
0.12, 0.12, 0.12, 0.12, 0.12)
unrat5yr1s <- c(-0.12, -0.12, -0.12, -0.12, -0.12, -0.12, -0.12, -0.14, -0.12, -0.18, -0.12, -
0.12, -0.12, -0.12, -0.11, -0.12, -0.10, -0.15, -0.12, -0.12, -0.12, -0.05, -0.11, -0.12, NA, -
0.12, -0.29, -0.18, -0.17, 8.00, -0.13, -0.11, -0.14)
herat5yr1s <- c(-0.12, -0.12, -0.12, -0.12, -0.12, -0.12, -0.12, -0.12, -0.12, -0.12, -0.12, -
0.12, -0.12, -0.12, -0.12, -0.12, -0.12, -0.12, -0.12, -0.12, -0.12, -0.12, -0.12, -0.12, -0.12,
-0.12, -0.12, -0.12, -0.12, -0.12, -0.12, -0.12, -0.12, -0.12)
unrat6yr1s <- c(-1.04, -0.88, 3.80, -1.08, -0.91, 0.52, -0.40, -1.22, -0.57, -1.94, -0.53,
0.44, -0.53, 0.27, 0.85, -0.81, 1.42, -0.18, -0.45, -0.55, -0.25, 3.64, -0.01, 0.09, NA, -0.26,
0.26, -0.61, -0.21, 3.48, -0.29, -0.05, -0.58)
herat6yr1s <- c(0.37, -0.27, 1.12, -0.15, 0.13, -0.66, -0.35, -0.25, -0.48, 0.09, -0.22, -0.16,
-0.66, -0.68, 0.22, -0.64, -0.67, -0.30, -0.67, -0.53, 0.14, 0.20, -0.31, 0.56, 0.87, 0.25,
0.40, 1.48, 0.10, -0.03, -0.43, -0.35, 0.61, -0.18)
unrat7yr1s <- c(-0.20, 0.14, 0.27, -0.05, NA, 0.12, 0.13, -7.88, 0.13, 0.19, 0.14, 0.13,
0.13, 0.13, 0.14, 0.13, 0.18, 0.15, NA, 0.14, 0.15, 0.34, 0.17, 0.12, 0.06, 0.13, -0.40, -
0.09, 0.02, 0.40, -0.06, 0.17, 0.72)
herat7yr1s <- c(0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.13, 0.12,
0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12, 0.12,
0.12, 0.12, 0.12, 0.12, 0.12)
unrat8yr1s <- c(-0.26, -0.15, -0.13, -0.17, -0.10, -0.12, -0.10, -0.20, -0.11, -0.31, -0.11, -
0.11, -0.11, -0.10, -0.07, -0.11, 0.01, -0.23, -0.10, -0.11, -0.10, 0.37, -0.08, -0.12, NA, -
0.10, -0.69, -0.30, -0.28, 7.95, -0.14, -0.10, -0.19)
herat8yr1s <- c(-0.11, -0.13, -0.07, -0.09, -0.14, -0.11, -0.09, -0.10, -0.13, -0.15, -0.11, -
0.10, -0.13, -0.12, -0.08, -0.12, -0.11, -0.09, -0.10, -0.11, -0.09, -0.09, -0.12, -0.12, -0.11,
-0.11, -0.10, -0.08, -0.08, -0.11, -0.08, -0.08, -0.09, -0.13)
unrat9yr1s <- c(-0.28, -0.28, -0.28, NA, -0.28, -0.28, -0.09, 0.31, -0.10, 1.51, -0.10, 0.74,
0.20, -0.09, -0.03, -0.15, 0.32, 7.60, 0.02, -0.11, -0.23, 0.38, -0.04, 0.63, -0.04, 0.04, -
0.20, 0.26, 0.51, -0.29, 0.13, -0.22, -0.17)
```

herat9yr1s <- c(-0.27, -0.28, -0.28, -0.28, -0.28, -0.28, -0.28, -0.28, -0.27, -0.28, -0.28, -0.28, -0.27, -0.28, -0.28, -0.28, -0.28, -0.28, -0.28, -0.28, -0.28, -0.28, -0.28, -0.28, -0.28, -0.27, -0.28, -0.28, -0.28, -0.28, -0.28, -0.28, -0.28)
unrat10yr1s <- c(-0.19, -0.07, -0.12, -0.09, -0.07, 7.69, NA, -0.15, -0.07, -0.52, -0.06, -0.13, -0.07, 0.00, -0.04, -0.04, -0.09, -2.00, -0.08, -0.08, -0.09, -0.11, -0.08, NA, -0.14, -0.06, -0.08, -0.08, -0.10, -0.01, -0.12, -0.11, -0.18)
herat10yr1s <- c(-0.14, -0.09, -0.07, -0.06, -0.09, -0.08, -0.10, -0.04, -0.23, 0.01, 0.03, -0.05, -0.21, -0.09, -0.06, -0.10, -0.10, -0.02, -0.10, -0.08, -0.04, -0.08, -0.07, -0.06, -0.07, -0.09, -0.13, -0.09, -0.06, -0.08, -0.06, -0.04, -0.08, -0.05)
unrat11yr1s <- c(-0.30, -0.28, -0.28, -0.27, -0.27, 0.38, -0.28, 0.19, -0.04, -0.30, 0.02, 7.11, 0.62, -0.13, 0.09, -0.10, 1.42, -0.46, 0.33, 0.04, -0.11, -0.86, 0.17, 2.88, -0.28, 0.31, -0.24, 0.28, -0.07, -0.28, -0.18, -0.05, -0.29)
herat11yr1s <- c(0.02, -0.26, -0.26, -0.27, -0.25, -0.26, -0.25, -0.27, -0.33, -0.28, -0.28, -0.27, -0.33, -0.26, -0.27, -0.24, -0.24, -0.28, -0.28, -0.28, -0.27, -0.26, -0.27, -0.27, -0.26, -0.26, -0.16, -0.25, -0.27, -0.26, -0.27, -0.27, -0.26, -0.27)
unrat12yr1s <- c(-0.31, 0.02, 2.10, -0.28, NA, -0.14, NA, -0.35, -0.22, -0.28, -0.09, -0.13, -0.19, 0.34, 0.04, -0.18, 0.05, -0.26, -0.04, -0.04, 0.81, -0.07, 0.40, -0.20, NA, -0.10, 0.48, -0.25, -0.26, NA, -0.23, 0.44, -0.24)
herat12yr1s <- c(-0.46, -0.19, -0.14, -0.14, -0.19, 0.76, -0.07, -4.60, -0.17, -1.97, 3.68, 0.40, -0.41, -0.38, -0.03, -0.66, 1.30, -0.26, -0.18, -0.45, 0.15, -0.16, 0.69, 0.32, 0.05, NA, -0.20, 0.33, 2.98, -0.52, NA, NA, -0.17, -0.11)
unrat13yr1s <- c(-0.08, 0.35, -0.10, -0.13, 0.47, 0.00, NA, -0.41, 0.06, -0.07, 0.05, -0.01, -0.01, 0.13, 0.14, 0.03, 0.30, -0.05, 0.11, 0.02, 0.53, 0.37, 0.50, -0.03, NA, 0.07, -6.88, -0.20, -0.05, NA, -0.05, 0.29, -0.14)
herat13yr1s <- c(-0.04, -0.05, 0.03, 0.07, -0.06, 0.70, 0.16, -1.68, -0.06, 1.13, 0.99, 0.22, 0.09, 0.03, 0.12, -0.04, 0.82, -0.02, 0.07, -0.05, 0.20, 0.03, -0.02, -0.08, 0.01, NA, 0.00, 0.15, 2.16, -0.05, NA, NA, 0.00, -0.06)
unrat14yr1s <- c(7.00, NA, -0.15, -0.15, -0.15, -0.14, -0.13, -0.15, -0.15, -0.15, -0.15, -0.15, -0.14, -0.15, -0.14, -0.07, -0.14, -0.14, -0.15, -0.12, -0.13, NA, NA, -0.15, NA, -0.15, -0.15, -0.15, -0.14, NA, -0.15, -0.13, -0.15)
herat14yr1s <- c(-0.15, NA, -0.15, -0.14, -0.15, -0.15, -0.15, NA, 0.02, -0.15, NA, -0.14, NA, -0.15, -0.15, -0.11, NA, NA, -0.14, -0.14, NA, -0.15, NA, -0.15, NA, NA, -0.15, NA, -0.15, -0.15, -0.15, -0.15, -0.15, -0.13)
unrat15yr1s <- c(2.33, NA, -5.80, 0.88, -0.14, -0.25, -0.29, -0.35, -0.14, -0.48, 0.03, -0.28, 0.51, -0.15, 0.03, -0.08, 2.21, 0.03, 0.66, 0.28, -0.27, -0.42, -0.10, -0.21, -0.72, 0.36, -0.57, 0.50, -0.56, -0.65, -0.47, -0.48, -0.36)
herat15yr1s <- c(-0.39, 0.03, 0.39, 0.56, 0.28, 1.05, -0.51, 0.04, 0.16, -0.20, -0.18, 0.01, 0.21, -0.23, 0.12, 0.03, -0.18, 0.31, 0.10, 0.25, -0.55, 0.02, -0.19, -0.37, -0.26, 0.01, 0.49, 0.52, NA, 0.17, NA, 3.23, 0.17, -0.14)
unrat16yr1s <- c(-0.01, 0.35, 1.43, -0.39, 0.40, -0.52, -0.42, 0.35, 0.69, -0.81, 1.01, -0.28, 0.91, 0.15, -0.36, 0.37, -0.10, -0.49, 1.63, 2.99, 1.27, -1.02, 0.95, -0.60, -1.46, -0.23, -1.00, -0.73, -1.15, -1.44, -0.17, -0.28, -0.12)
herat16yr1s <- c(0.53, -0.22, 2.23, 0.53, 1.62, -0.97, 0.11, -1.01, -0.64, -0.02, -0.55, -0.76, -0.80, -0.18, 0.32, -1.01, -0.95, -0.78, -0.91, -0.72, -0.46, 1.15, -1.04, -0.51, -0.62, -1.07, 1.25, 1.69, -0.43, -0.36, -0.36, 3.04, 1.36, -0.36)

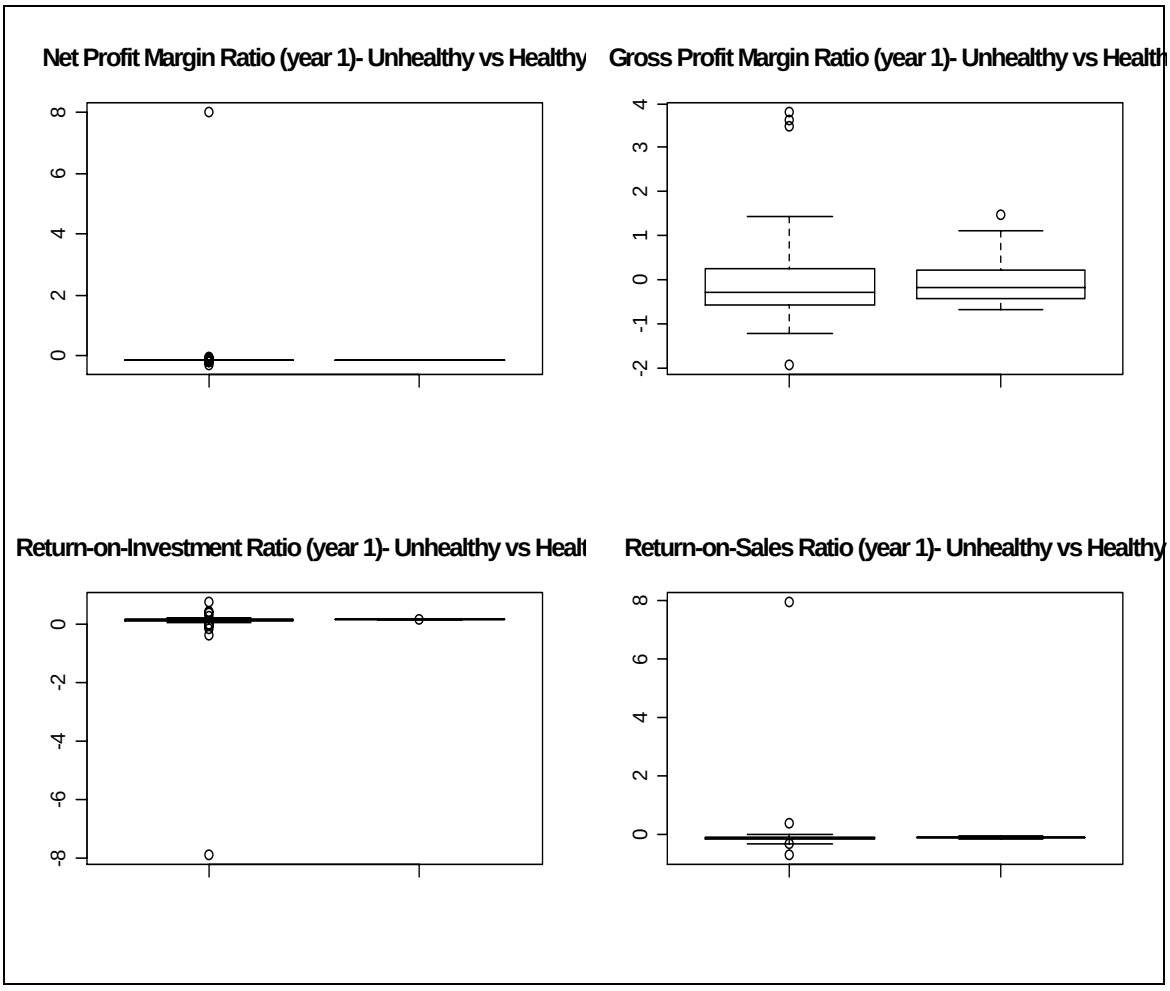
unrat17yr1s <- c(-0.12, -0.25, 0.03, -0.12, 0.48, 0.06, 0.03, 0.02, 0.35, -2.07, 0.19, 0.27, 0.13, 0.44, 0.25, 0.20, 0.05, -7.45, 0.19, 0.14, 0.28, -0.45, 0.10, -0.16, -0.23, 0.12, -0.10, -0.03, -0.45, 0.83, -0.11, NA, 0.28)
herat17yr1s <- c(0.07, 0.12, 0.04, 0.12, 0.02, 0.13, 0.70, 0.22, -0.06, 0.26, 0.45, 0.23, 0.00, 0.19, 0.11, 0.11, 0.23, 0.42, 0.11, 0.06, 0.29, 0.00, 0.38, 0.29, 0.22, 0.18, 0.01, -0.03, 0.62, 0.11, 0.44, 0.74, -0.01, 0.34)
unrat18yr1s <- c(0.05, 0.12, 0.12, 0.13, 0.43, 0.34, 0.20, 0.17, 0.28, -1.62, 0.35, 0.00, 0.36, 0.29, 0.44, 0.43, 0.29, -6.77, 0.31, 0.30, 0.30, -0.35, 0.30, 0.11, -1.26, 0.21, -2.49, -0.41, 0.12, -1.83, 0.10, 0.28, 0.00)
herat18yr1s <- c(0.22, 0.31, 0.28, 0.27, 0.23, 0.30, 0.31, 0.41, 0.02, 0.50, 0.18, 0.40, -0.24, 0.32, 0.28, 0.21, 0.22, 0.65, 0.66, 0.27, 0.29, 0.28, -0.16, 0.19, 0.26, NA, 0.18, 0.24, 0.30, 0.34, 0.36, 0.34, 0.20, 0.06)
unrat19yr1s <- c(-0.78, 0.31, 7.01, -0.78, -0.69, 0.09, -0.69, -1.01, -0.23, -1.23, -0.17, 0.35, -0.17, 0.47, 0.44, -0.59, 0.38, 0.38, 0.12, 0.15, 0.18, 0.57, 0.31, -0.20, -0.69, -0.23, -0.40, -0.52, -0.59, -0.65, -0.20, -0.14, -0.40)
herat19yr1s <- c(-0.14, -0.23, -0.20, -0.36, -0.40, -0.23, -0.36, 0.60, -0.23, -0.07, -0.01, 0.25, -0.36, -0.52, -0.14, -0.14, -0.27, 0.09, -0.30, -0.23, 0.22, -0.33, 0.57, 0.67, 1.15, 1.92, -0.27, -0.04, 0.15, 0.02, -0.30, -0.59, -0.20, -0.11)
unrat20yr1s <- c(-0.15, 0.22, 1.34, -0.54, 0.27, -0.67, -0.55, 0.32, 0.65, -0.64, 0.84, -0.26, 0.87, 0.13, -0.48, 0.22, -0.81, 0.99, 1.49, 2.56, 0.72, -1.14, 0.36, -0.74, -1.63, -0.38, -1.20, -0.76, -1.34, -1.62, -0.24, -0.46, -0.12)
herat20yr1s <- c(-0.85, -0.36, -1.21, -0.85, -1.12, 1.60, -0.63, 1.87, 0.30, -0.54, 0.11, 0.64, 0.74, -0.40, -0.74, 1.93, 1.45, 0.68, 1.22, 0.47, -0.06, -1.04, 2.12, 0.02, 0.23, 2.45, -1.05, -1.14, -0.11, -0.21, -0.21, -1.29, -1.07, -0.21)
unrat21yr1s <- c(-1.02, -0.12, -0.50, NA, -0.03, -0.10, NA, -0.73, -0.04, -1.47, 0.10, -0.63, -0.05, 1.67, 0.40, 0.45, -0.36, -1.77, -0.16, -0.18, -0.35, -0.50, -0.18, NA, -0.66, 0.12 ,-0.26, -0.19, -0.42, 1.46, -0.57, -0.33, -0.87)
herat21yr1s <- c(-0.70, -0.27, -0.12, -0.01, -0.36, -0.21, -0.40, 0.43, -1.04, 2.03, 4.87, 0.25, -1.01, -0.31, 0.12, -0.43, -0.43, 0.95, 3.62, 0.97, 0.52, -0.20, -0.03, 0.07, -0.11, -0.27, -0.64, -0.34, 0.07, -0.20, 0.12, 0.33, -0.15, 0.21)
unrat22yr1s <- c(-1.09, -0.84, -0.26, NA, 0.64, 0.32, 4.83, -0.92, -0.13, 0.86, -0.15, -0.30, -0.15, 0.09, 0.32, 0.02, 0.13, -0.43, -0.15, -0.15, -0.15, 1.16, 0.07, -0.30, -0.36, -0.17, -1.93, -1.31, -0.56, 3.69, -0.49, -0.06, -0.71)
herat22yr1s <- c(-0.34, -0.28, -0.11, -0.15, -0.28, -0.13, -0.19, 0.06, -0.39, -0.64, 0.60, 0.09, -0.38, -0.41, 0.04, -0.21, -0.11, 3.39, 0.64, -0.04, -0.58, -0.11, -0.38, -0.24, -0.17, NA, -0.19, -0.08, -0.02, -0.21, -0.06, -0.21, -0.15, -0.26)
unrat23yr1s <- c(-1.22, -0.80, -0.16, -0.61, 0.70, 0.47, 2.33, -1.25, -0.04, 5.20, -0.07, -0.20, -0.07, 0.00, 0.31, 0.06, 0.35, -2.18, -0.04, -0.04, 0.00, 1.85, 0.22, -0.20, -0.29, -0.07, -2.18, -1.38, -0.55, 2.10, -0.48, -0.04, -0.96)
herat23yr1s <- c(-0.26, -0.16, 0.00, -0.07, -0.20, 0.00, -0.04, 0.09, -0.39, -0.39, 0.03, 0.15, -0.36, -0.36, 0.12, -0.07, 0.03, 2.33, 0.22, -0.13, -0.45, 0.00, -0.29, -0.16, -0.07, NA, -0.04, 0.06, 0.06, -0.10, 0.03, -0.13, -0.04, -0.16)
unrat24yr1s <- c(0.43, -0.02, 0.11, -0.01, 0.24, 0.20, NA, -7.80, 0.11, -0.12, 0.10, 0.10, 0.11, 0.10, 0.15, 0.11, 0.23, 0.10, 0.11, 0.12, 0.13, 0.81, 0.17, NA, 0.03, 0.10, -0.32, -0.14, -0.01, 0.30, -0.04, 0.16, 0.46)

herat24yr1s <- c(0.05, 0.09, 0.12, 0.11, 0.09, 0.12, 0.13, 0.12, 0.11, 0.07, 0.10, 0.13, 0.11, 0.05, 0.13, 0.13, 0.16, 0.35, 0.20, 0.10, 0.06, 0.12, 0.07, 0.09, 0.11, NA, 0.23, 0.15, 0.12, 0.10, 0.12, 0.10, 0.12, 0.09)
unrat25yr1s <- c(-0.16, -0.14, -0.13, -0.14, -0.11, -0.10, -0.04, -0.15, -0.13, 0.08, -0.13, -0.13, -0.13, -0.13, -0.11, -0.12, -0.10, -0.16, -0.13, -0.13, -0.13, 0.03, -0.12, -0.13, NA, -0.13, -0.30, -0.18, -0.17, 7.93, -0.14, -0.12, -0.15)
herat25yr1s <- c(-0.13, -0.13, -0.11, -0.12, -0.13, -0.13, -0.12, -0.13, -0.13, -0.14, -0.12, -0.12, -0.13, -0.13, -0.12, -0.13, -0.13, -0.09, -0.12, -0.13, -0.14, -0.12, -0.13, -0.13, -0.13, NA, -0.12, -0.11, -0.12, -0.13, -0.12, -0.12, -0.12, -0.13)
unrat26yr1s <- c(-0.63, -0.27, -0.02, -0.13, 1.59, 0.11, NA, -0.37, 0.10, 0.13, 0.03, -0.04, -0.01, 0.11, 0.15, 0.26, 0.18, -0.06, 0.02, 0.03, 0.32, 0.38, 0.36, -0.04, NA, 0.03, -6.73, -0.20, -0.07, NA, -0.07, 0.30, -0.15)
herat26yr1s <- c(-0.04, -0.03, 0.04, 0.04, -0.03, 0.61, 0.11, -1.44, -0.09, 0.54, 2.01, 0.30, 0.03, 0.08, 0.15, -0.20, 1.27, 0.01, 0.09, -0.10, -0.18, 0.04, -0.10, 0.00, -0.01, NA, -0.01, 0.32, 1.43, -0.11, NA, NA, 0.01, -0.03)

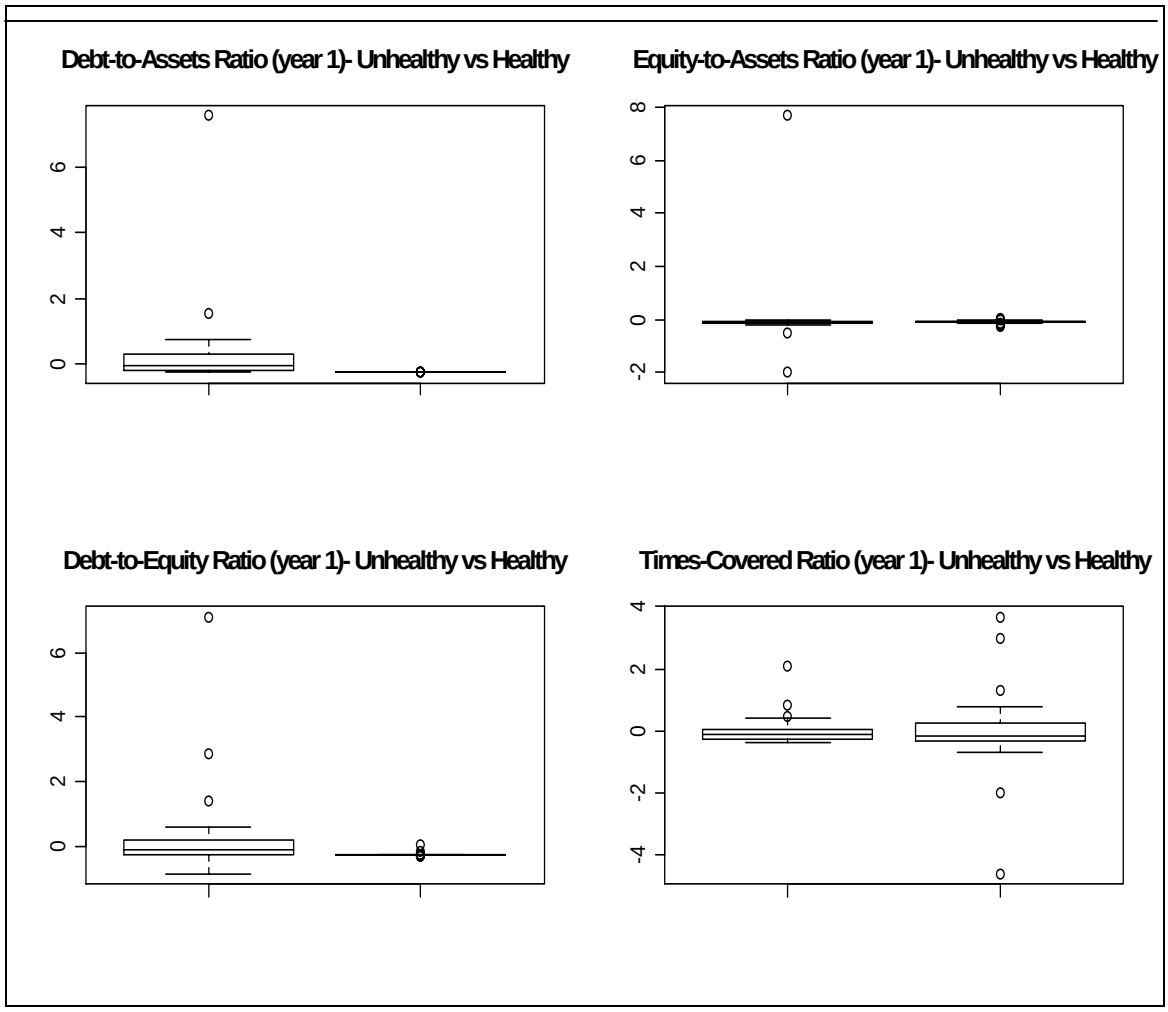
```
## unhealthy ratios are going to be called unrat#yr#s
## healthy ratios are going to be called herat#yr#s
par(mfrow = c(2, 2))
boxplot(unrat1yr1s, herat1yr1s,main="Quick Ratio (year 1)- Unhealthy vs Healthy")
boxplot(unrat2yr1s, herat2yr1s,main="Current Ratio (year 1)- Unhealthy vs Healthy")
boxplot(unrat3yr1s, herat3yr1s,main="Return on Assets Ratio (year 1)- Unhealthy vs
Healthy")
boxplot(unrat4yr1s, herat4yr1s,main="Return-on-Equity Ratio (year 1)- Unhealthy vs
Healthy")
```



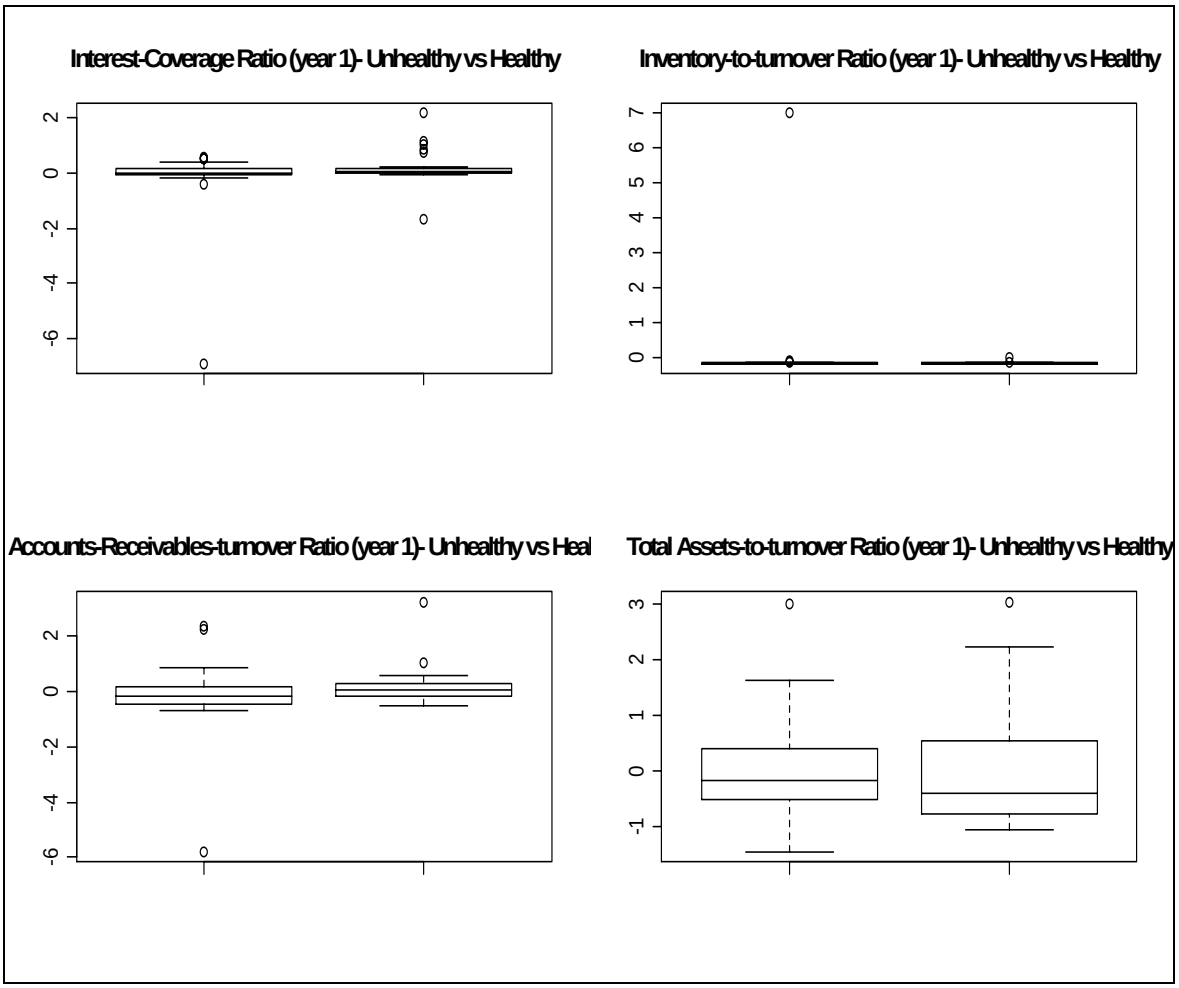
```
par(mfrow = c(2, 2))
boxplot(unrat5yr1s, herat5yr1s,main="Net Profit Margin Ratio (year 1)- Unhealthy vs
Healthy")
boxplot(unrat6yr1s, herat6yr1s,main="Gross Profit Margin Ratio (year 1)- Unhealthy vs
Healthy")
boxplot(unrat7yr1s, herat7yr1s,main="Return-on-Investment Ratio (year 1)- Unhealthy
vs Healthy")
boxplot(unrat8yr1s, herat8yr1s,main="Return-on-Sales Ratio (year 1)- Unhealthy vs
Healthy")
```



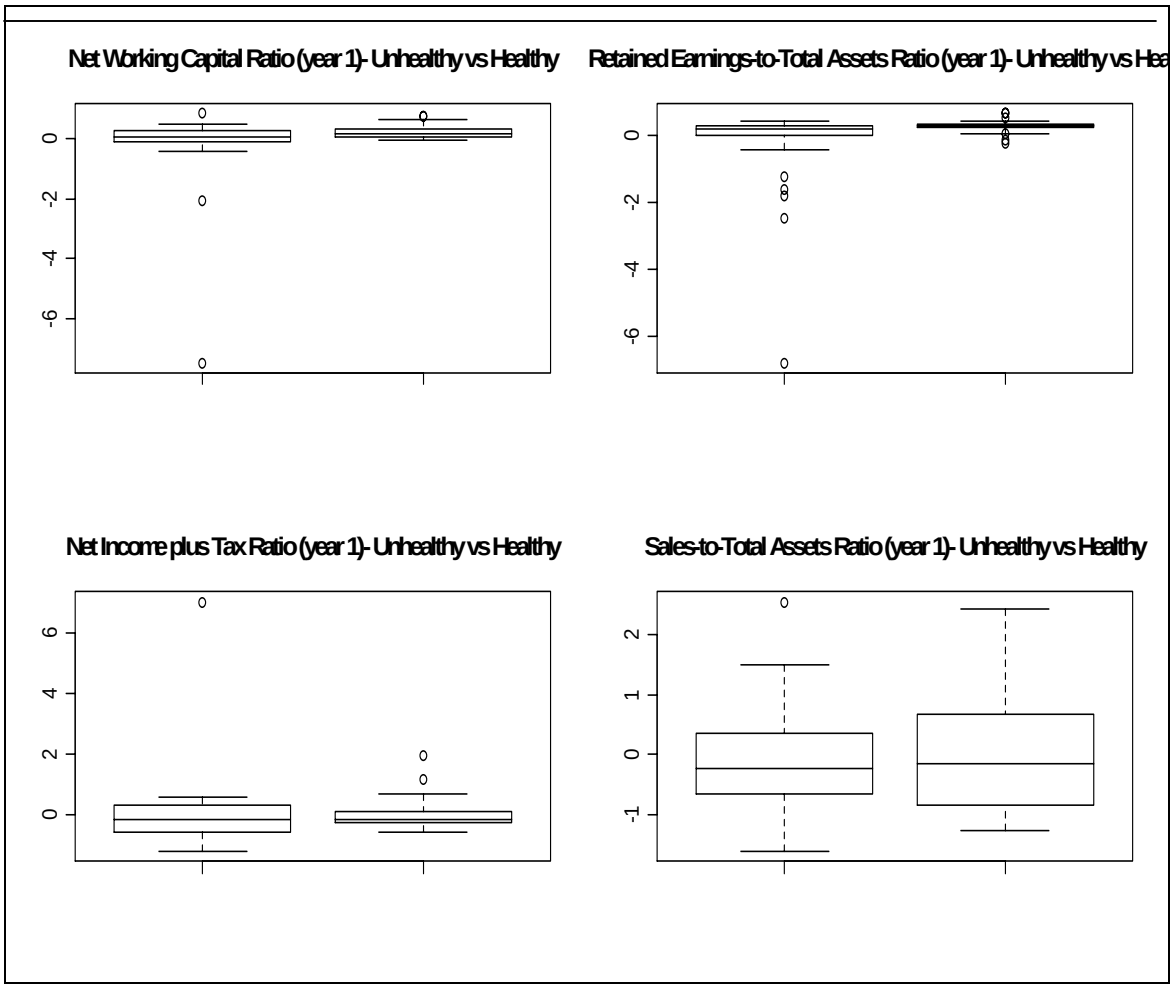
```
par(mfrow = c(2, 2))
boxplot(unrat9yr1s, herat9yr1s,main="Debt-to-Assets Ratio (year 1)- Unhealthy vs
Healthy")
boxplot(unrat10yr1s, herat10yr1s,main="Equity-to-Assets Ratio (year 1)- Unhealthy vs
Healthy")
boxplot(unrat11yr1s, herat11yr1s,main="Debt-to-Equity Ratio (year 1)- Unhealthy vs
Healthy")
boxplot(unrat12yr1s, herat12yr1s,main="Times-Covered Ratio (year 1)- Unhealthy vs
Healthy")
```



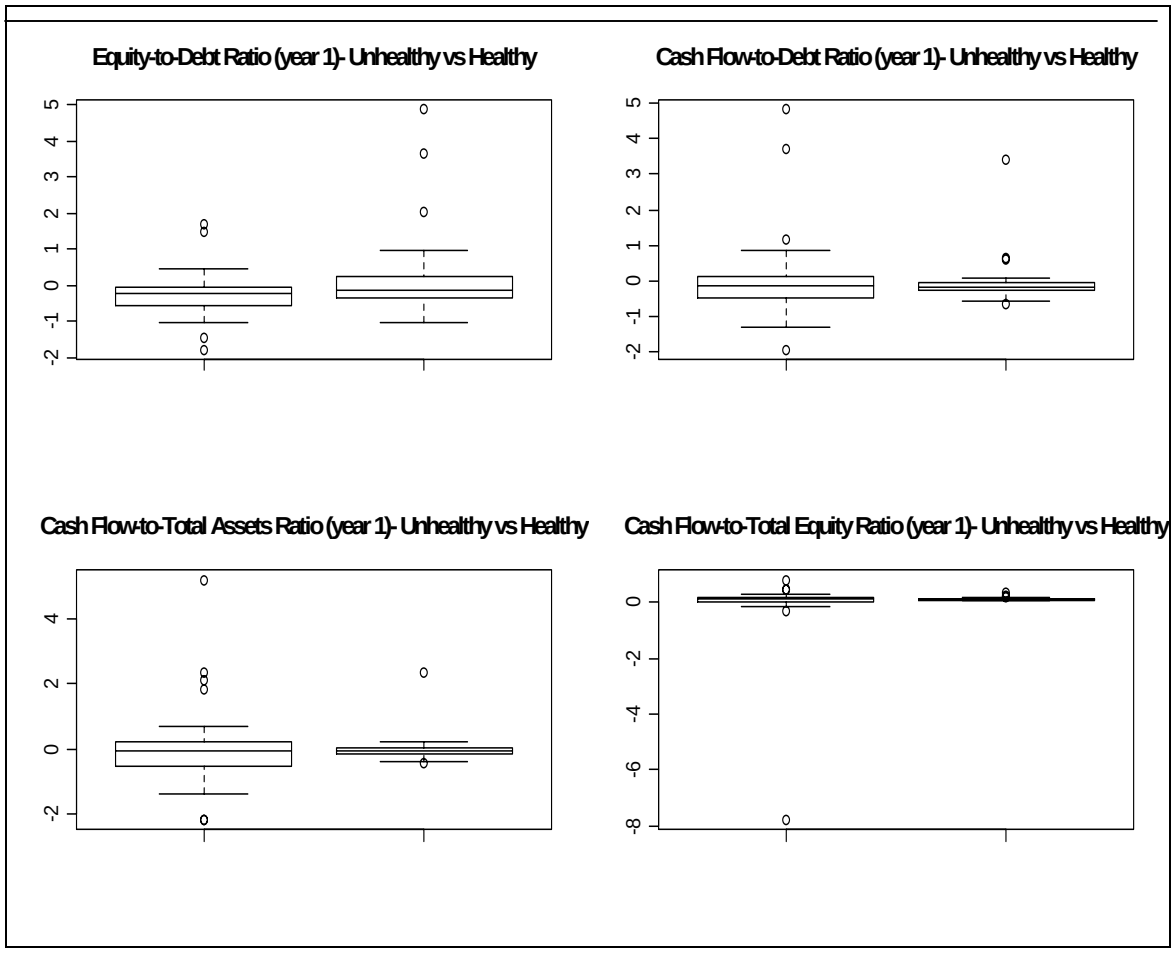
```
par(mfrow = c(2, 2))
boxplot(unrat13yr1s, herat13yr1s,main="Interest-Coverage Ratio (year 1)- Unhealthy vs
Healthy")
boxplot(unrat14yr1s, herat14yr1s,main="Inventory-to-turnover Ratio (year 1)- Unhealthy
vs Healthy")
boxplot(unrat15yr1s, herat15yr1s,main="Accounts-Receivables-turnover Ratio (year 1)-
Unhealthy vs Healthy")
boxplot(unrat16yr1s, herat16yr1s,main="Total Assets-to-turnover Ratio (year 1)-
Unhealthy vs Healthy")
```



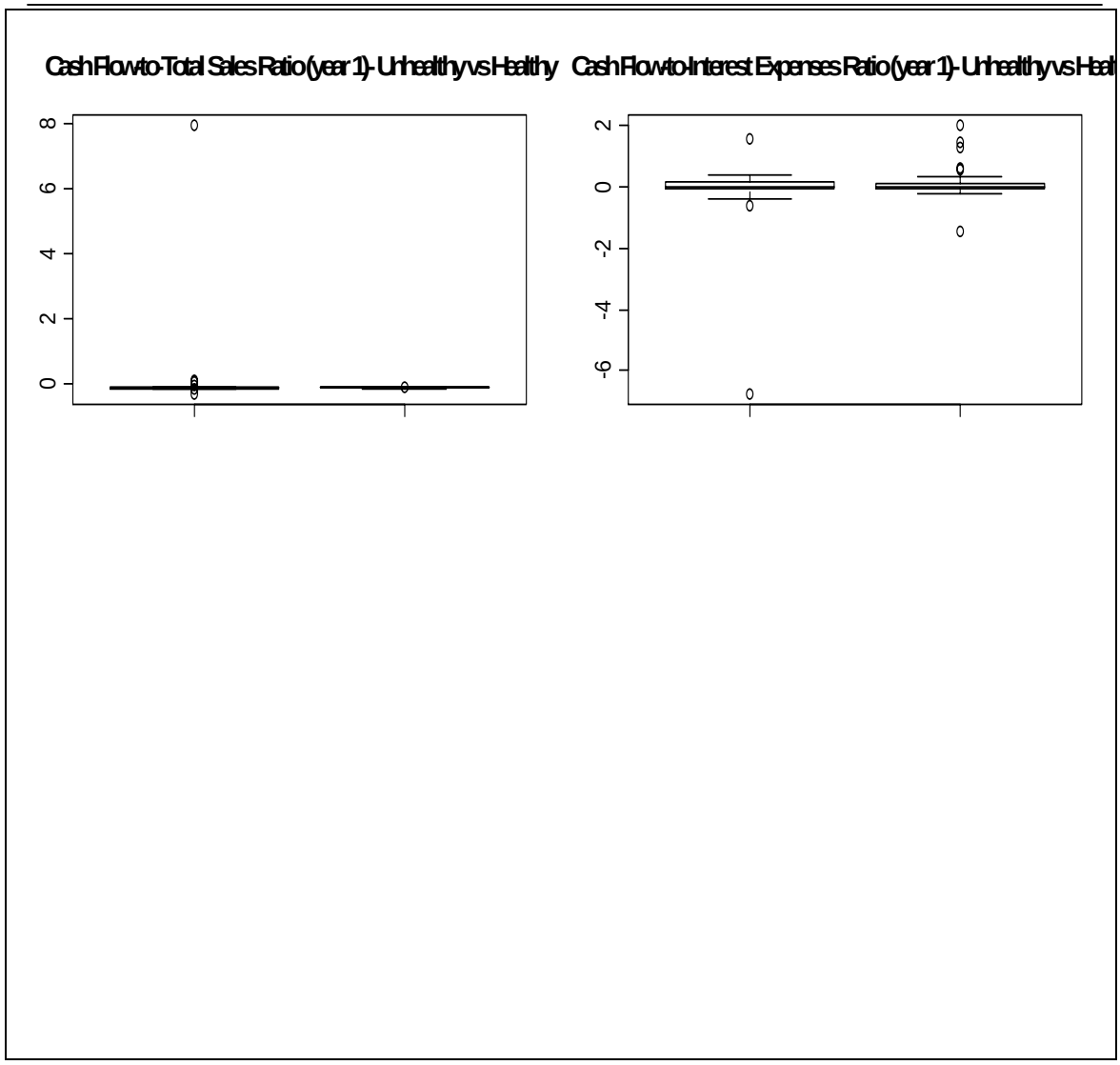
```
par(mfrow = c(2, 2))
boxplot(unrat17yr1s, herat17yr1s,main="Net Working Capital Ratio (year 1)- Unhealthy
vs Healthy")
boxplot(unrat18yr1s, herat18yr1s,main="Retained Earnings-to-Total Assets Ratio (year
1)- Unhealthy vs Healthy")
boxplot(unrat19yr1s, herat19yr1s,main="Net Income plus Tax Ratio (year 1)- Unhealthy
vs Healthy")
boxplot(unrat20yr1s, herat20yr1s,main="Sales-to-Total Assets Ratio (year 1)- Unhealthy
vs Healthy")
```



```
par(mfrow = c(2, 2))
boxplot(unrat21yr1s, herat21yr1s,main="Equity-to-Debt Ratio (year 1)- Unhealthy vs
Healthy")
boxplot(unrat22yr1s, herat22yr1s,main="Cash Flow-to-Debt Ratio (year 1)- Unhealthy vs
Healthy")
boxplot(unrat23yr1s, herat23yr1s,main="Cash Flow-to-Total Assets Ratio (year 1)-
Unhealthy vs Healthy")
boxplot(unrat24yr1s, herat24yr1s,main="Cash Flow-to-Total Equity Ratio (year 1)-
Unhealthy vs Healthy")
```

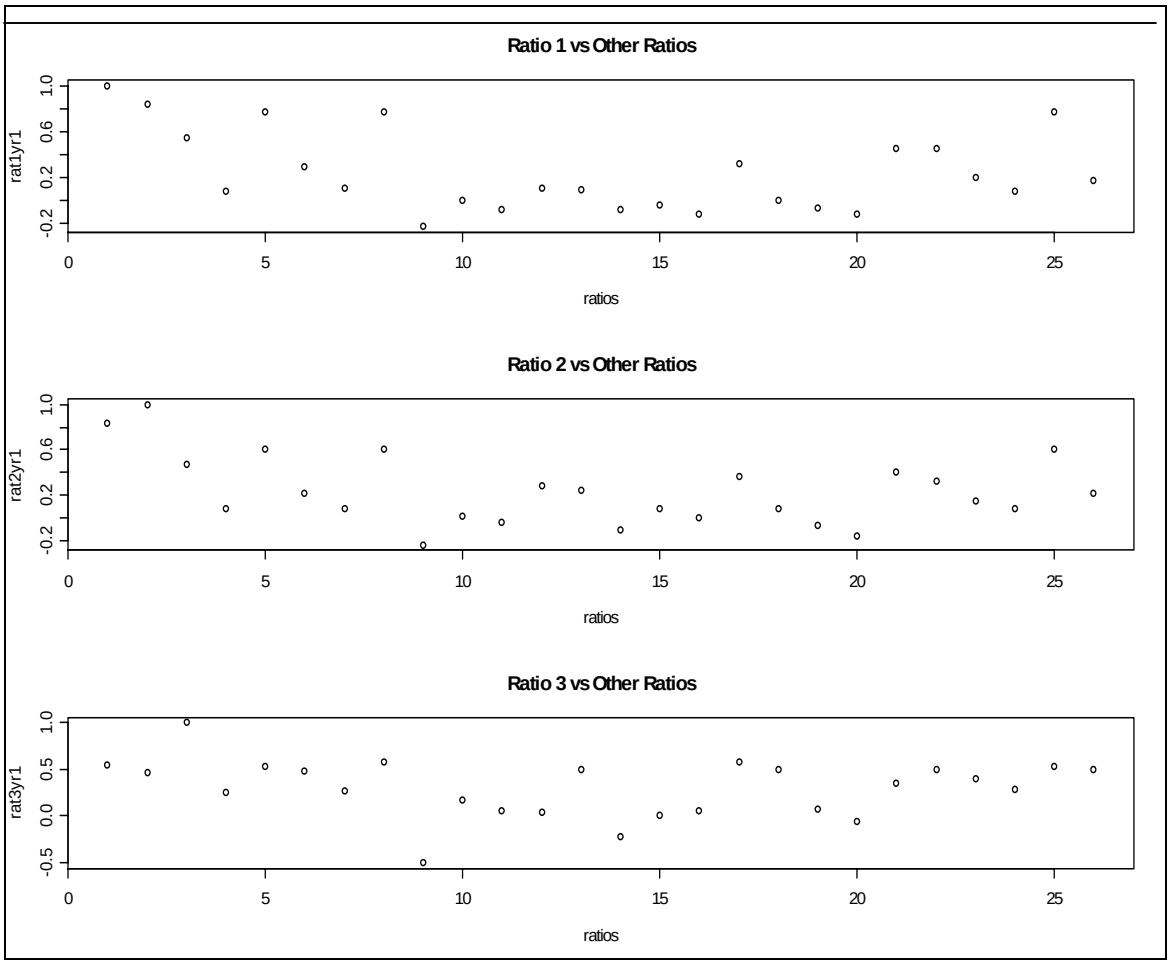


```
par(mfrow = c(2, 2))
boxplot(unrat25yr1s, herat25yr1s,main="Cash Flow-to-Total Sales Ratio (year 1)-
Unhealthy vs Healthy")
boxplot(unrat26yr1s, herat26yr1s,main="Cash Flow-to-Interest Expenses Ratio (year 1)-
Unhealthy vs Healthy")
```

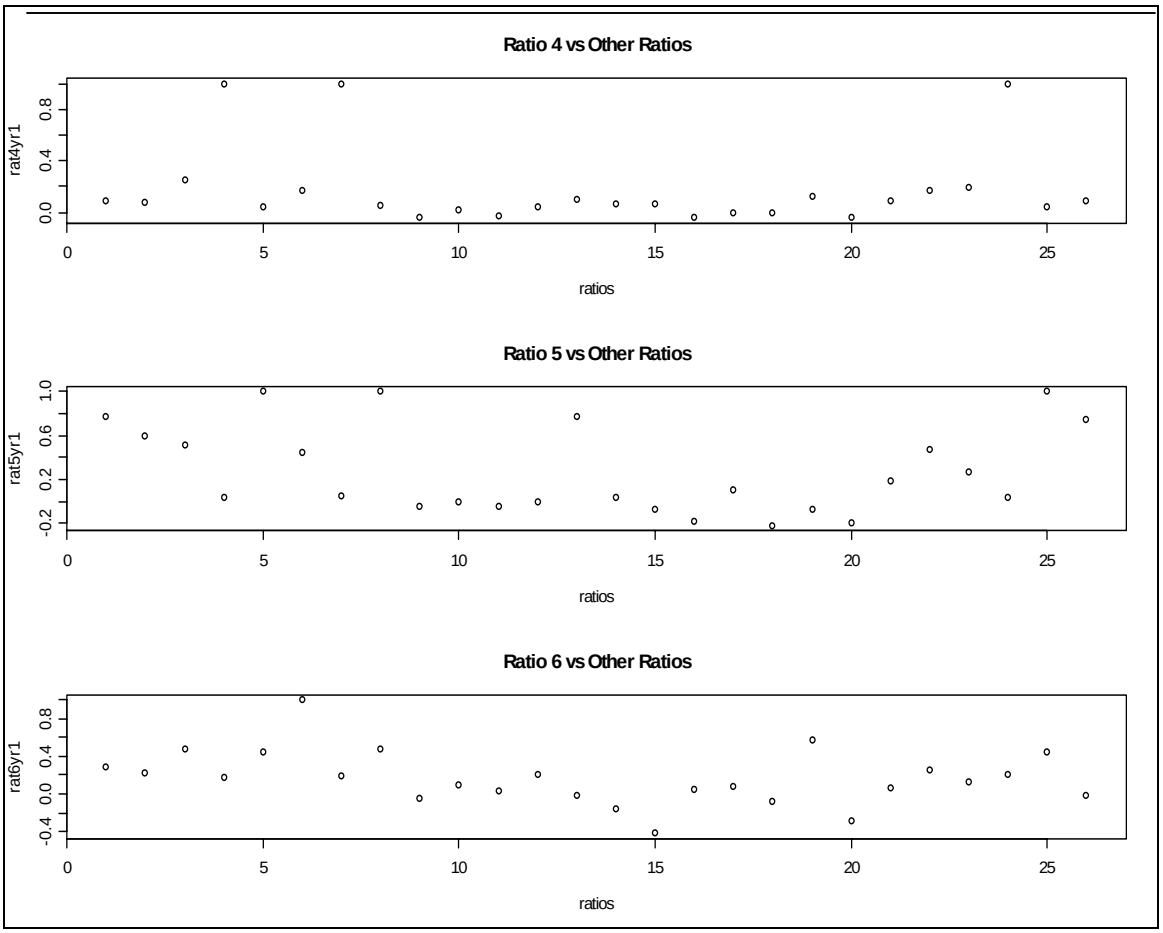


In order to select the financial ratios, each financial ratio will be compared to each other using the information calculated in the cross correlation matrix.

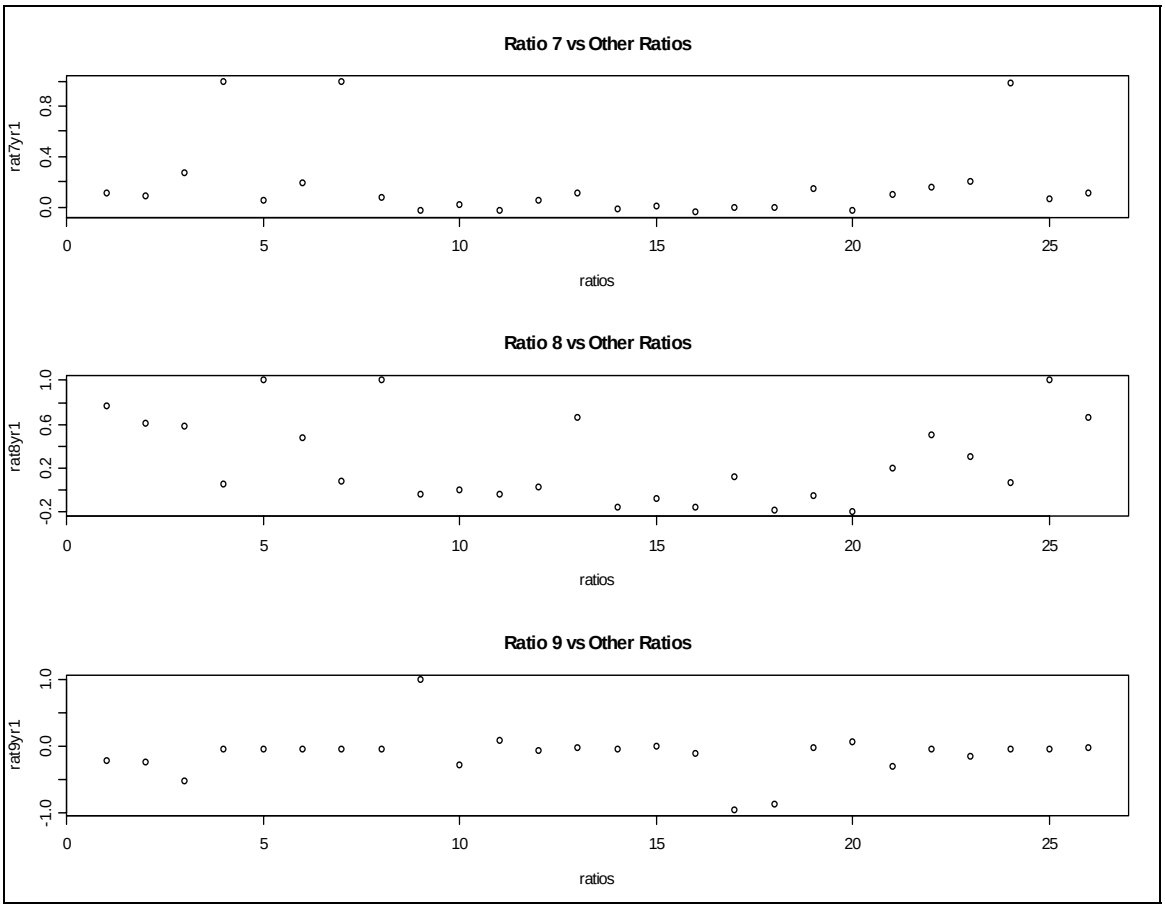
```
par(mfrow = c(3,1))
plot(ratios, rat1yr1, main="Ratio 1 vs Other Ratios")
plot(ratios, rat2yr1, main="Ratio 2 vs Other Ratios")
plot(ratios, rat3yr1, main="Ratio 3 vs Other Ratios")
```



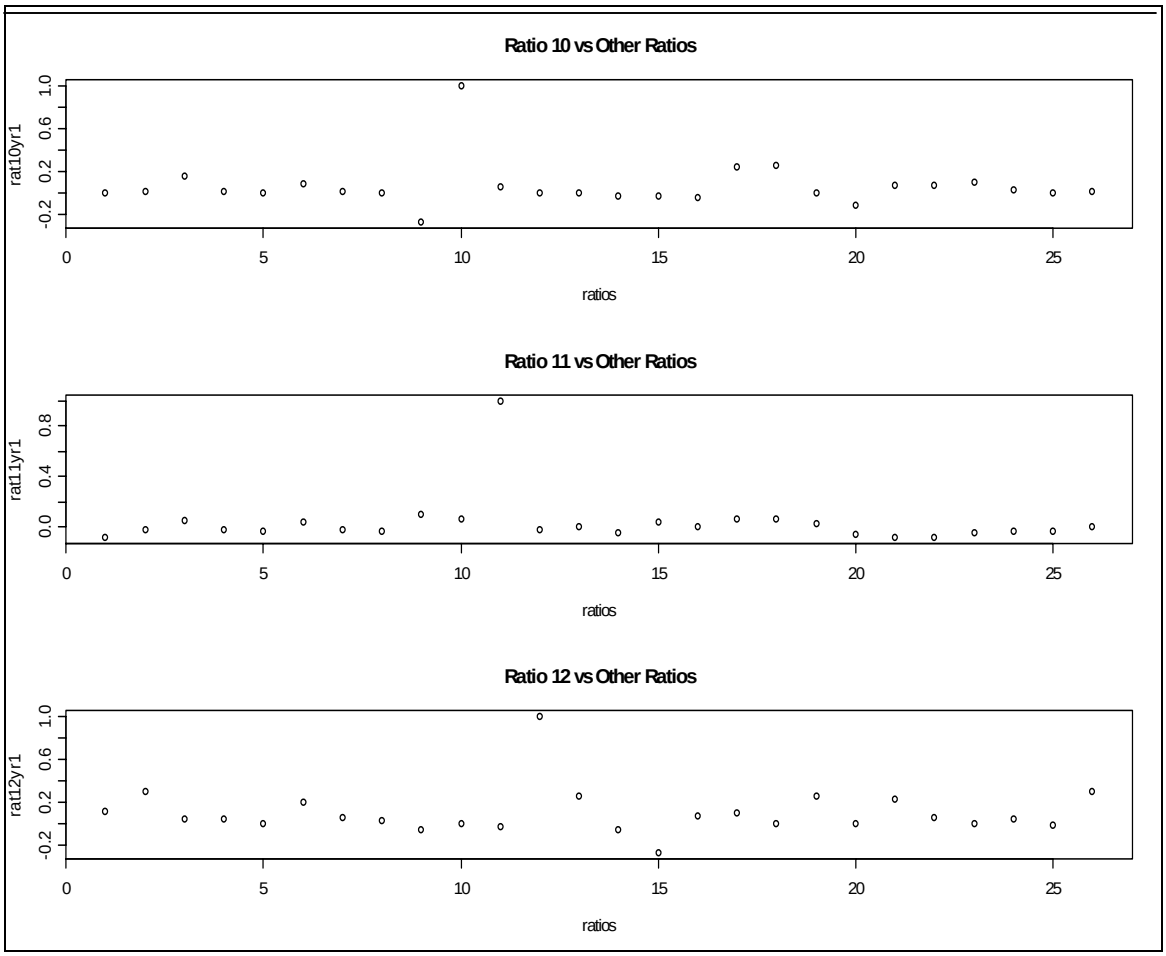
```
par(mfrow = c(3,1))
plot(ratios, rat4yr1, main="Ratio 4 vs Other Ratios")
plot(ratios, rat5yr1, main="Ratio 5 vs Other Ratios")
plot(ratios, rat6yr1, main="Ratio 6 vs Other Ratios")
```



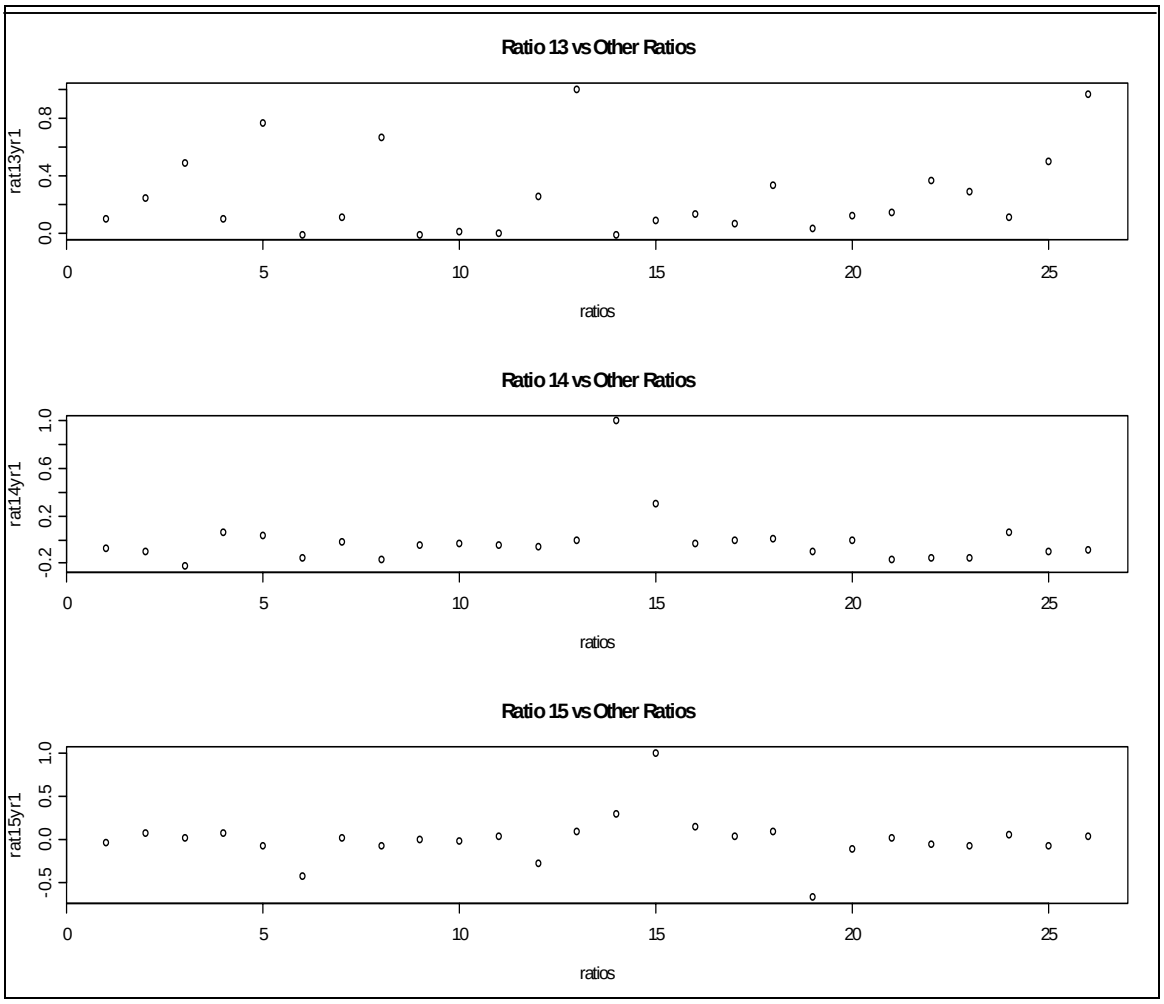
```
par(mfrow = c(3,1))
plot(ratios, rat7yr1, main="Ratio 7 vs Other Ratios")
plot(ratios, rat8yr1, main="Ratio 8 vs Other Ratios")
plot(ratios, rat9yr1, main="Ratio 9 vs Other Ratios")
```



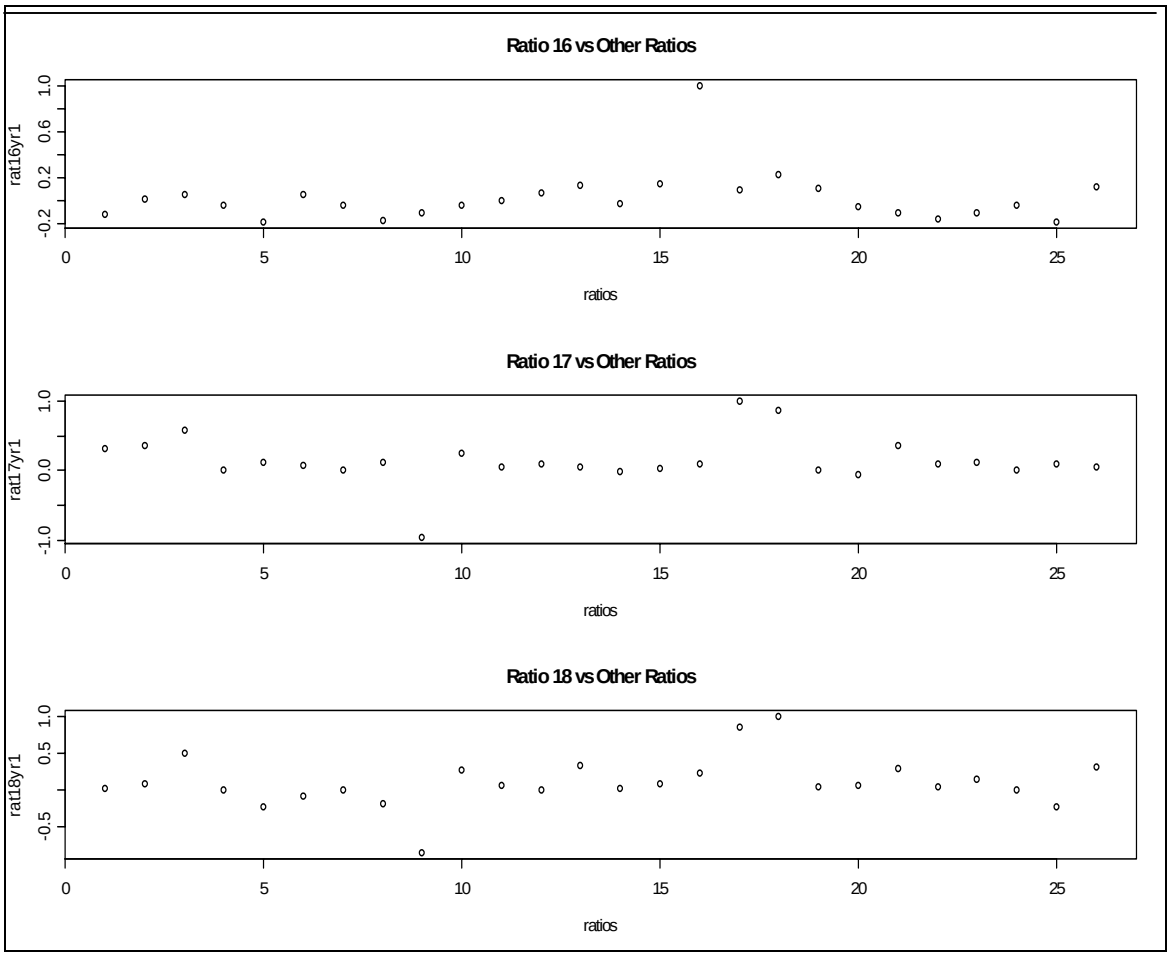
```
par(mfrow = c(3,1))
plot(ratios, rat10yr1, main="Ratio 10 vs Other Ratios")
plot(ratios, rat11yr1, main="Ratio 11 vs Other Ratios")
plot(ratios, rat12yr1, main="Ratio 12 vs Other Ratios")
```



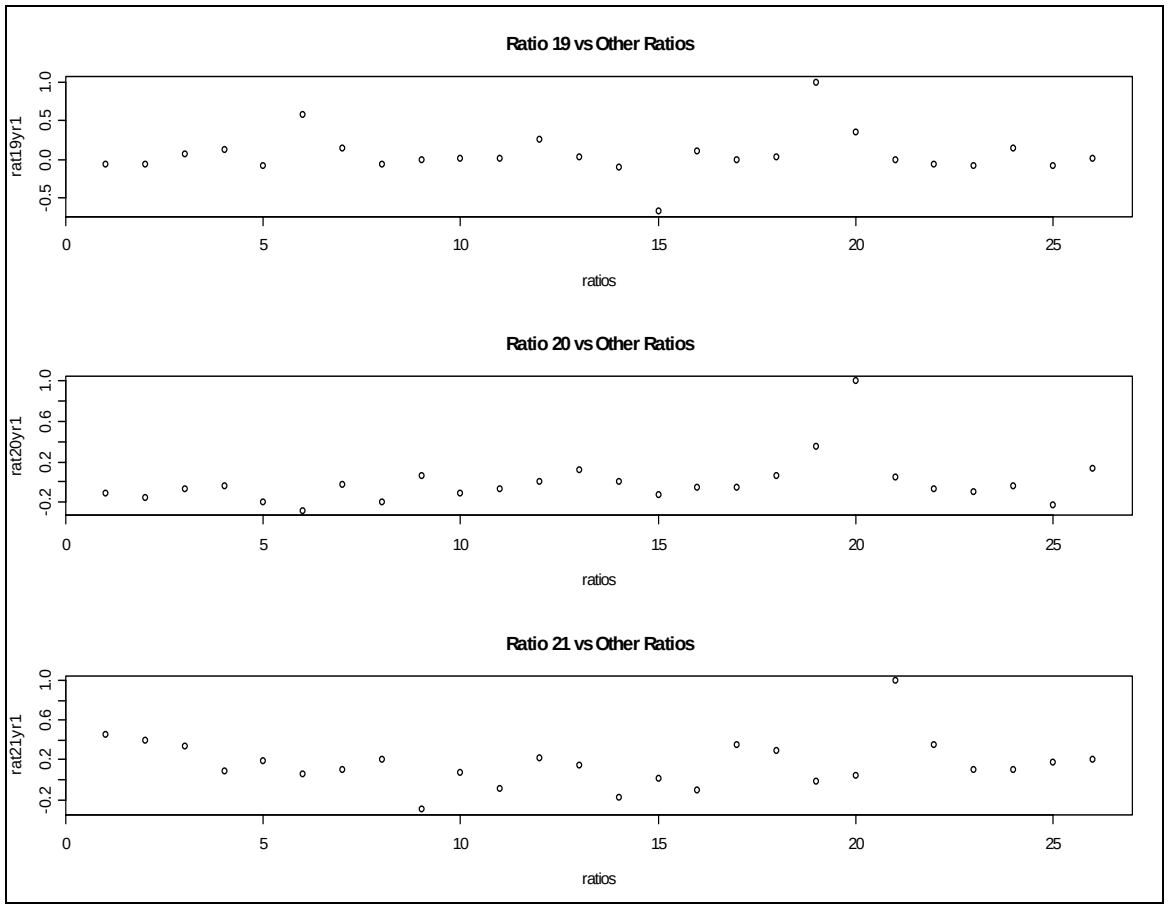
```
par(mfrow = c(3,1))
plot(ratios, rat13yr1, main="Ratio 13 vs Other Ratios")
plot(ratios, rat14yr1, main="Ratio 14 vs Other Ratios")
plot(ratios, rat15yr1, main="Ratio 15 vs Other Ratios")
```



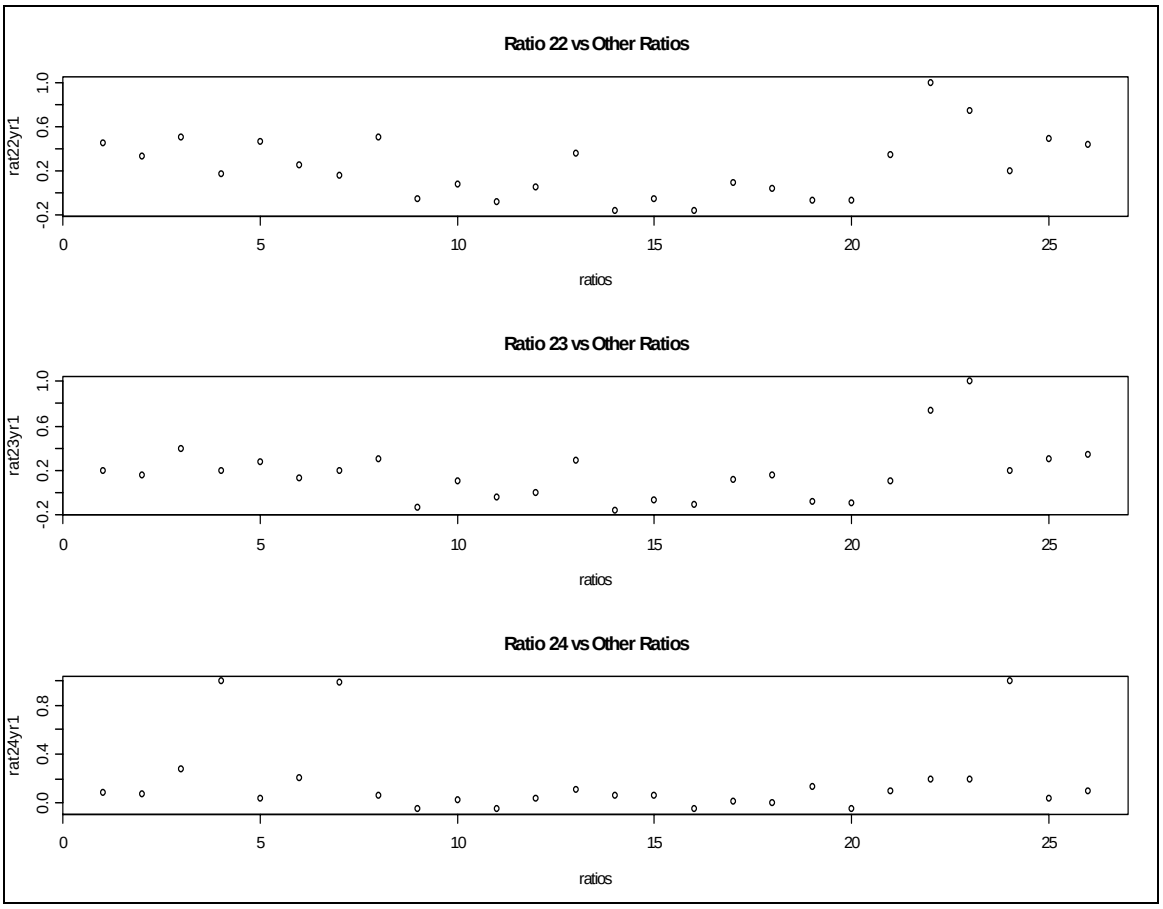
```
par(mfrow = c(3,1))
plot(ratios, rat16yr1, main="Ratio 16 vs Other Ratios")
plot(ratios, rat17yr1, main="Ratio 17 vs Other Ratios")
plot(ratios, rat18yr1, main="Ratio 18 vs Other Ratios")
```



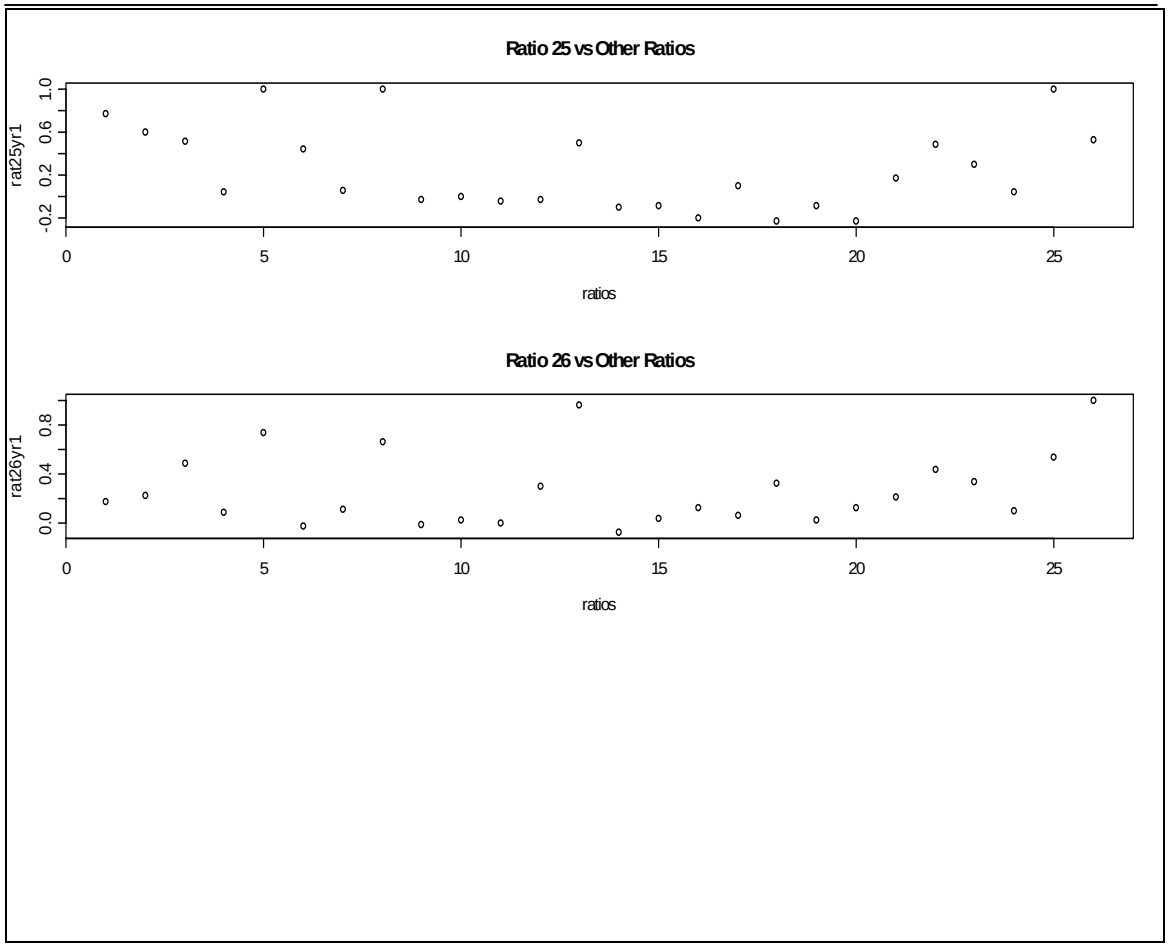
```
par(mfrow = c(3,1))
plot(ratios, rat19yr1, main="Ratio 19 vs Other Ratios")
plot(ratios, rat20yr1, main="Ratio 20 vs Other Ratios")
plot(ratios, rat21yr1, main="Ratio 21 vs Other Ratios")
```



```
par(mfrow = c(3,1))
plot(ratios, rat22yr1, main="Ratio 22 vs Other Ratios")
plot(ratios, rat23yr1, main="Ratio 23 vs Other Ratios")
plot(ratios, rat24yr1, main="Ratio 24 vs Other Ratios")
```



```
par(mfrow = c(3,1))
plot(ratios, rat25yr1, main="Ratio 25 vs Other Ratios")
plot(ratios, rat26yr1, main="Ratio 26 vs Other Ratios")
```



APPENDIX D
BOXPLOTS YEAR 2

Appendix D shows the complete set of Boxplots of the data two year before bankruptcy. Also, it shows the R-language commands used to calculate the figures mentioned before.

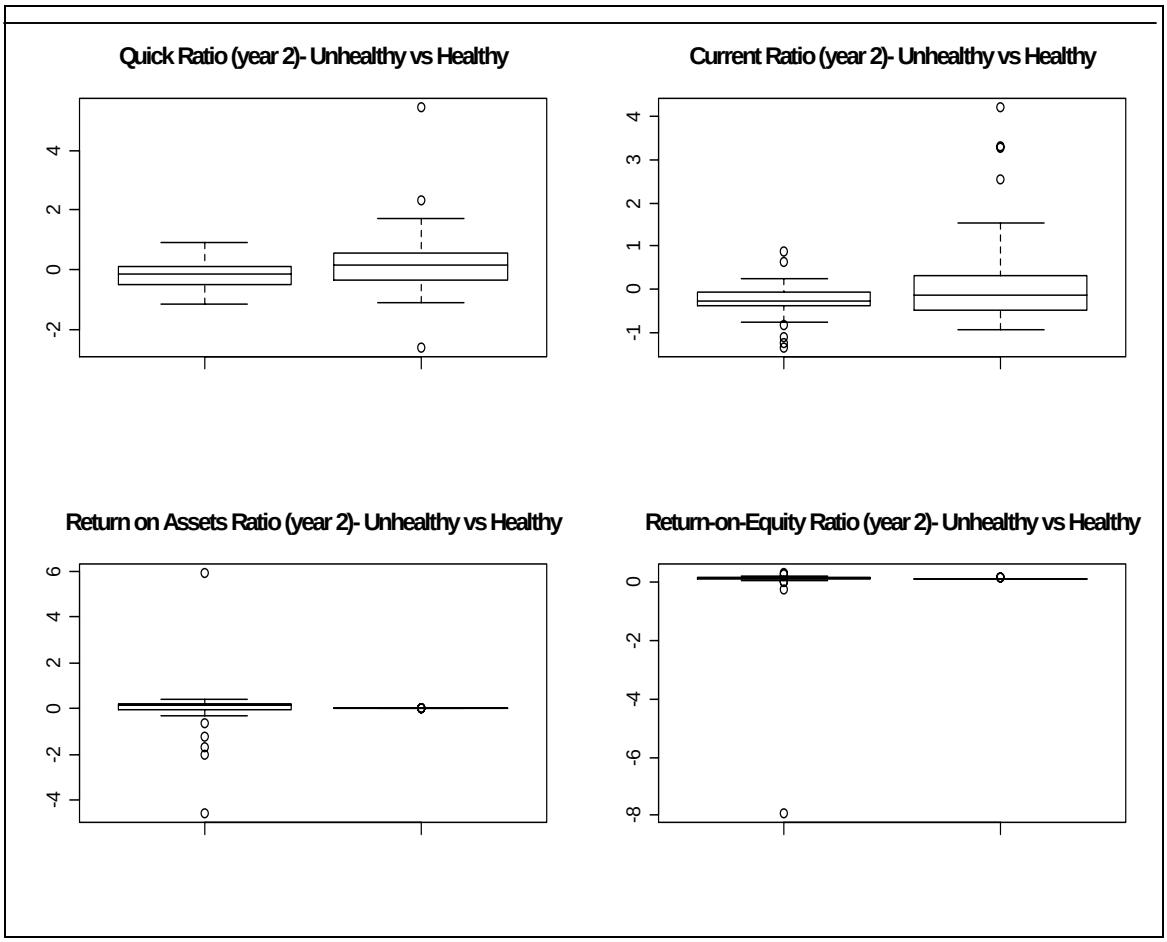
```
## Vectors creation
## un: Unhealthy and he: Healthy
unrat1yr2s <- c(-0.09,0.73,-0.31,-0.11,NA,-0.20,0.06,-0.36,-0.09,-0.96,-0.15,-0.33,-
0.52,0.36,0.89,0.25,-0.97,-1.18,-0.60,-0.13,0.19,-1.04,-0.13,-0.98,-0.47,-0.04,0.16,-0.91,-
0.11,0.15,-0.14,NA,0.32)
unrat2yr2s <- c(-0.18,0.25,-0.38,-0.32,-0.18,-0.39,-0.08,-0.16,-0.07,-1.13,-0.09,-0.15,-
0.30,0.63,0.88,-0.13,-0.84,-1.36,-0.33,-0.26,-0.38,-1.25,-0.37,-0.68,-0.77,-0.23,-0.07,-
0.38,-0.44,0.01,-0.33,NA,0.17)
unrat3yr2s <- c(0.18,0.22,-0.05,-0.09,0.03,0.41,0.16,0.10,0.04,-1.67,0.19,0.08,0.13,-
0.32,0.25,0.23,0.29,-2.03,0.22,0.17,0.06,0.36,0.31,0.00,0.28,0.14,-4.58,-1.25,-
0.65,5.91,0.01,0.18,-0.34)
unrat4yr2s <-
c(0.15,0.15,0.10,0.10,0.12,0.18,NA,0.14,0.13,0.27,0.15,0.16,0.14,0.09,0.15,0.15,0.20,0.1
9,0.16,0.15,0.13,0.09,0.16,NA,0.30,0.14,-0.26,-0.02,0.03,-7.92,0.12,0.17,-0.02)
unrat5yr2s <- c(-0.09,-0.09,-0.09,-0.09,-0.09,-0.09,-0.07,-0.08,-0.09,-0.12,-0.08,-0.08,-
0.08,-0.11,-0.07,-0.08,-0.06,-0.38,-0.08,-0.08,-0.09,0.03,-0.07,-0.09,0.25,-0.08,-1.98,-
0.27,-0.34,7.83,-0.09,-0.08,-0.12)
unrat6yr2s <- c(-0.82,-1.06,4.31,-1.04,-0.63,-0.09,-0.34,-0.54,-0.68,-1.00,-0.54,0.55,-
0.51,-0.27,0.87,-0.81,1.02,-0.53,-0.61,-0.51,-0.55,0.07,-0.20,0.08,4.25,-
0.30,1.45,0.12,0.20,0.04,-0.48,-0.11,0.09)
unrat7yr2s <-
c(0.21,0.18,0.44,0.09,NA,0.15,0.12,0.13,0.12,0.28,0.13,0.12,0.12,0.09,0.13,0.13,0.13,0.2
5,0.14,0.13,0.12,0.07,0.15,NA,0.29,0.13,-0.26,0.00,0.05,-7.92,0.11,0.15,0.09)
unrat8yr2s <- c(-0.10,-0.10,-0.11,-0.13,-0.10,-0.09,-0.09,-0.10,-0.11,-0.13,-0.10,-0.10,-
0.10,-0.14,-0.07,-0.09,-0.08,-0.32,-0.10,-0.10,-0.11,0.14,-0.09,-0.11,0.13,-0.10,-1.47,-
0.24,-0.31,7.93,-0.10,-0.10,-0.13)
unrat9yr2s <- c(-0.48,NA,-0.47,-0.47,-0.48,-0.47,-0.08,-0.08,-
0.03,1.77,0.36,1.79,0.74,0.07,0.10,-0.35,1.63,5.63,-0.01,0.17,-0.15,2.82,-
0.08,NA,0.07,0.34,NA,0.67,0.92,0.13,0.90,-0.33,1.53)
unrat10yr2s <- c(0.20,0.55,-0.22,-0.04,0.56,0.31,NA,0.20,0.20,-2.45,0.23,-
0.47,0.28,0.82,0.69,0.71,-0.20,-5.74,0.17,0.25,0.08,-2.11,0.35,NA,-
0.51,0.08,1.08,0.65,0.36,-0.84,-0.15,-0.23,-0.35)
unrat11yr2s <- c(-0.32,NA,-0.32,-0.31,-0.31,0.42,-0.27,-0.31,0.04,-0.46,0.38,5.69,0.57,-
0.09,0.03,-0.25,2.59,-0.92,-0.01,0.11,-0.09,-0.48,-0.20,NA,-0.32,0.71,-0.28,-0.04,0.20,-
0.32,0.64,-0.06,4.23)
unrat12yr2s <- c(-0.03,1.93,3.69,-0.38,NA,-0.18,NA,0.29,-0.37,-0.38,-0.20,-0.27,-
0.29,2.72,-0.10,0.00,-0.32,-0.39,-0.16,-0.12,-0.10,-0.38,0.19,-0.32,NA,-0.04,0.33,-0.35,-
0.38,-0.39,-0.36,0.76,-0.31)
unrat13yr2s <- c(0.33,1.79,0.04,-0.03,0.57,0.16,NA,0.14,0.10,0.01,0.12,0.08,0.09,-
2.01,0.16,0.39,0.08,0.02,0.14,0.11,0.07,0.12,0.30,0.06,NA,0.15,-7.19,-
0.03,0.03,0.22,0.07,0.30,0.04)
```

```
unrat14yr2s <- c(7.02,NA,-0.16,-0.16,-0.14,-0.14,-0.14,-0.16,-0.16,-0.12,-0.16,-0.16,-
0.16,-0.16,-0.16,NA,NA,-0.16,-0.16,-0.13,-0.16,-0.16,NA,-0.16,NA,-0.16,-0.16,-0.17,-
0.16,-0.14,-0.16,-0.14,-0.16)
unrat15yr2s <- c(-5.15,NA,0.80,0.75,0.17,0.39,-0.25,-0.15,-0.12,0.16,0.00,-0.26,0.23,-
0.14,-0.16,NA,NA,-0.24,0.44,0.13,-0.29,-0.45,-0.09,-0.38,-0.52,0.41,-0.47,0.36,-0.41,-
0.36,-0.35,-0.32,-0.26)
unrat16yr2s <- c(0.81,0.08,0.21,-0.85,0.71,0.60,-0.44,0.80,0.53,2.05,0.74,-
0.47,0.51,0.03,-0.40,NA,NA,-0.86,1.33,2.09,0.59,-1.16,0.71,-0.67,-1.35,-0.02,-1.17,-
0.78,-1.17,-1.35,-0.28,-0.10,-0.19)
unrat17yr2s <- c(0.06,1.04,0.00,0.06,1.31,-0.18,-0.27,0.44,0.47,-2.97,0.23,0.16,-
0.06,0.87,0.39,0.18,-0.57,-4.94,0.07,0.09,0.51,-3.41,-0.02,-0.46,-1.00,0.05,0.19,-0.11,-
0.19,0.78,0.08,NA,0.27)
unrat18yr2s <- c(0.28,0.18,0.10,0.14,0.73,0.44,0.14,0.42,0.25,-1.43,0.40,-
0.15,0.45,0.26,0.63,0.60,-0.21,-2.92,0.35,0.38,0.36,-1.36,0.30,NA,-2.74,0.16,-5.26,-
0.46,0.11,-2.70,0.06,0.29,0.04)
unrat19yr2s <- C(-0.52,0.75,5.99,-0.99,-0.22,0.61,-1.00,-0.08,-0.34,-0.69,-0.11,0.51,-
0.17,-0.11,0.58,-0.58,0.32,-0.72,-0.06,0.46,-0.18,-0.77,0.46,-0.32,-0.72,-0.13,-0.56,-0.40,-
0.76,-0.96,-0.48,-0.01,0.10)
unrat20yr2s <- c(0.73,-0.01,0.12,-0.95,0.63,0.51,-0.49,0.60,0.54,2.78,0.54,-0.35,0.32,-
0.14,-0.50,0.39,-0.72,-0.87,0.95,1.66,0.42,-1.26,0.56,-0.78,-1.46,-0.11,-1.30,-0.88,-1.28,-
1.46,-0.43,-0.23,-0.33)
unrat21yr2s <- c(0.25,NA,-0.38,-0.33,0.34,-0.12,NA,-0.19,-0.19,-0.92,-0.17,-0.52,-
0.14,0.43,0.25,0.27,-0.42,-1.13,-0.21,-0.16,-0.27,-0.88,-0.09,NA,-0.54,-0.27,0.94,0.21,-
0.08,-0.64,-0.39,-0.02,-0.48)
unrat22yr2s <- c(0.10,NA,-0.12,-0.26,0.85,0.66,3.43,-0.11,-0.14,0.85,-0.07,-0.38,-0.06,-
0.47,0.29,0.20,0.13,-0.48,-0.04,-0.01,-0.15,0.13,0.15,-0.20,-0.07,-0.10,-5.57,-1.16,-
0.61,2.16,-0.14,0.23,-0.31)
unrat23yr2s <- c(-0.03,NA,-0.12,-0.29,0.58,0.79,1.92,-0.10,-0.13,2.96,-0.05,-0.52,-0.05,-
0.43,0.24,0.15,0.29,-1.71,-0.01,0.02,-0.14,0.71,0.19,-0.22,0.02,-0.08,-3.69,-1.11,-
0.68,4.39,-0.13,-0.01,-0.38)
unrat24yr2s <- c(0.14,NA,0.14,0.08,0.22,0.29,NA,0.13,0.12,-0.24,0.14,-
0.13,0.13,0.08,0.16,0.15,0.28,0.16,0.15,0.15,0.12,-0.02,0.17,NA,0.30,0.14,-0.26,-
0.02,0.02,-7.75,0.13,0.18,0.02)
unrat25yr2s <- c(-0.10,NA,-0.10,-0.13,-0.07,-0.05,0.13,-0.10,-0.11,-0.02,-0.10,-0.14,-
0.10,-0.13,-0.06,-0.09,-0.04,-0.38,-0.10,-0.10,-0.11,0.29,-0.09,-0.11,0.27,-0.10,-1.92,-
0.28,-0.33,7.69,-0.10,-0.09,-0.13)
unrat26yr2s <- c(0.19,NA,0.09,-0.04,2.05,0.19,NA,0.12,0.05,0.14,0.06,-0.02,0.04,-
0.99,0.12,0.44,0.05,-0.03,0.08,0.07,0.05,0.08,0.22,0.01,NA,0.08,-7.21,-0.08,-
0.01,0.13,0.02,0.31,0.00)
herat1yr2s <- c(-0.32,0.26,-0.87,0.69,-0.29,-0.34,2.30,0.16,-0.28,1.70,5.44,0.55,-
0.36,0.52,0.34,-0.22,0.29,NA,0.20,0.12,NA,-0.71,0.57,0.40,0.66,0.15,-0.69,-0.77,-1.12,-
0.11,-2.62,-0.12,-0.12,1.30)
herat2yr2s <- c(-0.50,-0.16,-0.94,0.33,-0.54,-0.43,3.28,-0.24,-0.61,1.52,4.22,0.14,-
0.68,0.31,0.20,-0.50,-0.13,0.19,-0.08,-0.19,0.72,-0.88,0.11,0.23,0.22,-0.25,-0.86,-
0.53,3.33,-0.20,-0.83,2.56,-0.37,0.84)
```

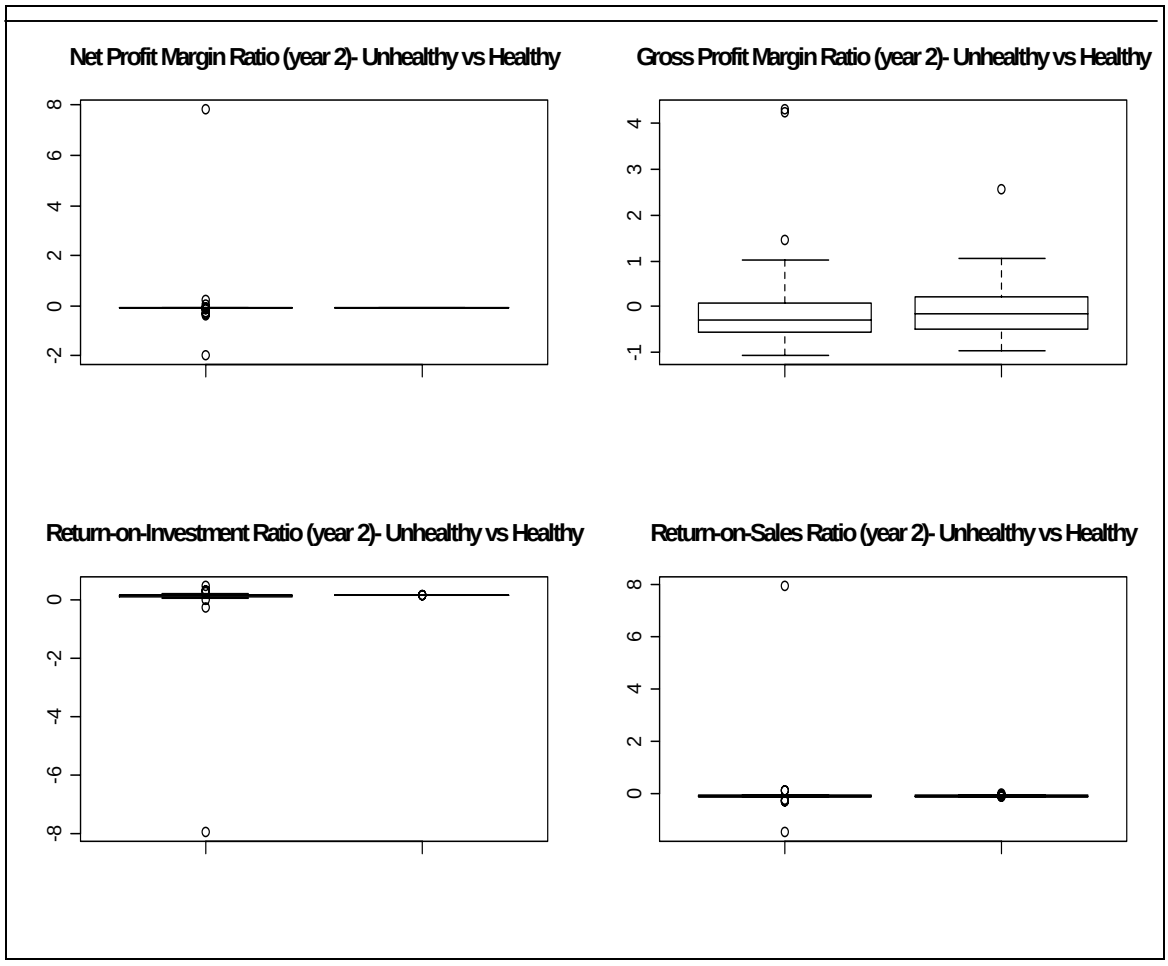
```
herat3yr2s <-
c(0.03,0.03,0.03,0.03,0.03,0.03,0.03,0.03,0.02,0.03,0.03,0.03,0.01,0.03,0.03,0.03,0.03,0.
03,0.03,0.03,0.03,0.03,0.03,0.03,0.03,0.03,0.03,0.02,0.03,0.03,0.03,0.03,0.03,0.03,0.02)
herat4yr2s <-
c(0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.13,0.12,0.12,0.12,0.13,0.12,0.12,0.12,0.12,0.
12,0.13,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12)
herat5yr2s <- c(-0.09,-0.09,-0.09,-0.09,-0.09,-0.09,-0.09,-0.09,-0.09,-0.09,-0.09,-0.09,-
0.09,-0.09,-0.09,-0.09,-0.09,-0.09,-0.09,-0.09,-0.09,-0.09,-0.09,-0.09,-0.09,-0.09,-0.09,-
0.09,-0.09,-0.09,-0.09,-0.09,-0.09,-0.09)
herat6yr2s <- c(0.16,-0.49,0.86,-0.15,0.57,-0.84,-0.48,-0.37,-0.89,0.18,0.03,-0.27,-0.96,-
0.32,0.19,-0.73,-0.79,-0.36,-0.93,-0.55,0.21,0.04,-0.49,0.97,1.05,0.23,0.49,2.57,-
0.01,0.03,-0.59,-0.28,0.69,-0.19)
herat7yr2s <-
c(0.11,0.11,0.11,0.11,0.11,0.11,0.11,0.11,0.11,0.11,0.11,0.11,0.12,0.11,0.11,0.11,0.11,0.
12,0.11,0.11,0.11,0.11,0.11,0.11,0.11,0.11,0.11,0.11,0.11,0.11,0.11,0.11,0.12,0.11,0.11)
herat8yr2s <- c(-0.11,-0.11,-0.07,-0.09,-0.08,-0.10,-0.09,-0.10,-0.13,-0.10,-0.10,-0.10,-
0.01,-0.09,-0.08,-0.11,-0.10,-0.09,-0.10,-0.10,-0.09,-0.09,-0.11,-0.10,-0.10,-0.10,-0.09,-
0.09,-0.09,-0.10,-0.09,-0.07,-0.09,-0.13)
herat9yr2s <- c(-0.47,-0.47,-0.47,-0.48,-0.47,-0.47,-0.47,-0.48,-0.45,-0.49,-0.49,-0.48,-
0.45,-0.48,-0.48,-0.47,-0.47,-0.48,-0.48,-0.49,-0.48,-0.47,-0.48,-0.48,-0.47,-0.47,-0.47,-
0.47,-0.48,-0.47,-0.48,-0.48,-0.47,-0.48)
herat10yr2s <- c(-0.56,-0.04,0.22,0.46,-0.04,0.05,-0.08,0.41,-1.47,1.49,1.75,0.52,-
1.63,0.47,0.49,-0.16,-0.13,0.74,-0.32,0.10,0.98,0.09,0.35,0.43,0.06,0.09,-0.53,-
0.15,0.31,0.17,0.38,0.34,0.21,0.51)
herat11yr2s <- c(-0.16,-0.29,-0.30,-0.31,-0.29,-0.30,-0.29,-0.31,-0.38,-0.32,-0.32,-0.31,-
0.37,-0.31,-0.31,-0.28,-0.28,-0.31,-0.32,-0.32,-0.32,-0.30,-0.31,-0.31,-0.30,-0.30,-0.19,-
0.28,-0.31,-0.30,-0.31,-0.31,-0.30,-0.31)
herat12yr2s <- c(-0.81,-0.30,-0.22,-0.28,-0.29,0.90,-0.21,-2.33,-0.35,-2.19,3.54,0.24,-
0.47,-0.70,-0.14,-0.94,0.58,-0.38,-0.36,-0.73,0.06,-0.28,0.49,0.32,0.02,NA,-
0.31,0.15,2.41,-0.67,-0.03,-0.32,-0.30,-0.20)
herat13yr2s <- c(0.06,0.06,0.13,0.11,0.09,0.57,0.16,-0.33,-0.02,-0.10,0.50,0.23,-0.82,-
0.05,0.16,0.03,0.34,0.07,0.09,-
0.05,0.17,0.10,0.10,0.13,0.09,NA,0.08,0.11,1.05,0.04,0.34,0.12,0.08,-0.03)
herat14yr2s <- c(-0.16,NA,-0.16,-0.15,-0.16,-0.16,-0.17,NA,-0.04,-0.16,NA,-0.14,0.70,-
0.16,-0.16,-0.14,NA,NA,-0.15,-0.16,NA,-0.16,NA,-0.16,NA,NA,-0.16,NA,-0.17,-0.16,-
0.17,-0.17,-0.16,-0.15)
herat15yr2s <- c(-0.26,0.36,0.40,0.41,-0.31,1.36,-0.34,-0.01,-0.04,-0.17,0.26,-0.08,-0.15,-
0.23,0.07,0.10,-0.05,0.11,0.05,0.16,-0.39,0.11,-0.08,-0.25,-
0.28,0.00,0.30,0.10,NA,0.16,NA,5.24,0.06,-0.07)
herat16yr2s <- c(0.20,-0.50,1.32,0.65,3.21,-1.04,-0.04,-0.98,-0.44,0.10,-0.23,-0.71,-0.55,-
0.41,0.30,-0.98,-0.98,-0.82,-0.78,-0.56,-0.34,0.51,-1.05,-0.53,-0.33,-1.07,1.53,3.21,-0.36,-
0.36,-0.33,0.91,1.39,-0.49)
herat17yr2s <- c(-0.24,0.03,-0.48,-0.03,-0.29,-0.11,1.64,0.12,-0.43,0.54,1.26,0.48,-
0.63,0.41,-0.05,-0.24,0.54,0.69,0.18,0.20,0.57,-0.58,0.61,0.65,0.29,0.26,-0.45,-0.29,1.43,-
0.05,-0.59,1.36,-0.23,0.38)
```

```
herat18yr2s <- c(0.28,0.33,0.30,0.27,0.23,0.33,0.36,0.48,-0.11,0.85,0.08,0.54,-
0.08,0.54,0.29,0.15,0.09,1.04,1.07,0.24,0.43,0.31,-
0.47,0.15,0.23,NA,0.07,0.20,0.28,0.43,0.41,0.40,0.13,0.33)
herat19yr2s <- c(-0.15,-0.28,-0.21,-0.50,-0.61,-0.22,-0.51,0.86,-0.78,-0.07,0.05,0.28,-
0.84,-0.14,-0.17,-0.08,-0.24,0.37,-0.72,-0.30,0.35,-0.36,0.81,1.59,1.20,3.29,-0.41,-
0.13,0.14,0.18,-0.49,-0.62,-0.30,0.09)
herat20yr2s <- c(-0.65,0.02,-1.01,-0.84,-1.22,2.29,-0.49,1.75,-0.07,-0.59,-0.33,0.48,0.12,-
0.11,-0.70,1.75,1.72,0.85,0.70,0.13,-0.20,-0.79,2.32,0.08,-0.22,2.59,-1.04,-1.22,-0.18,-
0.17,-0.22,-0.92,-1.02,0.02)
herat21yr2s <- c(-0.55,-0.33,-0.18,0.01,-0.34,-0.29,-0.36,-0.04,-0.78,2.74,6.53,0.06,-
0.81,0.02,0.04,-0.39,-0.38,0.31,1.12,1.18,0.72,-0.26,-0.09,-0.02,-0.28,-0.27,-0.54,-0.39,-
0.11,-0.22,-0.06,-0.09,-0.19,0.06)
herat22yr2s <- c(-0.19,-0.11,0.01,-0.05,-0.10,-0.03,-0.09,0.03,-0.40,0.52,1.23,0.13,-
0.88,0.14,0.10,-0.07,-0.07,2.58,0.19,0.43,0.14,-0.02,-0.09,0.01,-0.11,NA,-0.48,-0.04,-
0.01,-0.08,-0.01,-0.04,-0.05,-1.32)
herat23yr2s <- c(-0.20,-0.08,0.04,-0.05,-0.08,0.02,-0.05,0.05,-0.69,0.05,0.07,0.13,-
1.89,0.15,0.10,-0.02,-0.02,2.23,0.14,-0.05,0.03,0.03,-0.08,0.01,-0.09,NA,-
0.70,0.02,0.01,-0.06,0.00,-0.03,-0.03,-1.37)
herat24yr2s <-
c(0.11,0.14,0.15,0.13,0.14,0.16,0.15,0.15,0.23,0.13,0.13,0.15,0.46,0.16,0.15,0.17,0.17,0.
42,0.26,0.14,0.13,0.16,0.13,0.14,0.13,NA,-0.36,0.18,0.14,0.14,0.14,0.14,0.14,-0.07)
herat25yr2s <- c(-0.11,-0.10,-0.05,-0.08,-0.06,-0.10,-0.09,-0.10,-0.15,-0.08,-0.08,-0.09,-
0.23,-0.08,-0.07,-0.10,-0.10,0.01,-0.09,-0.10,-0.09,-0.07,-0.11,-0.09,-0.10,NA,-0.23,-
0.02,-0.09,-0.10,-0.09,-0.08,-0.07,-0.20)
herat26yr2s <- c(0.01,0.04,0.09,0.06,0.06,0.50,0.09,-0.33,-0.11,-0.63,1.35,0.23,0.88,-
0.15,0.14,-0.13,0.33,0.05,0.07,-0.08,0.12,0.07,0.09,0.10,0.05,NA,-0.07,0.20,0.71,-
0.03,0.20,0.06,0.05,-0.25)
```

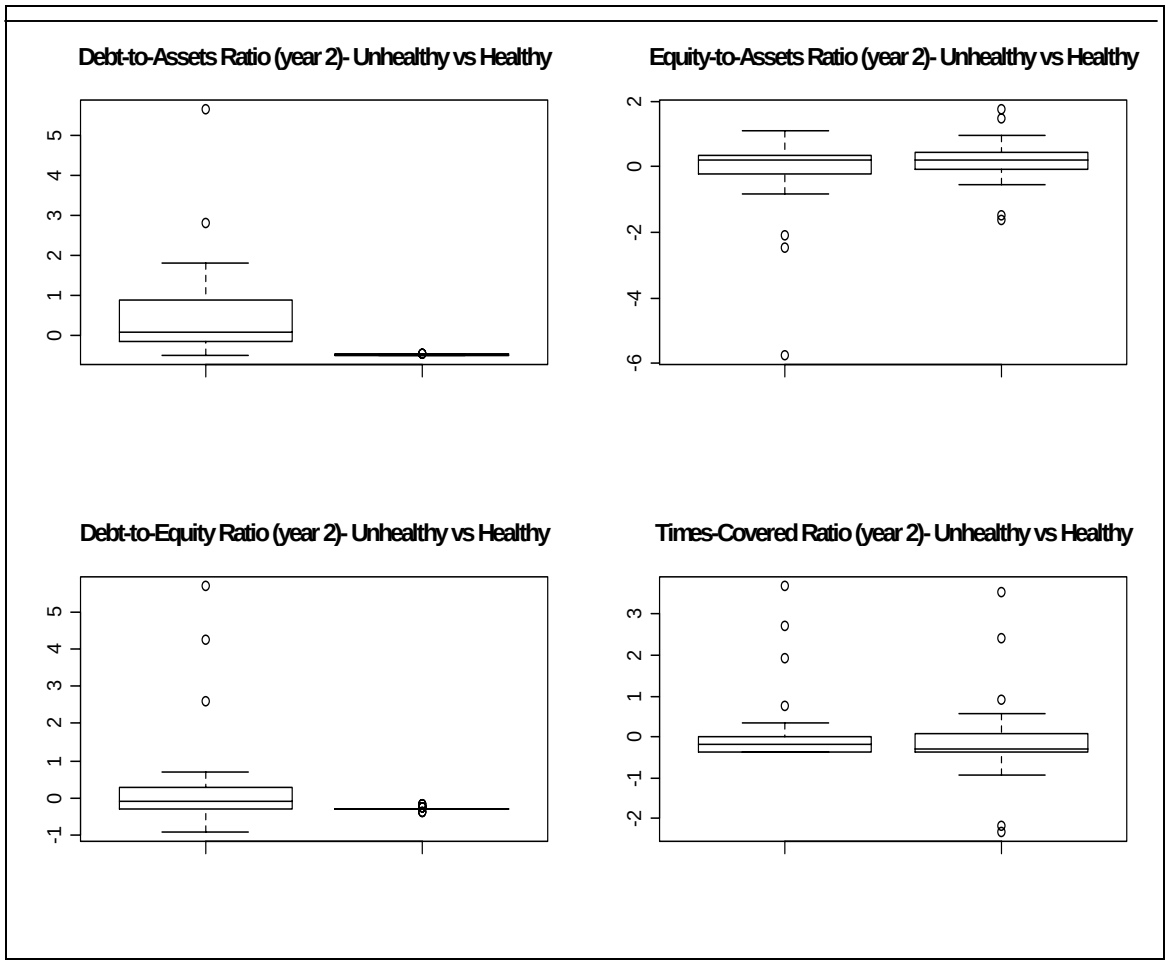
```
par(mfrow = c(2, 2))
boxplot(unrat1yr2s, herat1yr2s,main="Quick Ratio (year 2)- Unhealthy vs Healthy")
boxplot(unrat2yr2s, herat2yr2s,main="Current Ratio (year 2)- Unhealthy vs Healthy")
boxplot(unrat3yr2s, herat3yr2s,main="Return on Assets Ratio (year 2)- Unhealthy vs
Healthy")
boxplot(unrat4yr2s, herat4yr2s,main="Return-on-Equity Ratio (year 2)- Unhealthy vs
Healthy")
```



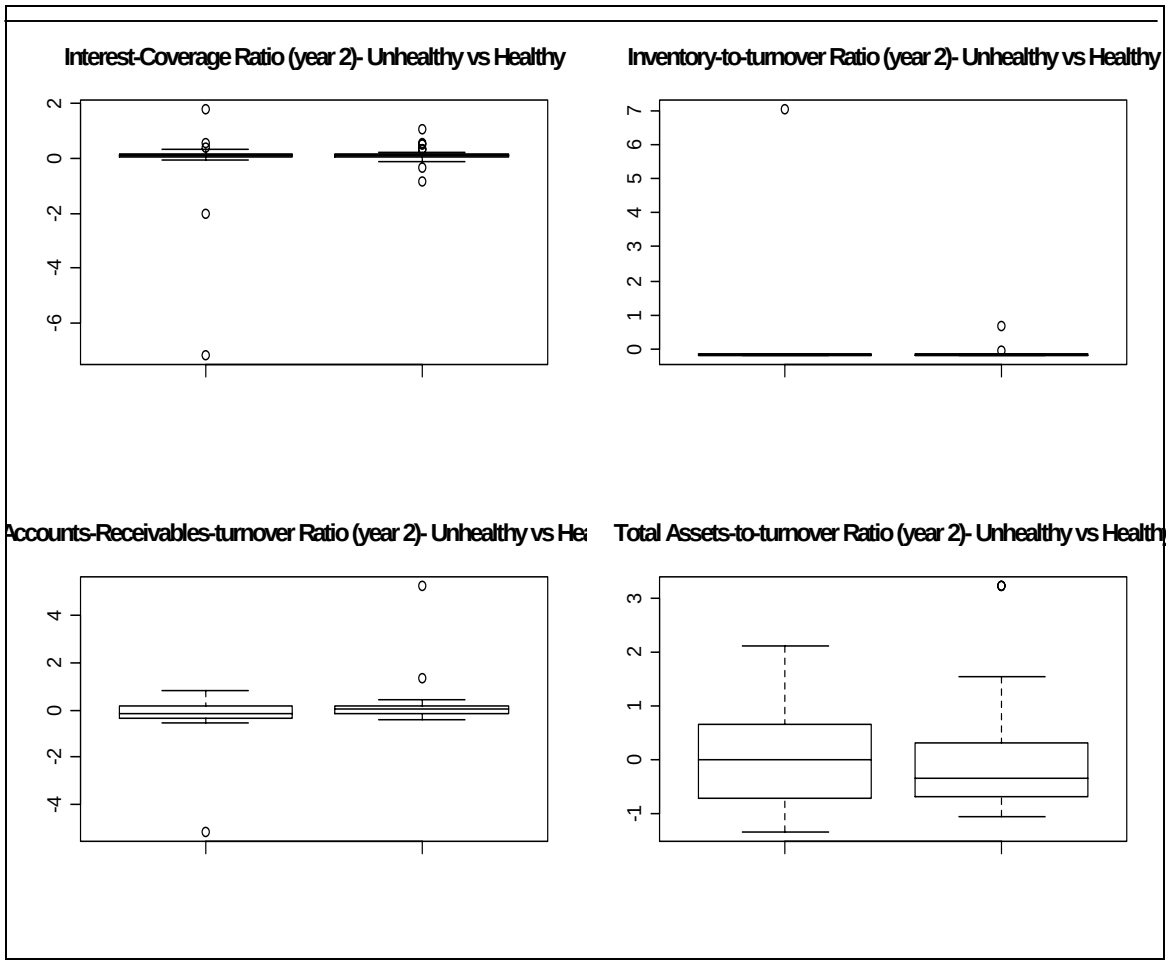
```
par(mfrow = c(2, 2))
boxplot(unrat5yr2s, herat5yr2s,main="Net Profit Margin Ratio (year 2)- Unhealthy vs
Healthy")
boxplot(unrat6yr2s, herat6yr2s,main="Gross Profit Margin Ratio (year 2)- Unhealthy vs
Healthy")
boxplot(unrat7yr2s, herat7yr2s,main="Return-on-Investment Ratio (year 2)- Unhealthy
vs Healthy")
boxplot(unrat8yr2s, herat8yr2s,main="Return-on-Sales Ratio (year 2)- Unhealthy vs
Healthy")
```



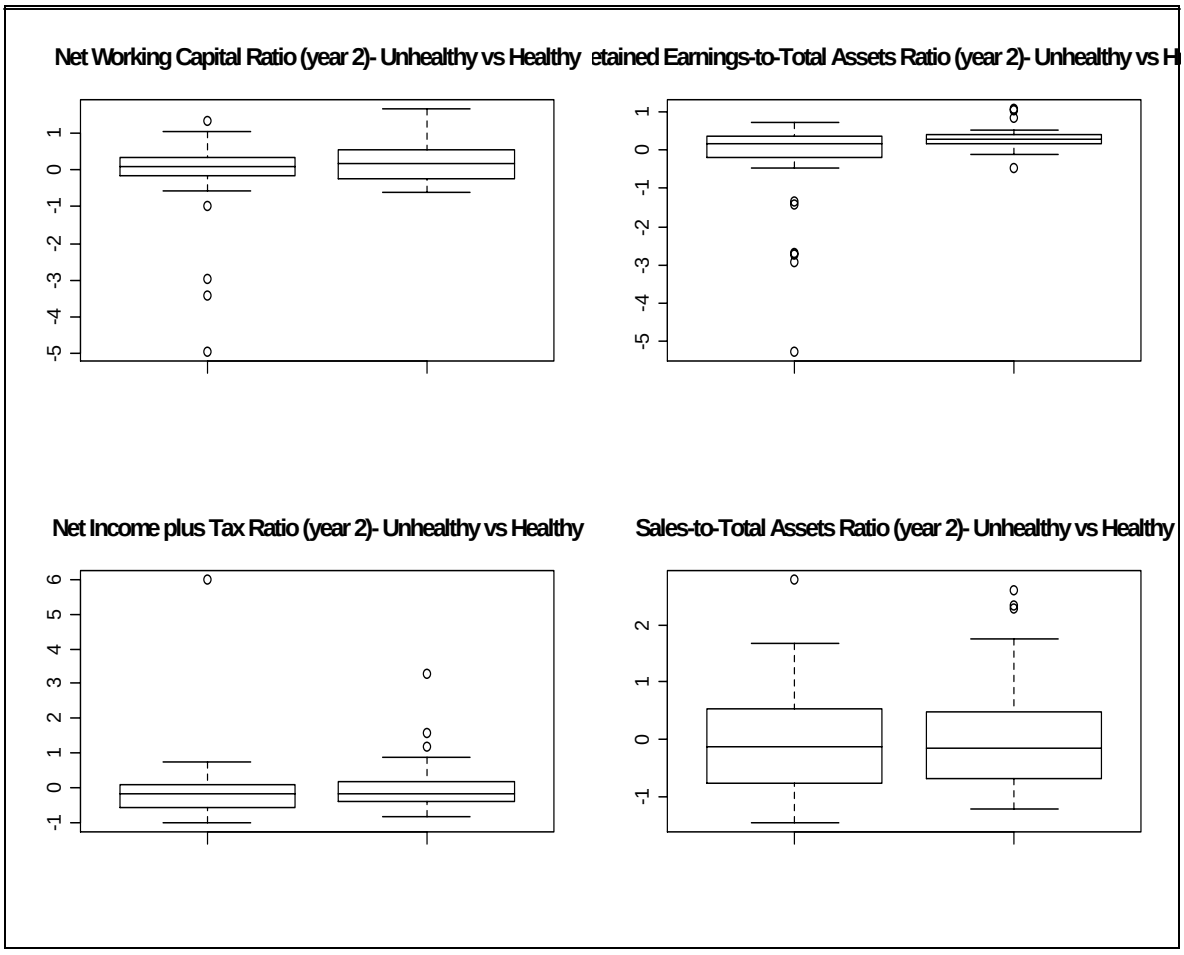
```
par(mfrow = c(2, 2))
boxplot(unrat9yr2s, herat9yr2s,main="Debt-to-Assets Ratio (year 2)- Unhealthy vs
Healthy")
boxplot(unrat10yr2s, herat10yr2s,main="Equity-to-Assets Ratio (year 2)- Unhealthy vs
Healthy")
boxplot(unrat11yr2s, herat11yr2s,main="Debt-to-Equity Ratio (year 2)- Unhealthy vs
Healthy")
boxplot(unrat12yr2s, herat12yr2s,main="Times-Covered Ratio (year 2)- Unhealthy vs
Healthy")
```



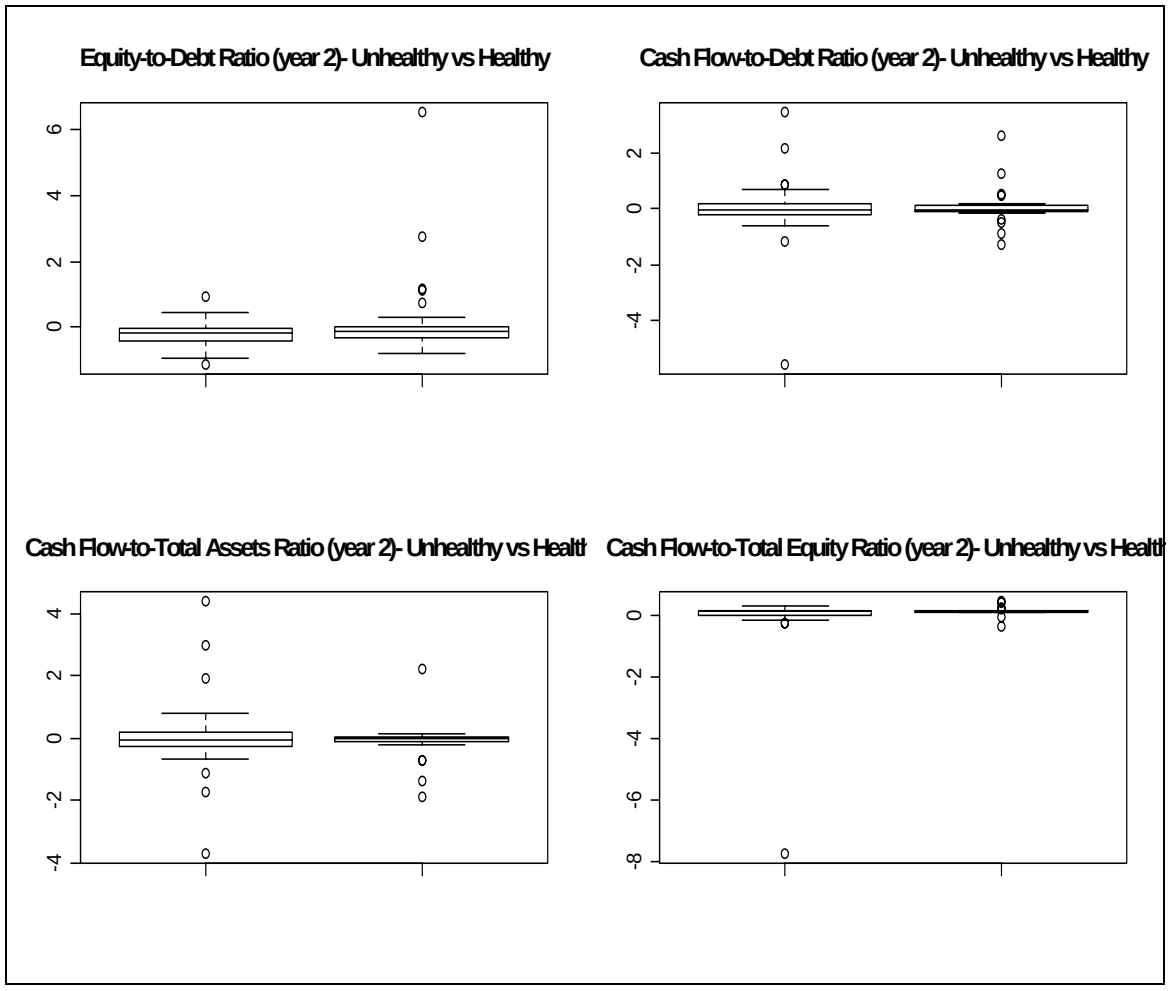
```
par(mfrow = c(2, 2))
boxplot(unrat13yr2s, herat13yr2s,main="Interest-Coverage Ratio (year 2)- Unhealthy vs
Healthy")
boxplot(unrat14yr2s, herat14yr2s,main="Inventory-to-turnover Ratio (year 2)- Unhealthy
vs Healthy")
boxplot(unrat15yr2s, herat15yr2s,main="Accounts-Receivables-turnover Ratio (year 2)-
Unhealthy vs Healthy")
boxplot(unrat16yr2s, herat16yr2s,main="Total Assets-to-turnover Ratio (year 2)-
Unhealthy vs Healthy")
```



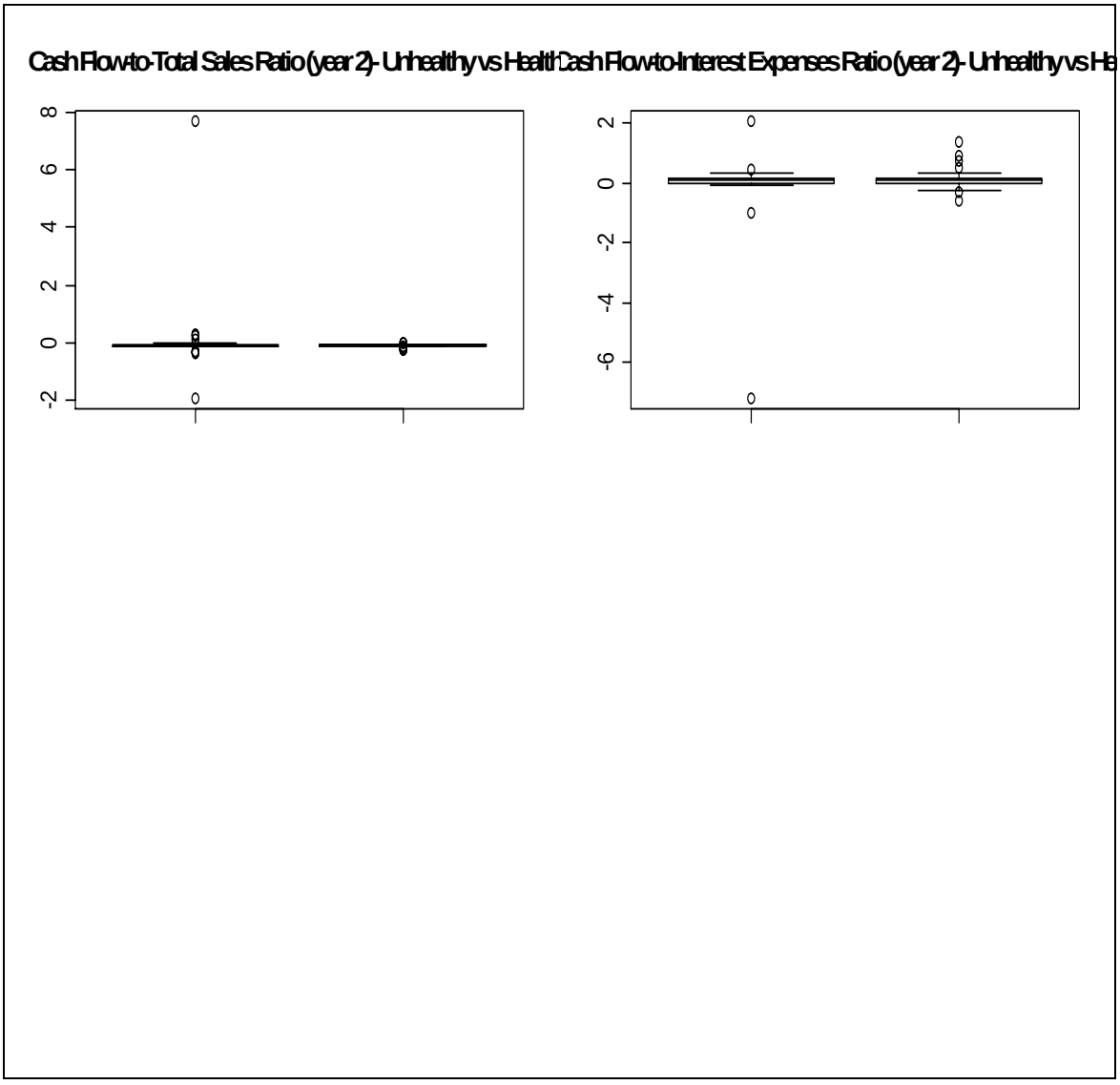
```
par(mfrow = c(2, 2))
boxplot(unrat17yr2s, herat17yr2s,main="Net Working Capital Ratio (year 2)- Unhealthy
vs Healthy")
boxplot(unrat18yr2s, herat18yr2s,main="Retained Earnings-to-Total Assets Ratio (year
2)- Unhealthy vs Healthy")
boxplot(unrat19yr2s, herat19yr2s,main="Net Income plus Tax Ratio (year 2)- Unhealthy
vs Healthy")
boxplot(unrat20yr2s, herat20yr2s,main="Sales-to-Total Assets Ratio (year 2)- Unhealthy
vs Healthy")
```



```
par(mfrow = c(2, 2))
boxplot(unrat21yr2s, herat21yr2s,main="Equity-to-Debt Ratio (year 2)- Unhealthy vs
Healthy")
boxplot(unrat22yr2s, herat22yr2s,main="Cash Flow-to-Debt Ratio (year 2)- Unhealthy vs
Healthy")
boxplot(unrat23yr2s, herat23yr2s,main="Cash Flow-to-Total Assets Ratio (year 2)-
Unhealthy vs Healthy")
boxplot(unrat24yr2s, herat24yr2s,main="Cash Flow-to-Total Equity Ratio (year 2)-
Unhealthy vs Healthy")
```

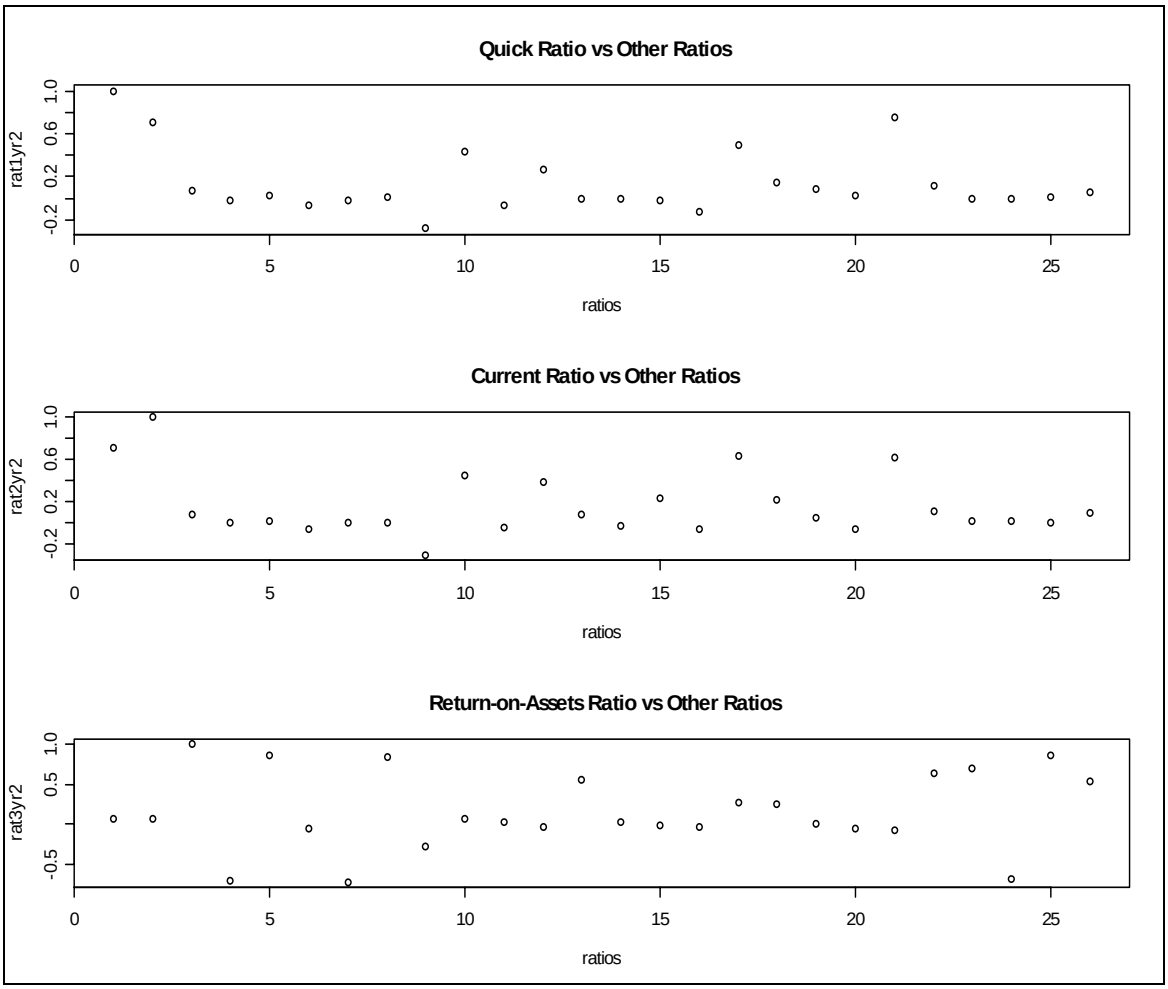


```
par(mfrow = c(2, 2))
boxplot(unrat25yr2s, herat25yr2s,main="Cash Flow-to-Total Sales Ratio (year 2)-
Unhealthy vs Healthy")
boxplot(unrat26yr2s, herat26yr2s,main="Cash Flow-to-Interest Expenses Ratio (year 2)-
Unhealthy vs Healthy")
```

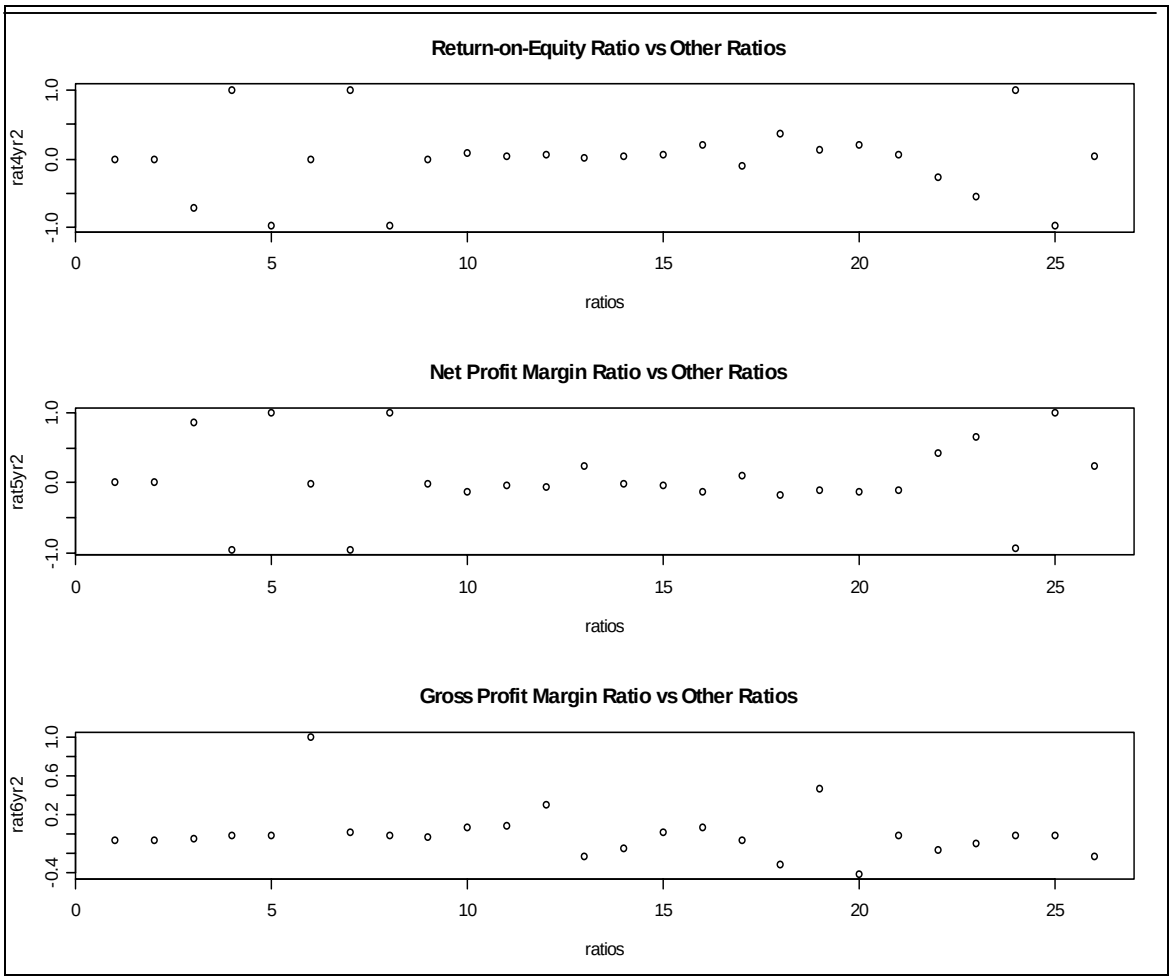


In order to select the financial ratios, each financial ratio will be compared to each other using the information calculated in the cross correlation matrix.

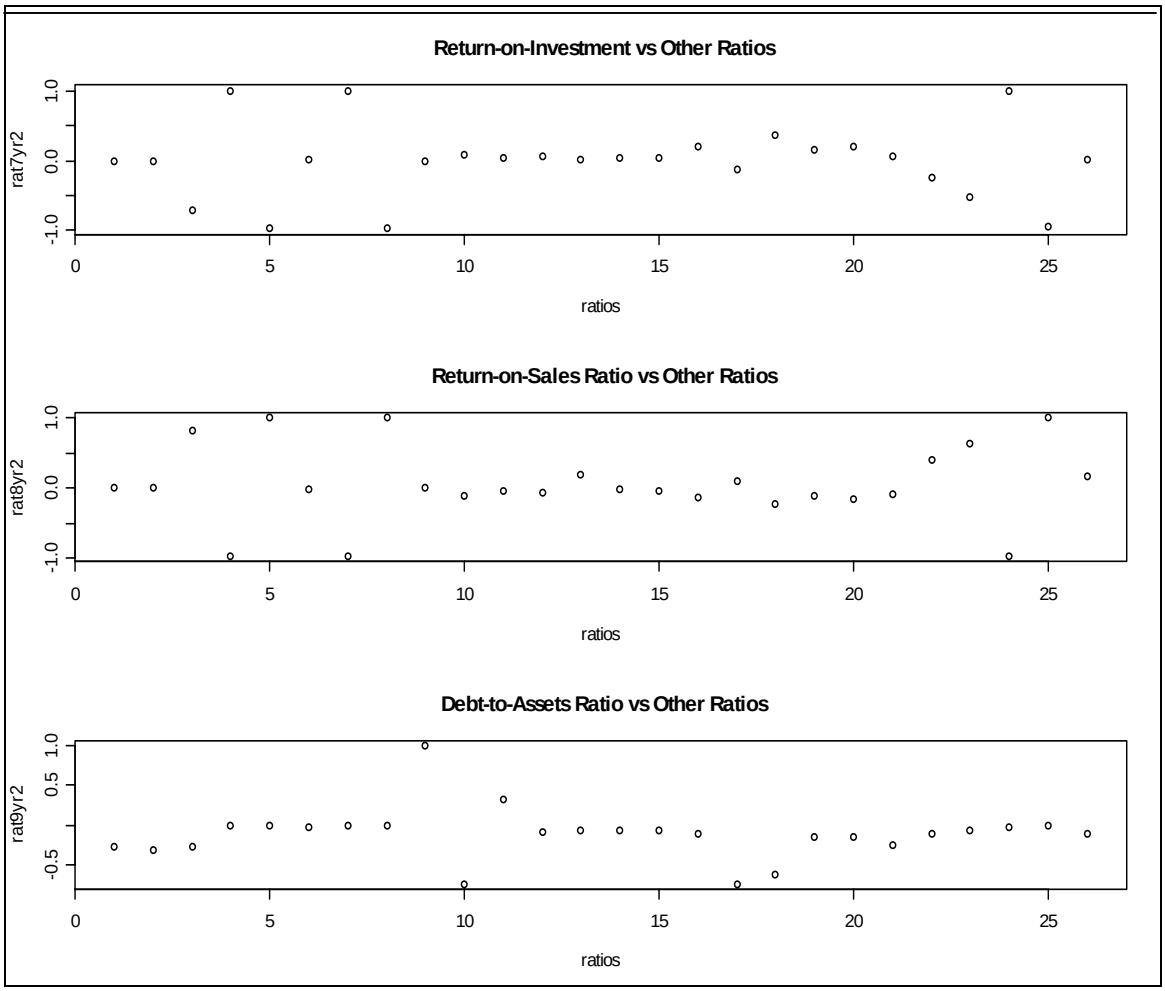
```
par(mfrow = c(3,1))
plot(ratios, rat1yr2, main=" Quick Ratio vs Other Ratios")
plot(ratios, rat2yr2, main=" Current Ratio vs Other Ratios")
plot(ratios, rat3yr2, main=" Return-on-Assets Ratio vs Other Ratios")
```



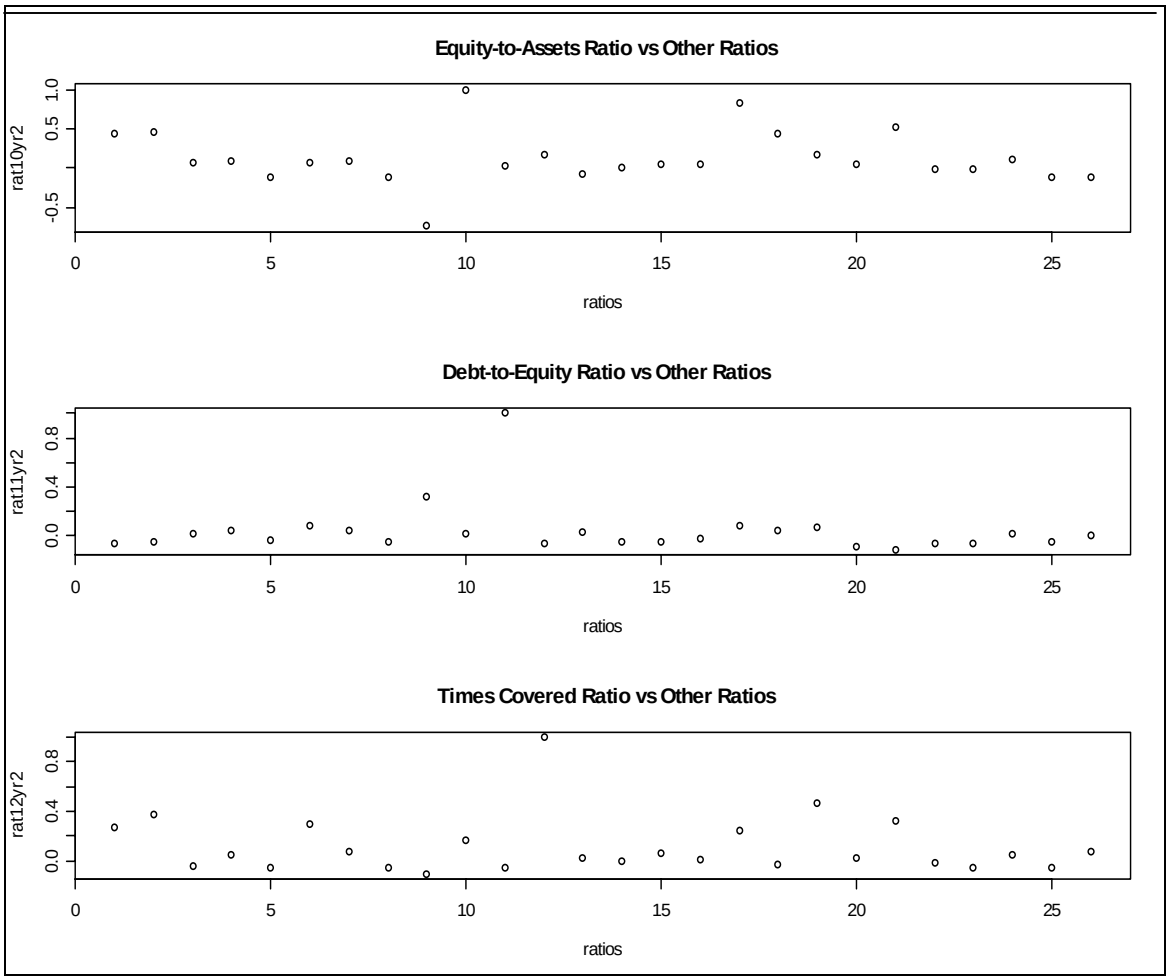
```
par(mfrow = c(3,1))
plot(ratios, rat4yr2, main=" Return-on-Equity Ratio vs Other Ratios")
plot(ratios, rat5yr2, main=" Net Profit Margin Ratio vs Other Ratios")
plot(ratios, rat6yr2, main=" Gross Profit Margin Ratio vs Other Ratios")
```



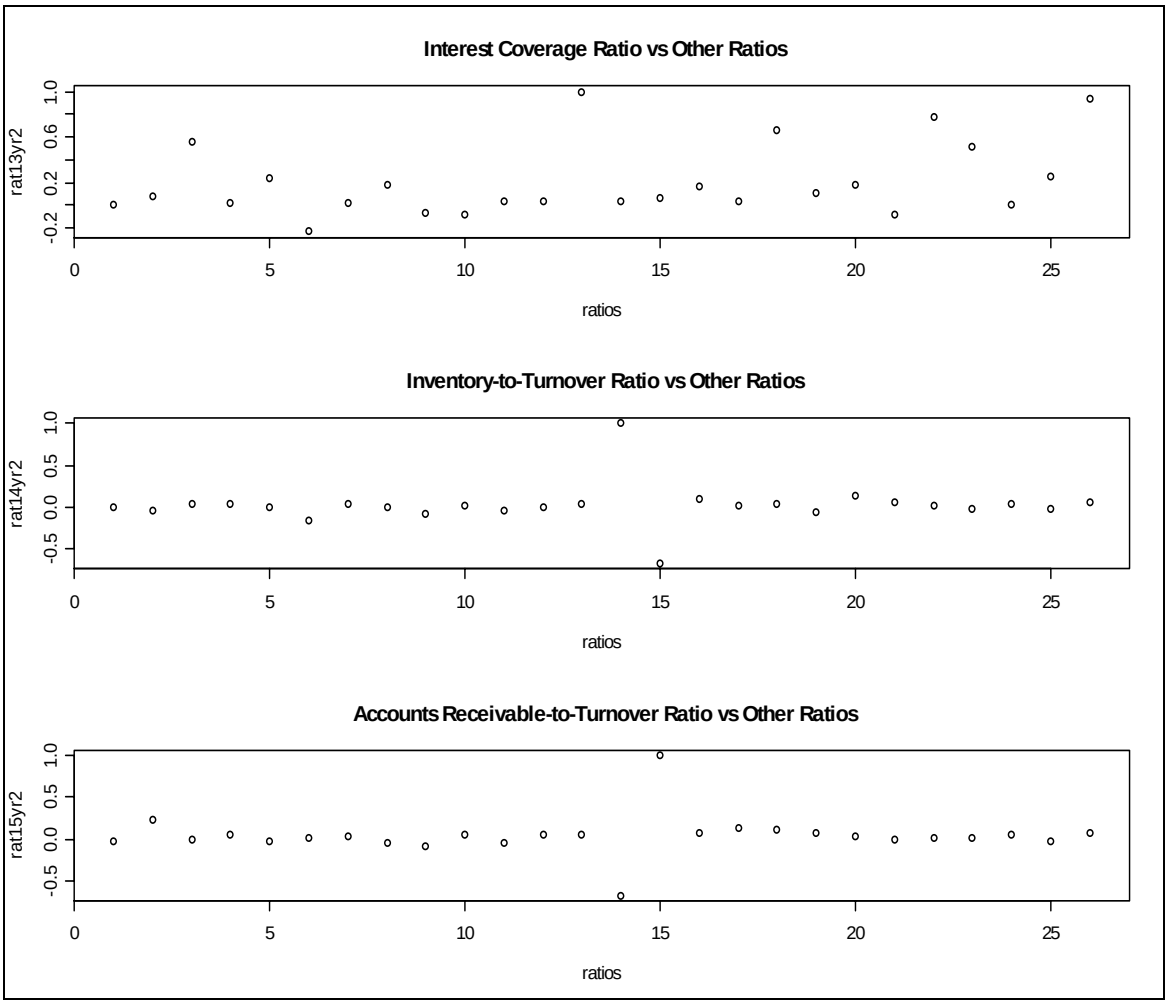
```
par(mfrow = c(3,1))
plot(ratios, rat7yr2, main=" Return-on-Investment vs Other Ratios")
plot(ratios, rat8yr2, main=" Return-on-Sales Ratio vs Other Ratios")
plot(ratios, rat9yr2, main=" Debt-to-Assets Ratio vs Other Ratios")
```



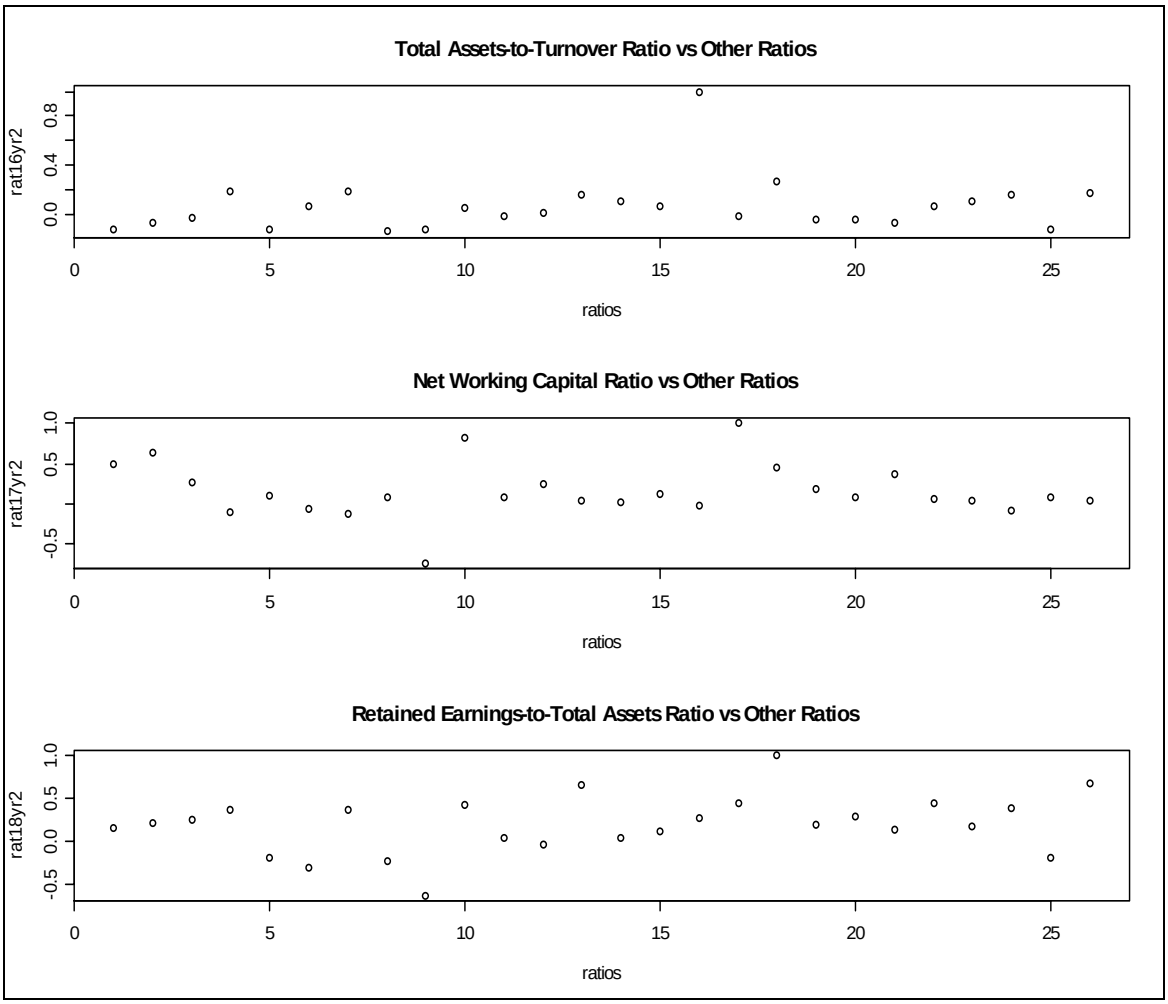
```
par(mfrow = c(3,1))
plot(ratios, rat10yr2, main=" Equity-to-Assets Ratio vs Other Ratios")
plot(ratios, rat11yr2, main=" Debt-to-Equity Ratio vs Other Ratios")
plot(ratios, rat12yr2, main=" Times Covered Ratio vs Other Ratios")
```



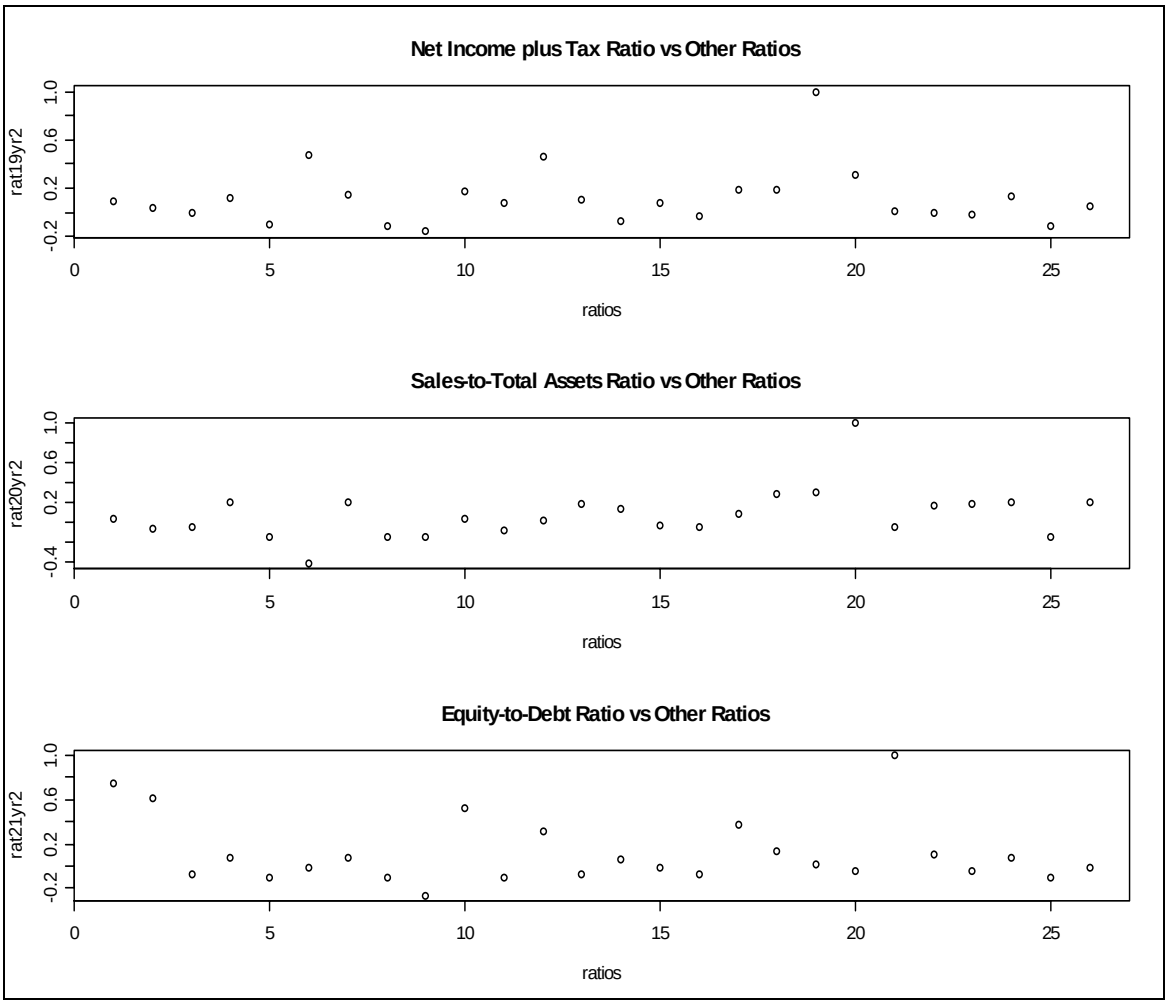
```
par(mfrow = c(3,1))
plot(ratios, rat13yr2, main=" Interest Coverage Ratio vs Other Ratios")
plot(ratios, rat14yr2, main=" Inventory-to-Turnover Ratio vs Other Ratios")
plot(ratios, rat15yr2, main=" Accounts Receivable-to-Turnover Ratio vs Other Ratios")
```



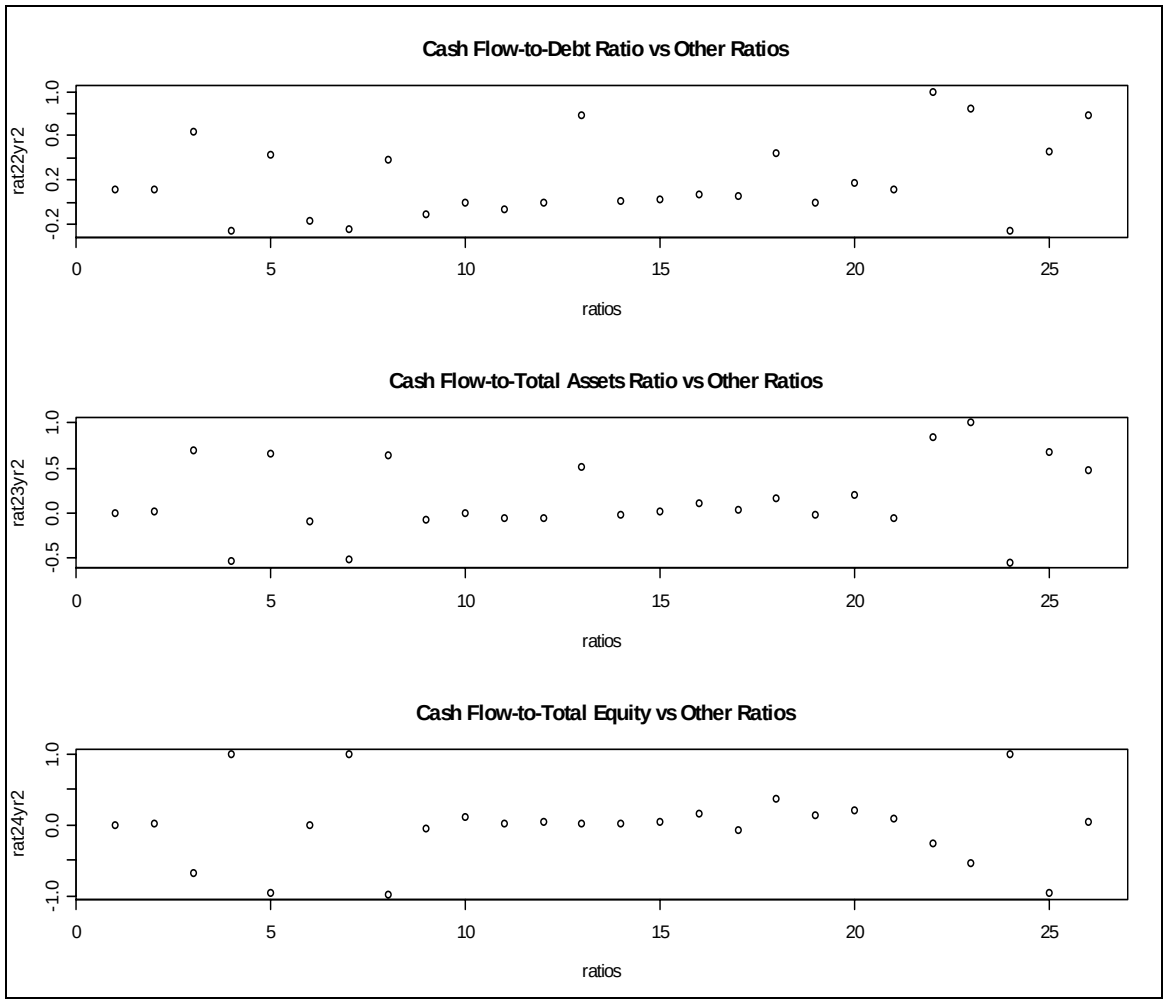
```
par(mfrow = c(3,1))
plot(ratios, rat16yr2, main=" Total Assets-to-Turnover Ratio vs Other Ratios")
plot(ratios, rat17yr2, main=" Net Working Capital Ratio vs Other Ratios")
plot(ratios, rat18yr2, main=" Retained Earnings-to-Total Assets Ratio vs Other Ratios")
```



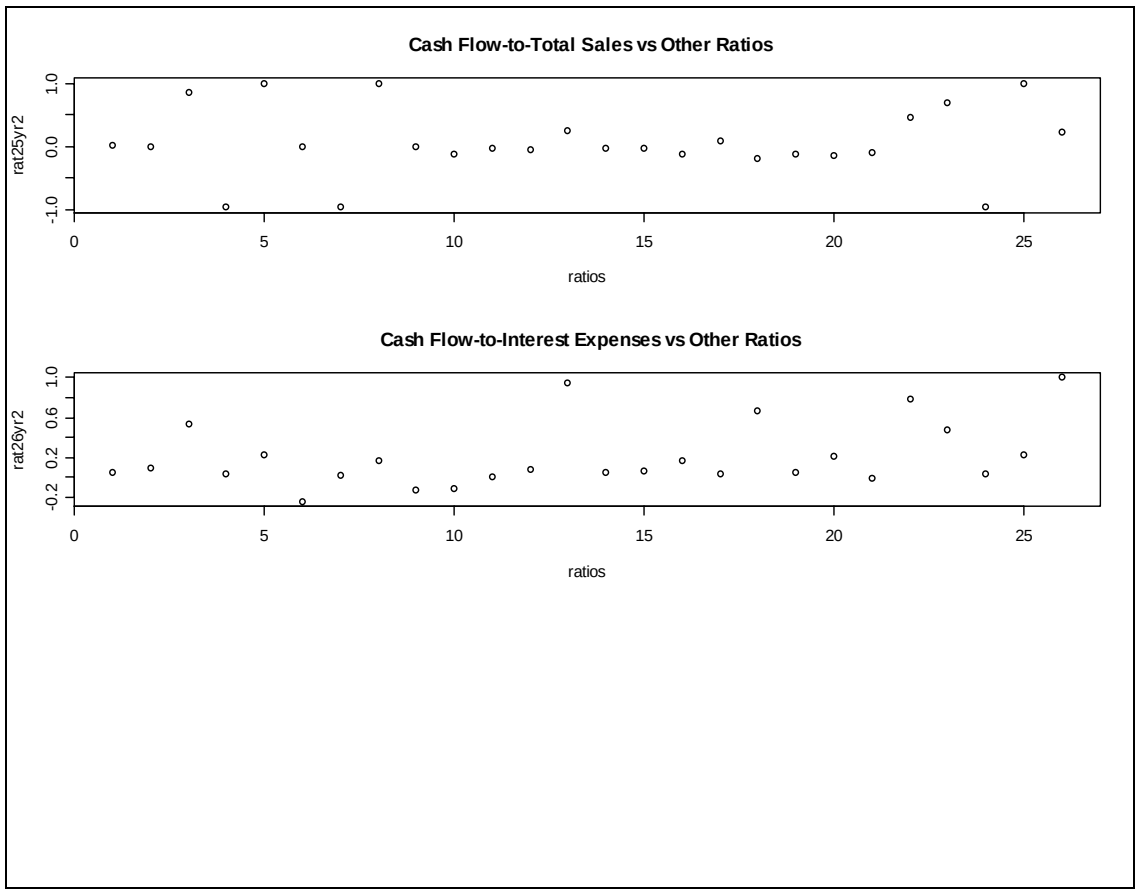
```
par(mfrow = c(3,1))
plot(ratios, rat19yr2, main=" Net Income plus Tax Ratio vs Other Ratios")
plot(ratios, rat20yr2, main=" Sales-to-Total Assets Ratio vs Other Ratios")
plot(ratios, rat21yr2, main=" Equity-to-Debt Ratio vs Other Ratios")
```



```
par(mfrow = c(3,1))
plot(ratios, rat22yr2, main=" Cash Flow-to-Debt Ratio vs Other Ratios")
plot(ratios, rat23yr2, main=" Cash Flow-to-Total Assets Ratio vs Other Ratios")
plot(ratios, rat24yr2, main=" Cash Flow-to-Total Equity vs Other Ratios")
```



```
par(mfrow = c(3,1))
plot(ratios, rat25yr2, main=" Cash Flow-to-Total Sales vs Other Ratios")
plot(ratios, rat26yr2, main=" Cash Flow-to-Interest Expenses vs Other Ratios")
```



APPENDIX E
BOXPLOTS YEAR 3

Appendix E shows the complete set of Boxplots of the data two year before bankruptcy. Also, it shows the R-language commands used to calculate the figures mentioned before.

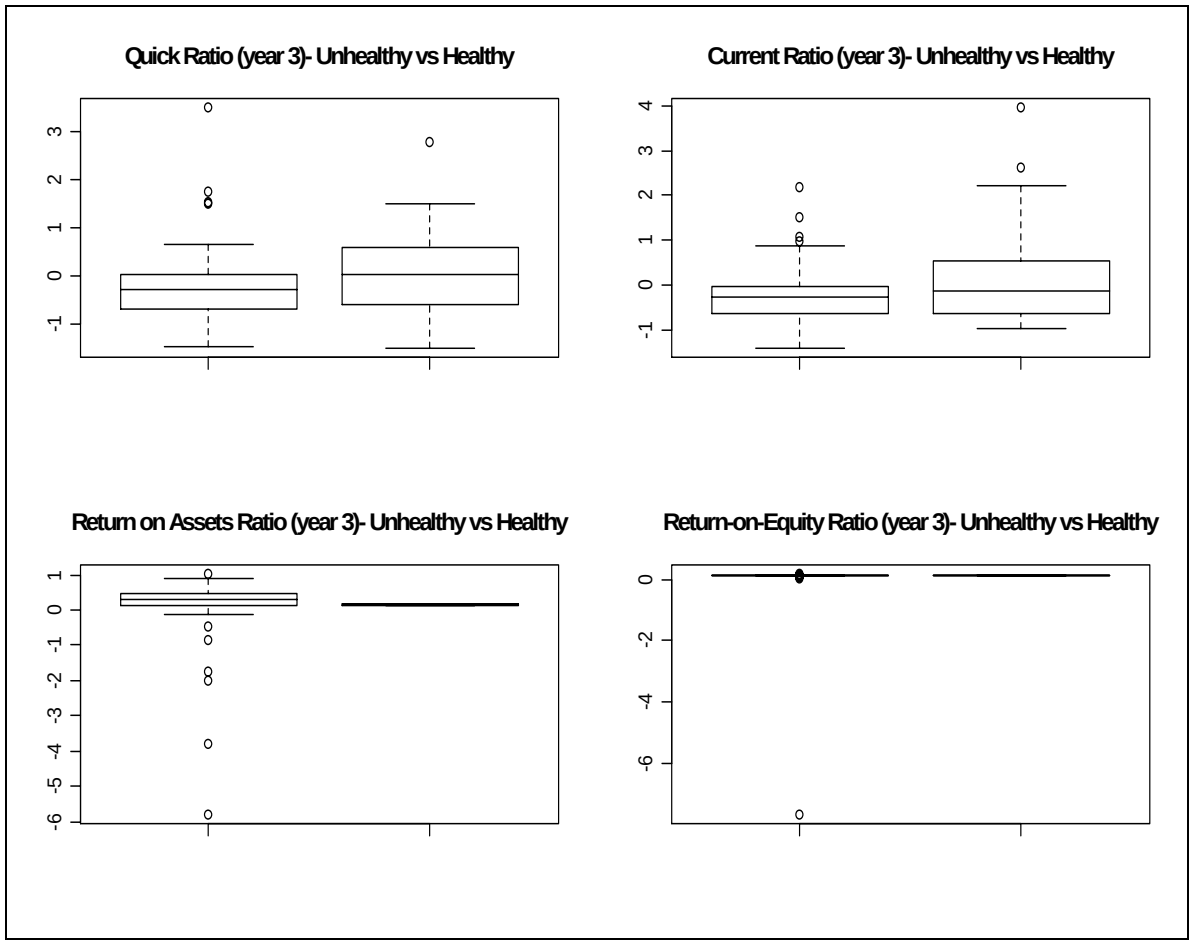
```
## Vectors creation
## un: Unhealthy and he: Healthy
unrat1yr3s <- c(-0.13,3.49,-0.06,-0.58,NA,-0.50,0.04,-0.28,-0.06,-0.92,-0.22,-0.47,-
0.36,1.51,0.65,NA,NA,-1.32,-0.69,-0.16,0.05,-1.34,-0.31,1.75,-0.69,-0.82,1.52,-1.18,-
1.12,-1.47,0.04,NA,0.46)
unrat2yr3s <- c(-0.27,2.17,-0.16,-0.61,NA,-0.54,-0.29,-0.25,-0.18,-0.98,-0.23,-0.32,-
0.16,1.53,0.31,NA,NA,-1.38,-0.38,-0.34,-0.25,-1.39,-0.61,0.97,-0.93,-0.81,0.88,1.07,-
1.21,-1.32,-0.01,NA,0.18)
unrat3yr3s <- c(0.52,-
0.87,0.32,1.02,NA,0.45,0.50,0.27,0.34,0.42,0.46,0.24,0.38,0.32,0.53,NA,NA,-
1.74,0.41,0.30,0.13,-3.80,0.53,0.17,0.91,0.22,-5.80,-0.46,0.18,-2.01,-0.13,0.62,0.42)
unrat4yr3s <-
c(0.13,0.11,0.13,0.16,NA,0.13,NA,0.13,0.13,0.11,0.13,0.13,0.13,0.13,0.13,NA,NA,0.15,
0.13,0.13,0.13,0.18,0.14,NA,-7.68,0.13,0.05,0.12,0.13,0.14,0.11,0.15,0.14)
unrat5yr3s <-
c(0.19,0.19,0.19,0.19,0.19,0.19,0.30,0.21,0.22,0.23,0.24,0.22,0.23,0.22,0.29,NA,NA,-
0.64,0.23,0.21,0.19,-2.59,0.26,0.20,0.31,0.20,-7.18,-0.78,0.24,-1.05,0.13,0.30,0.28)
unrat6yr3s <- c(-0.67,-0.88,4.41,0.33,-0.67,0.30,0.04,-0.33,-0.52,-0.31,-0.33,0.45,-
0.22,0.11,0.53,NA,NA,-1.07,-0.50,-0.22,-0.47,-4.02,-0.15,0.33,-0.48,-
0.13,0.87,1.44,0.76,-1.26,-0.32,-0.10,0.36)
unrat7yr3s <- c(3.18,-0.05,4.81,-0.02,NA,-0.05,-0.05,-0.05,-0.05,-0.37,-0.05,-0.05,-0.05,-
0.05,-0.05,NA,NA,0.52,-0.05,-0.05,-0.05,-0.01,-0.05,NA,-5.21,-0.05,-0.10,-0.06,-0.05,-
0.04,-0.06,-0.04,-0.05)
unrat8yr3s <- c(0.19,-
0.23,0.17,0.41,0.17,0.17,0.34,0.14,0.16,0.16,0.21,0.17,0.19,0.16,0.30,NA,NA,-
0.70,0.16,0.14,0.08,-2.60,0.24,0.13,0.23,0.15,-7.10,-0.85,0.25,-1.10,0.10,0.24,0.25)
unrat9yr3s <- c(-0.48,NA,-0.48,-0.47,NA,-0.47,0.04,-0.45,0.08,1.30,0.32,1.31,0.68,-
0.44,0.15,NA,NA,3.60,-0.05,-0.08,0.00,3.21,0.14,NA,0.08,0.68,-
0.32,0.62,0.71,4.59,0.96,-0.37,1.11)
unrat10yr3s <- c(0.52,1.31,0.18,-0.04,NA,0.08,NA,0.20,0.08,-1.13,0.18,-
0.35,0.34,1.27,0.55,NA,NA,-3.38,0.22,0.34,0.01,-2.74,0.21,NA,-0.80,-
0.30,1.33,0.70,0.43,-4.86,-0.20,-0.23,-0.13)
unrat11yr3s <- c(NA,NA,NA,-0.30,NA,1.62,-0.13,-0.28,0.37,-1.88,0.83,4.08,0.89,-
0.28,0.35,NA,NA,-1.92,0.16,0.13,0.06,-0.52,-0.01,NA,-0.31,3.09,-0.24,0.56,0.72,-
0.31,1.79,-0.09,3.01)
unrat12yr3s <- c(1.32,1.30,6.11,0.31,NA,-0.24,NA,0.49,-0.32,-0.30,-0.25,-0.26,-
0.23,2.84,-0.13,NA,NA,-0.38,-0.16,-0.20,-0.10,-0.50,-0.14,-0.31,NA,-0.17,-0.31,-0.30,-
0.37,-0.38,-0.34,0.61,-0.28)
unrat13yr3s <- c(4.65,4.58,0.18,0.95,-0.08,-0.20,NA,-0.03,-0.08,-0.26,-0.15,-0.26,-
0.18,0.78,-0.05,NA,NA,-0.43,-0.11,-0.24,-0.45,-1.15,0.01,-0.29,NA,-0.23,-2.36,-0.54,-
0.29,-0.36,-0.30,0.86,-0.22)
```

```
unrat14yr3s <- c(NA,NA,-0.49,NA,-0.54,0.09,0.32,-0.35,-0.48,1.02,-0.43,-0.59,-0.37,-
0.55,-0.29,NA,NA,-0.37,-0.55,0.59,-0.16,-0.48,NA,-0.16,-0.04,-0.45,0.21,-
0.65,NA,4.01,NA,0.54,-0.22)
unrat15yr3s <- c(6.38,NA,0.22,-1.26,NA,-0.08,-0.28,-0.15,-0.18,-0.08,-0.16,-0.26,-0.11,-
0.23,-0.23,NA,NA,-0.30,0.00,-0.18,-0.28,-0.33,-0.22,-0.37,-0.32,-0.03,-0.37,-0.19,NA,-
0.25,NA,-0.28,-0.27)
unrat16yr3s <- c(1.79,-0.01,0.69,0.10,NA,0.22,-0.48,1.13,1.05,2.40,0.84,-0.46,0.77,0.46,-
0.01,NA,NA,-0.90,1.39,1.39,1.06,-1.18,0.69,-0.90,0.21,0.51,-1.38,-1.37,NA,-
1.13,NA,0.18,0.03)
unrat17yr3s <- c(0.13,1.69,0.37,0.13,NA,-0.23,-0.27,0.40,0.42,-
1.15,0.13,0.07,0.08,1.25,0.26,NA,NA,-2.43,0.10,0.10,0.39,-3.61,-0.25,1.02,-1.12,-
0.49,0.64,0.59,-0.59,-4.64,0.55,NA,0.26)
unrat18yr3s <- c(0.25,0.08,0.05,0.24,NA,0.36,0.12,0.39,0.20,-0.75,0.35,-
0.05,0.45,0.35,0.57,NA,NA,-1.91,0.32,0.38,0.31,-1.69,0.18,NA,-2.99,NA,-5.66,-
0.19,NA,-0.11,-0.02,NA,0.08)
unrat19yr3s <- c(-0.45,0.40,6.06,0.31,NA,0.36,-0.86,-0.07,-0.30,0.34,-0.13,0.06,-
0.02,0.41,0.30,NA,NA,-0.99,-0.21,0.21,-0.24,-1.85,0.02,-0.37,-0.31,0.05,-0.62,-0.61,-
0.71,-1.04,-0.39,-0.17,-0.07)
unrat20yr3s <- c(1.28,-0.26,0.34,-0.16,NA,-0.06,-0.65,0.54,0.73,1.51,0.38,-
0.59,0.30,0.31,-0.38,NA,NA,-0.95,0.90,0.81,0.65,-1.23,0.20,-1.01,0.44,0.19,-1.43,-1.48,-
1.50,-1.12,-0.32,-0.26,-0.66)
unrat21yr3s <- c(0.44,NA,-0.02,-0.33,NA,-0.31,NA,-0.22,-0.31,-0.86,-0.23,-0.45,-
0.09,2.01,0.15,NA,NA,-1.23,-0.19,-0.09,-0.36,-1.16,-0.21,NA,-0.76,-
0.54,2.40,0.38,0.01,-1.34,-0.49,0.45,-0.45)
unrat22yr3s <- c(0.11,NA,0.13,0.14,NA,0.53,3.05,-0.13,-0.13,1.52,-0.11,-0.81,-
0.02,0.05,0.24,NA,NA,-0.47,-0.10,-0.07,-0.22,-0.73,0.06,-0.24,0.59,-0.18,-5.94,-0.46,-
0.19,-0.46,-0.25,0.72,-0.11)
unrat23yr3s <- c(0.00,NA,0.09,0.25,NA,0.93,2.57,-0.14,-0.13,4.32,-0.11,-0.98,0.01,-
0.14,0.27,NA,NA,-1.28,-0.10,-0.07,-0.27,-2.20,0.14,-0.29,1.66,-0.19,-3.47,-0.55,-0.25,-
1.50,-0.31,0.05,-0.07)
unrat24yr3s <- c(-0.02,NA,0.05,0.17,NA,0.41,NA,-0.04,-0.03,-5.29,-0.03,-0.66,0.00,-
0.08,0.05,NA,NA,0.02,-0.03,-0.03,-0.09,0.24,0.06,NA,NA,-0.01,-0.66,-0.17,-0.09,-0.01,-
0.10,0.13,0.03,)
unrat25yr3s <- c(0.09,NA,0.15,0.25,NA,0.47,1.65,0.07,0.07,0.87,0.09,-
0.32,0.12,0.08,0.29,NA,NA,-0.71,0.08,0.08,0.04,-2.31,0.17,0.06,0.57,0.07,-6.86,-
0.60,0.28,-1.17,0.03,0.18,0.17)
unrat26yr3s <- c(4.10,NA,1.18,0.90,NA,0.18,NA,0.43,-0.11,0.64,-0.19,-0.62,-
0.11,1.41,0.14,NA,NA,-0.48,-0.06,-0.17,-0.22,-1.26,0.13,-0.30,NA,-0.21,-2.85,-0.53,-
0.31,-0.40,-0.32,1.55,-0.21)
herat1yr3s <- c(-0.30,0.50,-0.83,1.34,-0.54,-0.55,1.38,0.13,-0.65,1.50,2.79,0.57,-
0.54,0.02,0.41,-0.47,0.07,NA,-0.05,0.62,NA,-0.78,0.77,0.42,1.02,NA,-0.82,-0.92,-0.97,-
0.14,-1.50,0.11,-0.71,1.29)
herat2yr3s <- c(-0.45,-0.04,-0.85,0.72,-0.73,-0.63,2.21,-0.32,-0.89,1.09,1.73,0.07,-0.82,-
0.23,0.24,-0.68,-0.37,0.07,-0.27,0.19,0.80,-0.79,0.15,0.13,0.40,-0.37,-0.97,-0.56,3.95,-
0.22,0.55,2.61,-0.85,0.63)
```

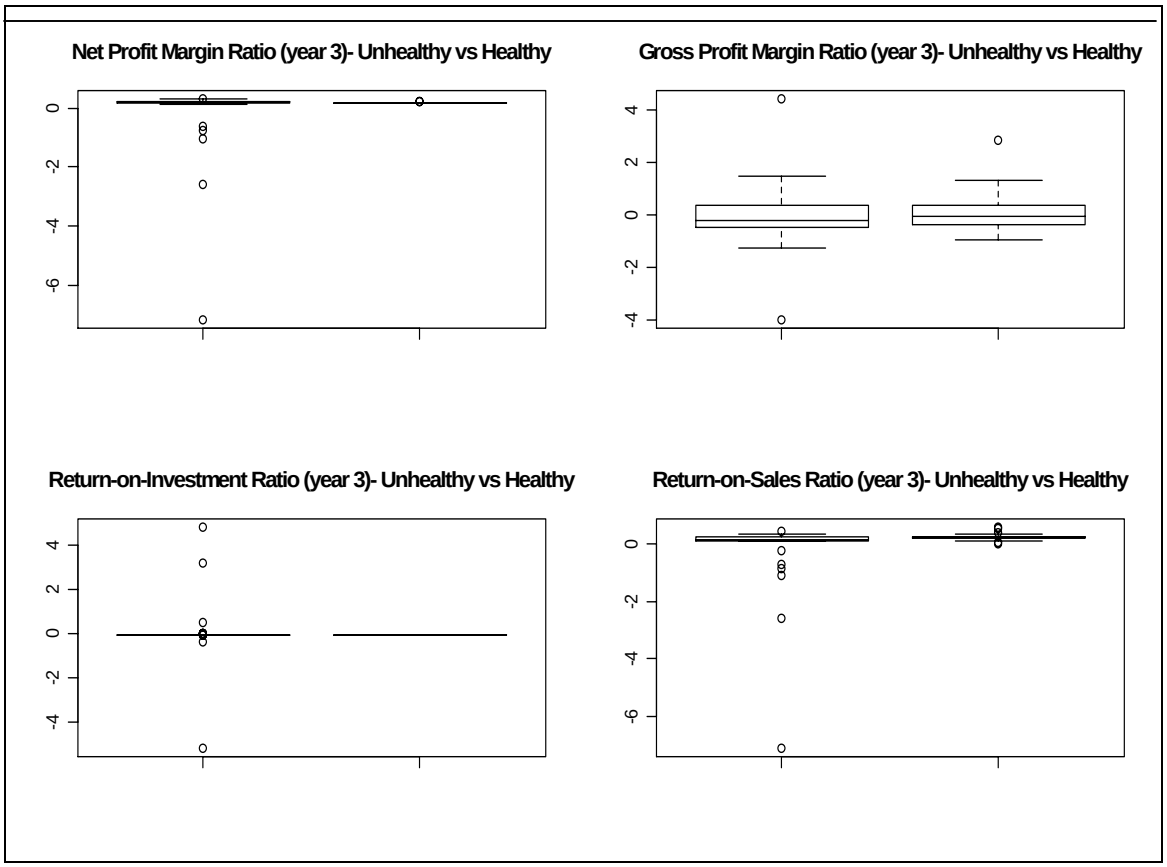
```
herat3yr3s <-
c(0.16,0.15,0.16,0.16,0.16,0.15,0.16,0.15,0.15,0.16,0.16,0.16,0.15,0.16,0.16,0.15,0.15,0.
16,0.15,0.16,0.16,0.16,0.15,0.16,0.15,NA,0.16,0.16,0.16,0.16,0.16,0.16,0.15,0.16)
herat4yr3s <-
c(0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.
13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,NA,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13)
herat5yr3s <-
c(0.19,0.19,0.19,0.19,0.20,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.
19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,NA,0.19,0.20,0.19,0.19,0.19,0.19,0.19,0.19)
herat6yr3s <- c(0.56,-0.30,1.27,0.24,-0.38,-0.67,-0.41,-0.19,-0.59,0.56,0.20,0.04,-0.06,-
0.41,0.21,-0.69,-0.72,-0.33,-0.98,-0.06,0.49,-0.09,-0.26,1.10,1.32,0.35,-0.51,2.84,0.19,-
0.04,-0.45,-0.16,0.34,0.32)
herat7yr3s <- c(-0.05,-0.05,-0.05,-0.05,-0.05,-0.05,-0.05,-0.05,-0.05,-0.05,-0.05,-0.05,-
0.05,-0.05,-0.05,-0.05,-0.05,-0.05,-0.05,-0.05,-0.05,-0.05,-0.05,-0.05,-0.05,NA,-0.05,-
0.05,-0.05,-0.05,-0.05,-0.05,-0.05)
herat8yr3s <-
c(0.23,0.12,0.51,0.25,0.23,0.16,0.26,0.19,0.00,0.24,0.26,0.25,0.21,0.17,0.34,0.08,0.15,0.
26,0.04,0.25,0.23,0.20,0.09,0.23,0.21,NA,0.18,0.57,0.30,0.27,0.30,0.40,0.23,0.27)
herat9yr3s <- c(-0.46,-0.47,-0.47,-0.47,-0.47,-0.47,-0.47,-0.47,-0.46,-0.48,-0.49,-0.48,-
0.47,-0.47,-0.47,-0.46,-0.47,-0.48,-0.47,-0.48,-0.48,-0.47,-0.47,-0.47,-0.47,-0.47,-0.47,-
0.46,-0.47,-0.47,-0.47,-0.47,-0.47,-0.48)
herat10yr3s <- c(-0.33,-0.15,0.19,0.50,-0.05,-0.08,-0.08,0.27,-
0.82,1.41,1.59,0.69,0.23,0.29,0.40,-0.31,-0.26,0.67,-0.51,0.19,0.92,0.03,0.04,0.40,-0.18,-
0.07,-0.17,-0.28,0.16,0.08,0.32,0.19,0.10,0.85)
herat11yr3s <- c(-0.23,-0.26,-0.28,-0.29,-0.27,-0.27,-0.27,-0.29,-2.18,-0.31,-0.31,-0.30,-
0.28,-0.29,-0.29,-0.23,-0.24,-0.30,-0.30,-0.30,-0.30,-0.27,-0.27,-0.29,-0.26,-0.27,-0.26,-
0.24,-0.28,-0.28,-0.29,-0.28,-0.28,-0.30)
herat12yr3s <- c(-0.56,-0.29,-0.24,-0.28,-0.24,-0.08,-0.26,-1.16,-0.32,-0.97,1.36,0.08,-
0.51,-0.51,-0.20,-0.64,0.14,-0.36,-0.38,-0.64,-0.03,-0.30,-0.06,0.01,-0.12,NA,NA,-
0.03,0.75,-0.51,-0.27,-0.33,-0.30,-0.06,)
herat13yr3s <- c(-0.41,-0.29,-0.10,-0.21,-0.07,0.07,-0.06,-0.88,-0.43,-0.67,1.43,0.22,-
0.41,-0.41,-0.02,0.03,0.38,-0.27,-0.35,-0.61,-0.08,-0.24,-0.38,-0.12,-
0.21,NA,NA,0.03,1.14,-0.49,0.01,-0.16,-0.24,0.01)
herat14yr3s <- c(-0.58,NA,-0.51,-0.19,0.15,-0.33,-0.62,NA,3.89,-0.50,0.31,0.36,2.82,-
0.43,-0.38,0.09,NA,NA,-0.41,-0.44,NA,-0.47,NA,-0.53,NA,NA,0.47,NA,-0.64,-0.44,-
0.64,-0.65,-0.22,0.29)
herat15yr3s <- c(-0.28,0.01,-0.09,-0.02,0.08,0.28,-0.29,-0.19,-0.30,-0.21,-0.17,-0.16,-
0.07,-0.27,-0.07,-0.05,-0.11,-0.10,-0.21,-0.21,-0.35,-0.08,-0.19,-0.25,-0.27,-0.18,0.52,-
0.16,NA,-0.10,NA,3.60,-0.09,-0.21)
herat16yr3s <- c(0.29,-0.76,2.02,0.71,-0.50,-1.18,-0.23,-1.11,-0.22,0.13,-0.28,-0.92,-
0.12,-0.44,0.04,-1.17,-1.30,-1.09,-0.38,-0.06,-0.47,0.25,-1.24,-0.59,-0.76,-1.25,-
0.71,3.44,-0.49,-0.46,-0.13,1.37,0.73,-0.20)
herat17yr3s <- c(-0.02,0.02,-0.37,0.09,-0.34,-0.26,1.27,0.12,-0.80,0.34,0.69,0.38,-
0.52,0.16,-0.06,-0.35,0.30,0.58,0.07,0.52,0.55,-0.39,0.64,0.54,0.48,0.22,-0.59,-0.25,1.54,-
0.03,0.73,1.20,-0.38,0.14)
```

```
herat18yr3s <- c(0.09,0.27,0.26,0.22,0.21,0.25,0.35,0.40,0.02,0.85,-0.02,0.59,-
0.07,0.48,0.23,0.07,NA,1.15,1.33,0.17,0.37,0.25,-
0.65,0.04,0.19,NA,NA,0.21,0.23,0.37,0.34,0.30,0.06,0.16)
herat19yr3s <- c(-0.03,-0.13,-0.22,-0.34,-0.39,-0.32,-0.50,0.60,-0.65,0.05,0.03,0.55,-
0.27,-0.43,-0.15,-0.40,-0.30,0.24,-0.98,-0.29,0.45,-0.41,0.83,1.27,1.96,2.49,-0.42,-
0.05,0.18,-0.07,-0.56,-0.63,-0.30,0.07)
herat20yr3s <- c(-0.76,0.30,-1.19,-0.92,-0.14,1.96,-0.42,1.51,-0.44,-0.67,-0.38,0.70,-
0.51,-0.21,-0.62,1.84,3.00,1.37,-0.28,-0.55,-0.18,-0.73,2.43,0.00,0.30,2.48,0.21,-1.33,-
0.16,-0.18,-0.50,-1.09,-0.93,-0.45)
herat21yr3s <- c(-0.56,-0.46,-0.22,0.09,-0.40,-0.42,-0.42,-0.16,-0.77,2.99,5.07,0.35,-
0.19,-0.13,-0.02,-0.55,-0.53,0.32,1.16,0.98,0.80,-0.34,-0.34,-0.02,-0.48,-0.41,-0.48,-0.54,-
0.25,-0.31,-0.11,-0.23,-0.30,0.66)
herat22yr3s <- c(-0.09,-0.17,-0.01,0.02,-0.08,-0.18,-0.13,-0.01,-0.41,0.73,1.53,0.35,-
0.14,0.05,0.12,-0.25,-0.09,2.63,-0.32,0.31,0.16,-0.08,-0.04,0.11,-0.09,NA,-0.11,-0.12,-
0.03,0.00,-0.07,-0.09,-0.09,0.07)
herat23yr3s <- c(0.00,-0.17,0.05,0.02,-0.02,-0.20,-0.12,0.03,-0.69,0.15,0.27,0.33,-
0.16,0.11,0.17,-0.31,-0.02,2.88,-0.40,-0.07,0.05,-0.04,0.02,0.15,-0.02,NA,-0.06,-
0.06,0.03,0.08,-0.07,-0.08,-0.07,-0.02)
herat24yr3s <- c(0.14,-0.02,0.03,-0.02,0.04,-0.05,0.00,0.01,5.31,-0.04,-0.02,0.05,-
0.05,0.04,0.04,-0.10,0.10,0.70,-0.20,-0.02,-
0.03,0.02,0.04,0.03,0.07,NA,0.05,0.08,0.02,0.06,-0.03,-0.02,-0.01,-0.05)
herat25yr3s <- c(0.23,0.07,0.47,0.29,0.14,0.05,0.12,0.09,-
0.14,0.30,0.29,0.19,0.11,0.20,0.30,0.03,0.06,0.64,0.00,0.16,0.17,0.20,0.07,0.19,0.12,NA,
0.11,0.46,0.16,0.18,0.15,0.27,0.22,0.17)
herat26yr3s <- c(-0.58,-0.26,-0.05,-0.10,-0.03,-0.08,-0.11,-1.04,-0.58,-1.43,3.86,0.46,-
0.46,-0.78,0.11,-0.36,0.63,-0.18,-0.35,-0.75,0.04,-0.17,-0.08,0.00,-
0.22,NA,NA,0.08,1.05,-0.57,-0.05,-0.17,-0.21,0.05)
```

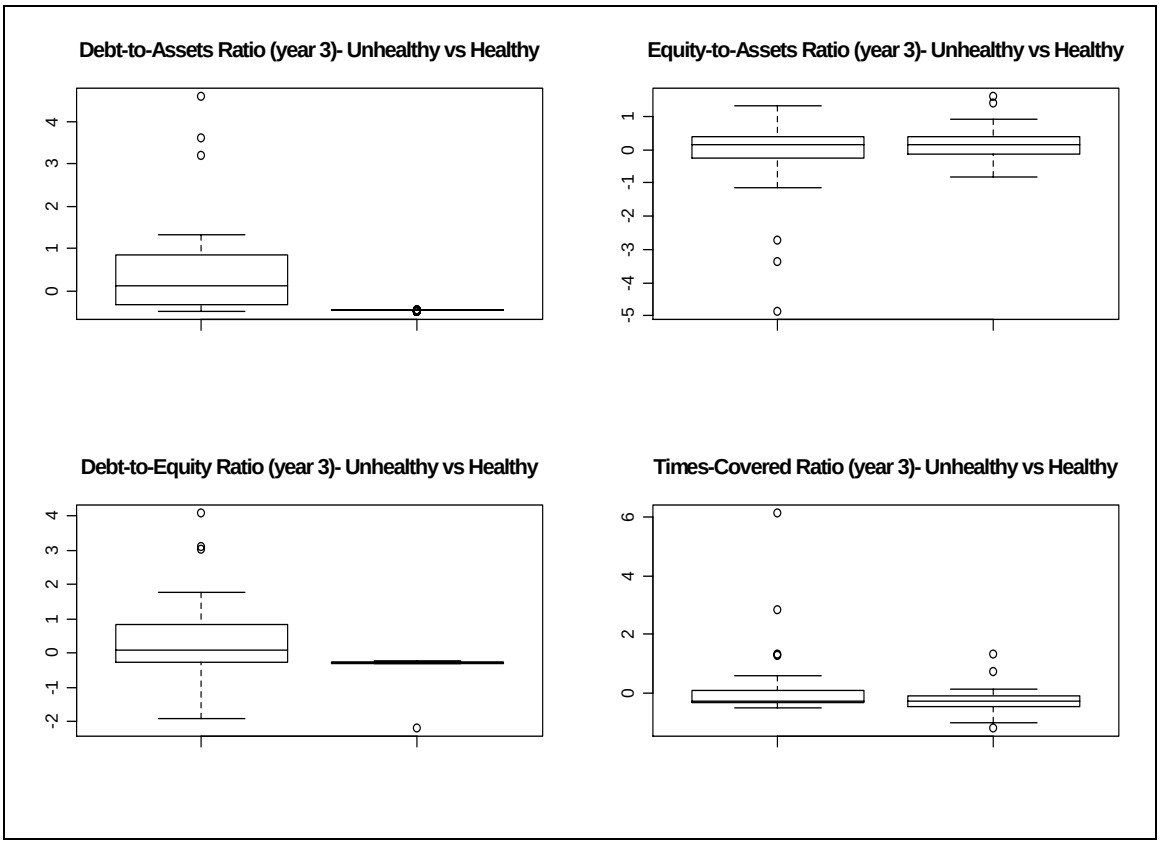
```
par(mfrow = c(2, 2))
boxplot(unrat1yr3s, herat1yr3s,main="Quick Ratio (year 3)- Unhealthy vs Healthy")
boxplot(unrat2yr3s, herat2yr3s,main="Current Ratio (year 3)- Unhealthy vs Healthy")
boxplot(unrat3yr3s, herat3yr3s,main="Return on Assets Ratio (year 3)- Unhealthy vs
Healthy")
boxplot(unrat4yr3s, herat4yr3s,main="Return-on-Equity Ratio (year 3)- Unhealthy vs
Healthy")
```



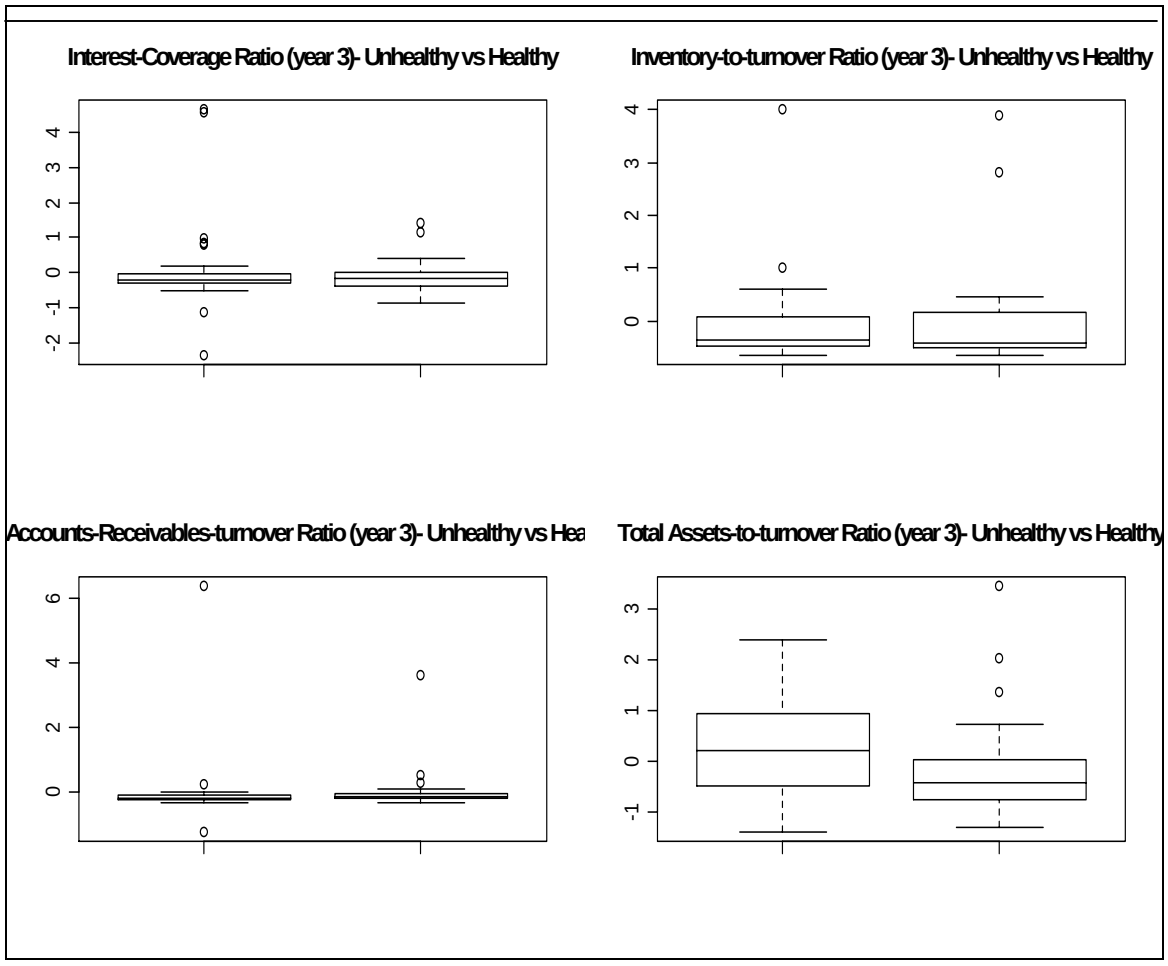
```
par(mfrow = c(2, 2))
boxplot(unrat5yr3s, herat5yr3s,main="Net Profit Margin Ratio (year 3)- Unhealthy vs
Healthy")
boxplot(unrat6yr3s, herat6yr3s,main="Gross Profit Margin Ratio (year 3)- Unhealthy vs
Healthy")
boxplot(unrat7yr3s, herat7yr3s,main="Return-on-Investment Ratio (year 3)- Unhealthy
vs Healthy")
boxplot(unrat8yr3s, herat8yr3s,main="Return-on-Sales Ratio (year 3)- Unhealthy vs
Healthy")
```



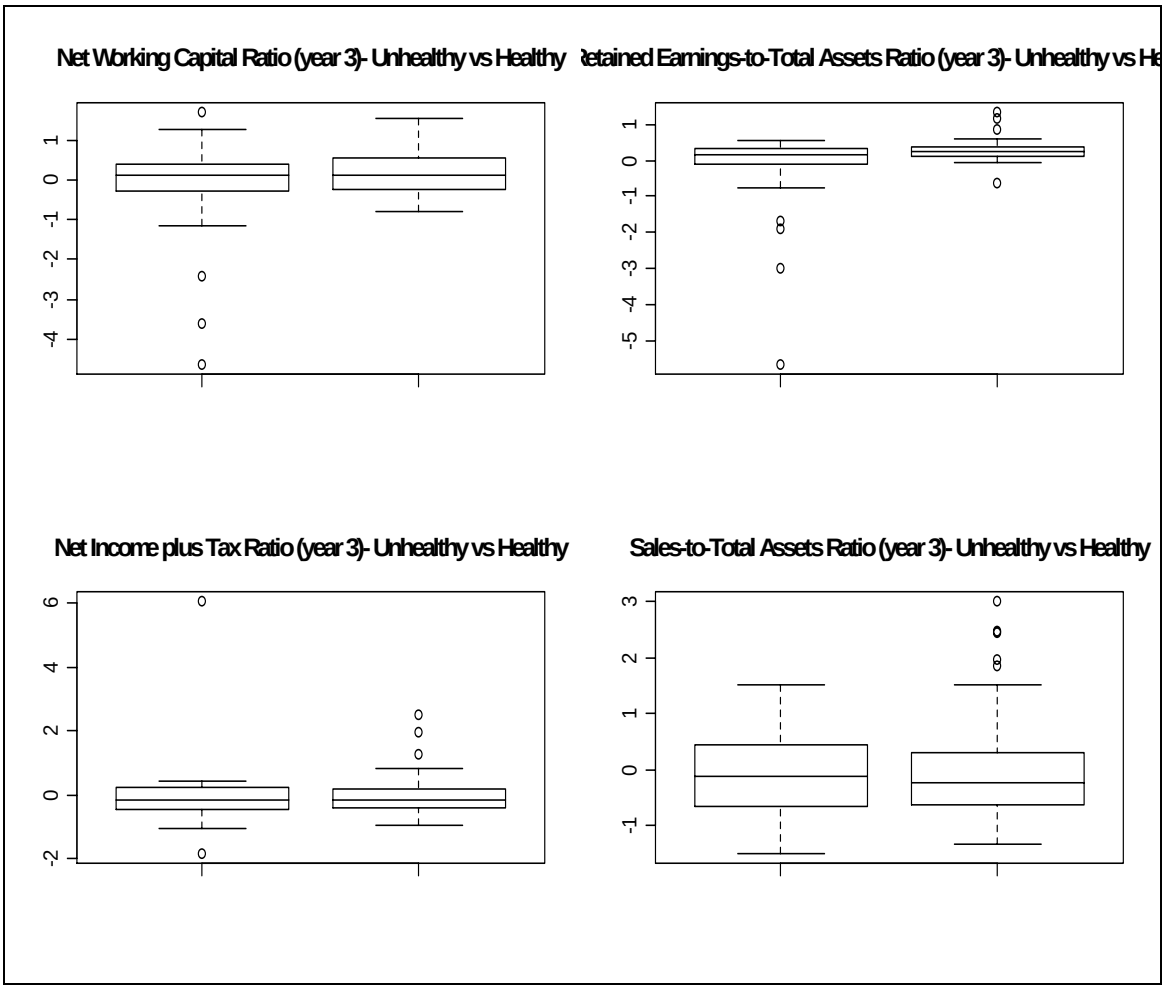
```
par(mfrow = c(2, 2))
boxplot(unrat9yr3s, herat9yr3s,main="Debt-to-Assets Ratio (year 3)- Unhealthy vs
Healthy")
boxplot(unrat10yr3s, herat10yr3s,main="Equity-to-Assets Ratio (year 3)- Unhealthy vs
Healthy")
boxplot(unrat11yr3s, herat11yr3s,main="Debt-to-Equity Ratio (year 3)- Unhealthy vs
Healthy")
boxplot(unrat12yr3s, herat12yr3s,main="Times-Covered Ratio (year 3)- Unhealthy vs
Healthy")
```



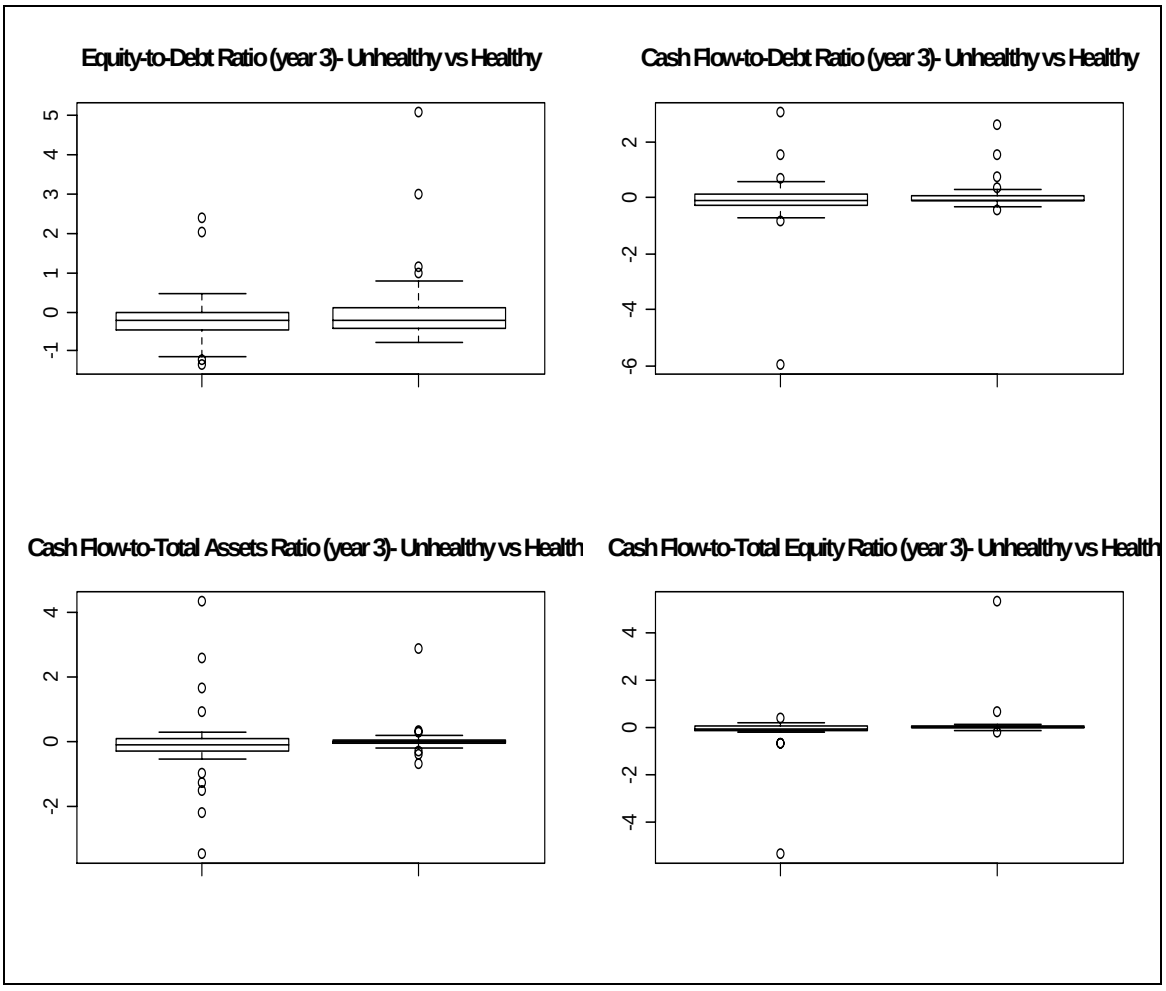
```
par(mfrow = c(2, 2))
boxplot(unrat13yr3s, herat13yr3s,main="Interest-Coverage Ratio (year 3)- Unhealthy vs
Healthy")
boxplot(unrat14yr3s, herat14yr3s,main="Inventory-to-turnover Ratio (year 3)- Unhealthy
vs Healthy")
boxplot(unrat15yr3s, herat15yr3s,main="Accounts-Receivables-turnover Ratio (year 3)-
Unhealthy vs Healthy")
boxplot(unrat16yr3s, herat16yr3s,main="Total Assets-to-turnover Ratio (year 3)-
Unhealthy vs Healthy")
```



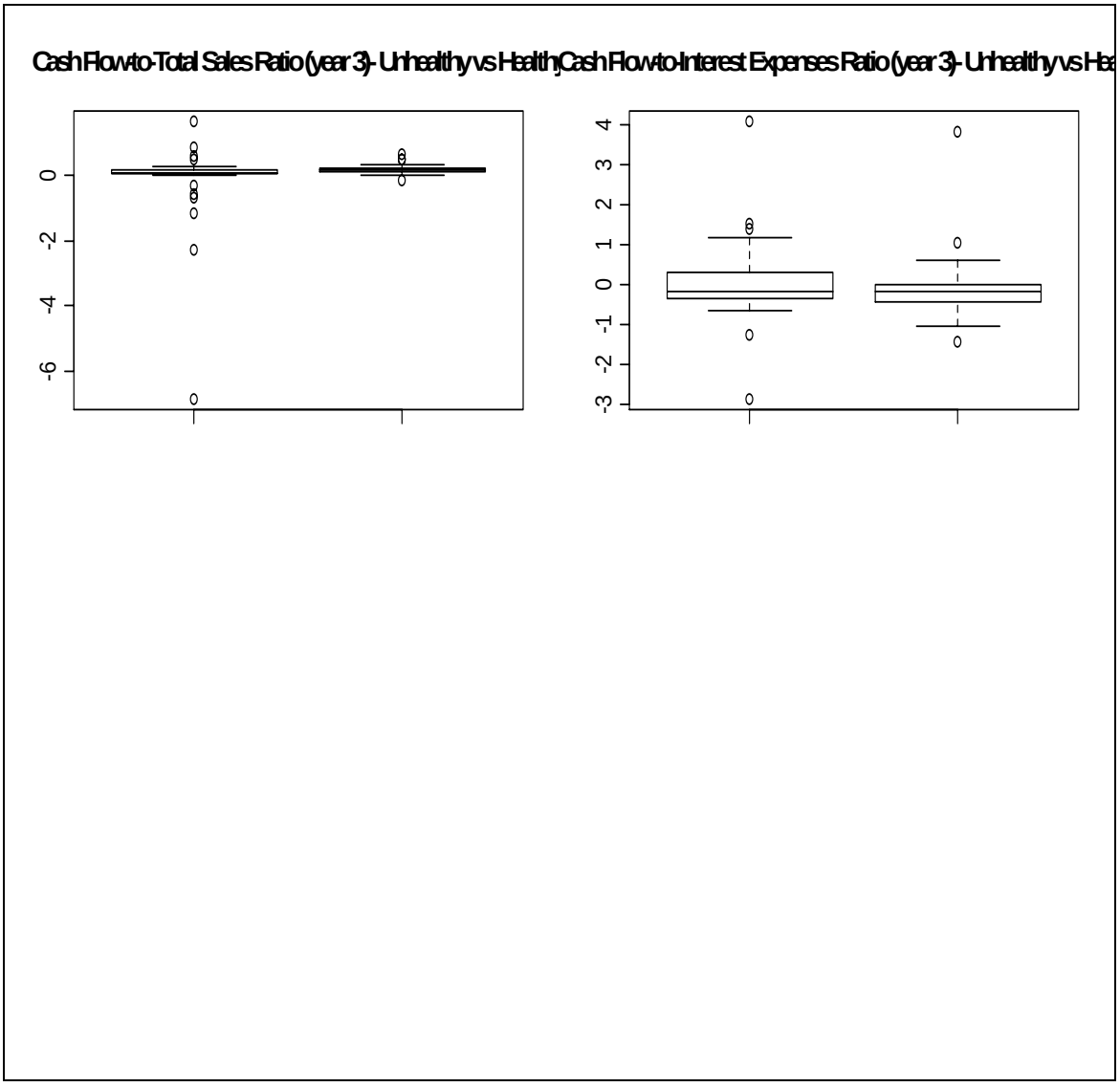
```
par(mfrow = c(2, 2))
boxplot(unrat17yr3s, herat17yr3s,main="Net Working Capital Ratio (year 3)- Unhealthy
vs Healthy")
boxplot(unrat18yr3s, herat18yr3s,main="Retained Earnings-to-Total Assets Ratio (year
3)- Unhealthy vs Healthy")
boxplot(unrat19yr3s, herat19yr3s,main="Net Income plus Tax Ratio (year 3)- Unhealthy
vs Healthy")
boxplot(unrat20yr3s, herat20yr3s,main="Sales-to-Total Assets Ratio (year 3)- Unhealthy
vs Healthy")
```



```
par(mfrow = c(2, 2))
boxplot(unrat21yr3s, herat21yr3s,main="Equity-to-Debt Ratio (year 3)- Unhealthy vs
Healthy")
boxplot(unrat22yr3s, herat22yr3s,main="Cash Flow-to-Debt Ratio (year 3)- Unhealthy vs
Healthy")
boxplot(unrat23yr3s, herat23yr3s,main="Cash Flow-to-Total Assets Ratio (year 3)-
Unhealthy vs Healthy")
boxplot(unrat24yr3s, herat24yr3s,main="Cash Flow-to-Total Equity Ratio (year 3)-
Unhealthy vs Healthy")
```



```
par(mfrow = c(2, 2))
boxplot(unrat25yr3s, herat25yr3s,main="Cash Flow-to-Total Sales Ratio (year 3)-
Unhealthy vs Healthy")
boxplot(unrat26yr3s, herat26yr3s,main="Cash Flow-to-Interest Expenses Ratio (year 3)-
Unhealthy vs Healthy")
```

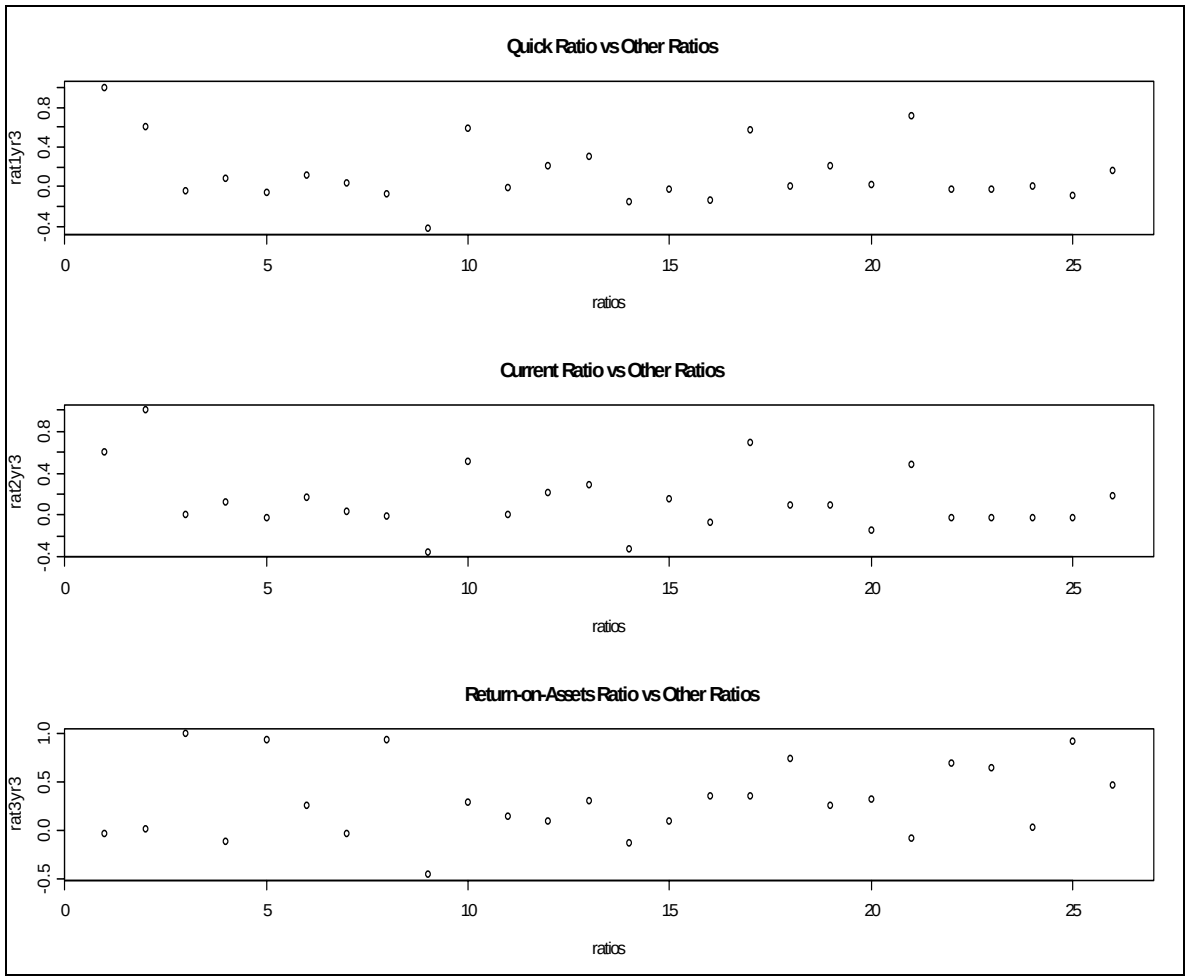


In order to select the financial ratios, each financial ratio will be compared to each other using the information calculated in the cross correlation matrix.

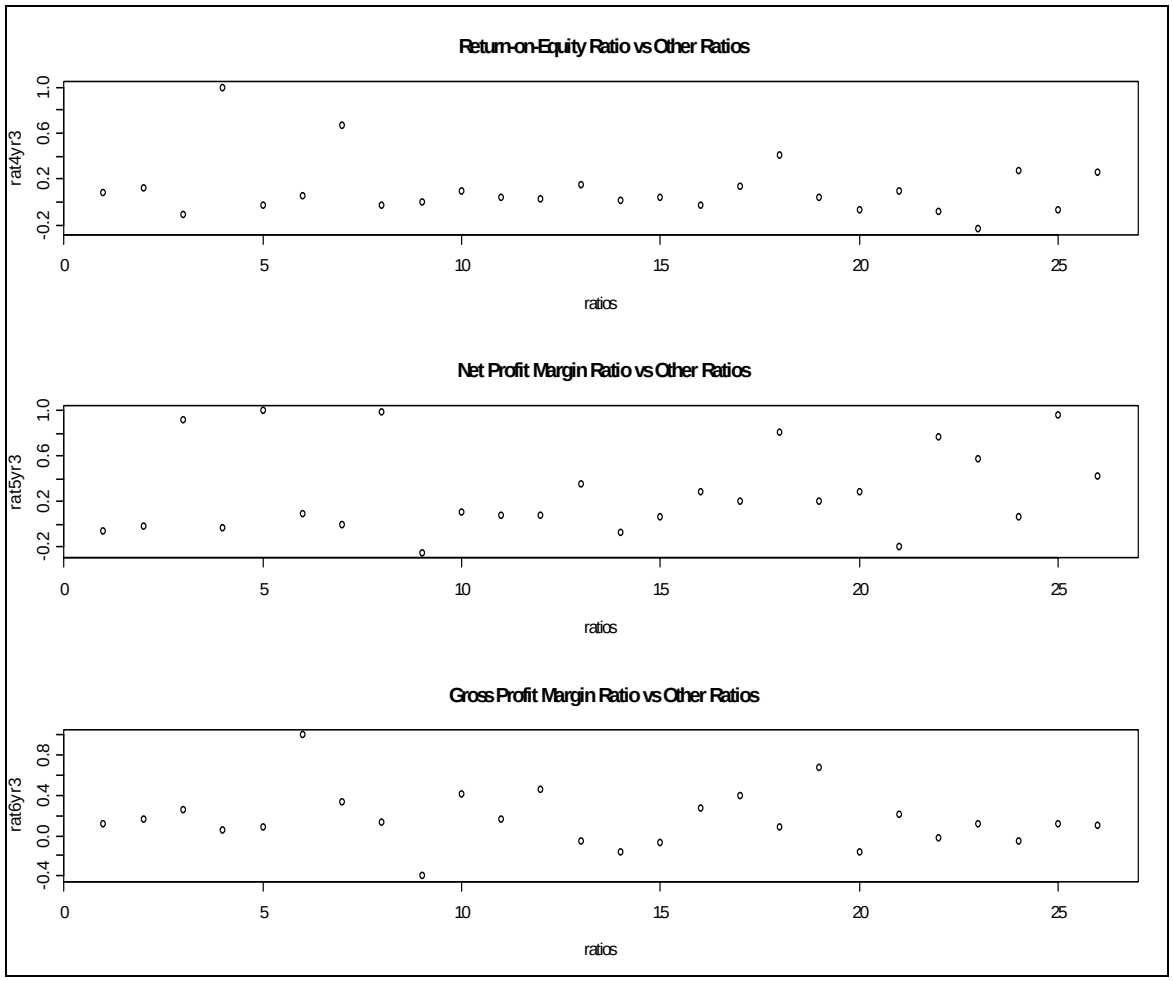
```
rat1yr3 <- c(1.00,0.60,-0.04,0.08,-0.06,0.12,0.04,-0.08,-0.42,0.58,-0.01,0.21,0.30,-0.16,-
0.03,-0.14,0.57,0.01,0.21,0.02,0.71,-0.02,-0.02,0.00,-0.09,0.16)
rat2yr3 <- c(0.60,1.00,0.01,0.12,-0.02,0.17,0.04,-0.01,-0.35,0.51,0.01,0.22,0.29,-
0.33,0.16,-0.07,0.70,0.10,0.10,-0.14,0.48,-0.03,-0.03,-0.02,-0.03,0.19)
rat3yr3 <- c(-0.04,0.01,1.00,-0.11,0.93,0.25,-0.04,0.94,-0.46,0.29,0.14,0.10,0.31,-
0.13,0.09,0.35,0.36,0.74,0.26,0.33,-0.09,0.70,0.64,0.03,0.92,0.47)
rat4yr3 <- c(0.08,0.12,-0.11,1.00,-0.03,0.06,0.67,-
0.02,0.00,0.10,0.04,0.03,0.15,0.01,0.04,-0.02,0.14,0.41,0.04,-0.06,0.10,-0.08,-0.23,0.28,-
0.07,0.26)
rat5yr3 <- c(-0.06,-0.02,0.93,-0.03,1.00,0.09,0.00,0.99,-0.25,0.10,0.08,0.08,0.36,-
0.08,0.07,0.29,0.20,0.81,0.20,0.28,-0.20,0.77,0.58,0.07,0.97,0.43)
rat6yr3 <- c(0.12,0.17,0.25,0.06,0.09,1.00,0.34,0.13,-0.40,0.41,0.17,0.46,-0.05,-0.17,-
0.07,0.27,0.40,0.08,0.68,-0.16,0.21,-0.02,0.12,-0.05,0.12,0.10)
rat7yr3 <- c(0.04,0.04,-0.04,0.67,0.00,0.34,1.00,0.00,-0.04,0.08,0.03,0.76,0.35,-
0.05,0.39,0.11,0.11,0.27,0.49,0.04,0.08,-0.04,-0.17,0.04,-0.04,0.42)
rat8yr3 <- c(-0.08,-0.01,0.94,-0.02,0.99,0.13,0.00,1.00,-0.28,0.11,0.08,0.07,0.33,-
0.10,0.08,0.32,0.20,0.82,0.20,0.25,-0.19,0.77,0.58,0.06,0.97,0.44)
rat9yr3 <- c(-0.42,-0.35,-0.46,0.00,-0.25,-0.40,-0.04,-0.28,1.00,-0.82,0.12,-0.15,-
0.20,0.28,-0.11,-0.13,-0.79,-0.29,-0.30,-0.26,-0.35,-0.11,-0.25,-0.17,-0.25,-0.19)
rat10yr3 <- c(0.58,0.51,0.29,0.10,0.10,0.41,0.08,0.11,-0.82,1.00,0.16,0.19,0.22,-
0.42,0.09,0.13,0.86,0.20,0.26,0.09,0.62,0.04,0.19,0.01,0.11,0.18)
rat11yr3 <- c(-0.01,0.01,0.14,0.04,0.08,0.17,0.03,0.08,0.12,0.16,1.00,-0.03,0.00,-0.30,-
0.02,0.04,0.17,0.13,0.07,-0.09,-0.04,-0.09,-0.13,-0.07,0.02,-0.06)
rat12yr3 <- c(0.21,0.22,0.10,0.03,0.08,0.46,0.76,0.07,-0.15,0.19,-0.03,1.00,0.43,-
0.10,0.17,0.17,0.23,0.03,0.73,0.12,0.22,0.09,0.05,0.00,0.06,0.55)
rat13yr3 <- c(0.30,0.29,0.31,0.15,0.36,-0.05,0.35,0.33,-0.20,0.22,0.00,0.43,1.00,-
0.08,0.66,0.23,0.28,0.31,0.12,0.20,0.14,0.40,0.26,0.01,0.41,0.91)
rat14yr3 <- c(-0.16,-0.33,-0.13,0.01,-0.08,-0.17,-0.05,-0.10,0.28,-0.42,-0.30,-0.10,-
0.08,1.00,-0.11,-0.13,-0.51,-0.08,-0.14,-0.04,-0.14,0.00,-0.03,0.29,-0.09,-0.02)
rat15yr3 <- c(-0.03,0.16,0.09,0.04,0.07,-0.07,0.39,0.08,-0.11,0.09,-0.02,0.17,0.66,-
0.11,1.00,0.29,0.10,0.09,-0.06,0.11,0.02,0.02,0.01,-0.02,0.06,0.47)
rat16yr3 <- c(-0.14,-0.07,0.35,-0.02,0.29,0.27,0.11,0.32,-0.13,0.13,0.04,0.17,0.23,-
0.13,0.29,1.00,0.08,0.20,0.05,-0.12,-0.05,0.17,0.29,-0.23,0.32,0.30)
rat17yr3 <- c(0.57,0.70,0.36,0.14,0.20,0.40,0.11,0.20,-0.79,0.86,0.17,0.23,0.28,-
0.51,0.10,0.08,1.00,0.26,0.31,0.16,0.42,0.03,0.16,0.01,0.17,0.20)
rat18yr3 <- c(0.01,0.10,0.74,0.41,0.81,0.08,0.27,0.82,-0.29,0.20,0.13,0.03,0.31,-
0.08,0.09,0.20,0.26,1.00,0.15,0.20,-0.04,0.63,0.37,0.16,0.77,0.35)
rat19yr3 <- c(0.21,0.10,0.26,0.04,0.20,0.68,0.49,0.20,-0.30,0.26,0.07,0.73,0.12,-0.14,-
0.06,0.05,0.31,0.15,1.00,0.33,0.05,0.12,0.20,-0.07,0.18,0.23)
rat20yr3 <- c(0.02,-0.14,0.33,-0.06,0.28,-0.16,0.04,0.25,-0.26,0.09,-0.09,0.12,0.20,-
0.04,0.11,-0.12,0.16,0.20,0.33,1.00,-0.14,0.24,0.36,-0.14,0.25,0.27)
rat21yr3 <- c(0.71,0.48,-0.09,0.10,-0.20,0.21,0.08,-0.19,-0.35,0.62,-0.04,0.22,0.14,-
0.14,0.02,-0.05,0.42,-0.04,0.05,-0.14,1.00,-0.02,-0.07,-0.03,-0.18,0.28)
```

```
rat22yr3 <- c(-0.02,-0.03,0.70,-0.08,0.77,-0.02,-0.04,0.77,-0.11,0.04,-
0.09,0.09,0.40,0.00,0.02,0.17,0.03,0.63,0.12,0.24,-0.02,1.00,0.82,-0.07,0.87,0.50)
rat23yr3 <- c(-0.02,-0.03,0.64,-0.23,0.58,0.12,-0.17,0.58,-0.25,0.19,-0.13,0.05,0.26,-
0.03,0.01,0.29,0.16,0.37,0.20,0.36,-0.07,0.82,1.00,-0.39,0.72,0.36)
rat24yr3 <- c(0.00,-0.02,0.03,0.28,0.07,-0.05,0.04,0.06,-0.17,0.01,-0.07,0.00,0.01,0.29,-
0.02,-0.23,0.01,0.16,-0.07,-0.14,-0.03,-0.07,-0.39,1.00,0.00,-0.07)
rat25yr3 <- c(-0.09,-0.03,0.92,-0.07,0.97,0.12,-0.04,0.97,-0.25,0.11,0.02,0.06,0.41,-
0.09,0.06,0.32,0.17,0.77,0.18,0.25,-0.18,0.87,0.72,0.00,1.00,0.44)
rat26yr3 <- c(0.16,0.19,0.47,0.26,0.43,0.10,0.42,0.44,-0.19,0.18,-0.06,0.55,0.91,-
0.02,0.47,0.30,0.20,0.35,0.23,0.27,0.28,0.50,0.36,-0.07,0.44,1.00)
```

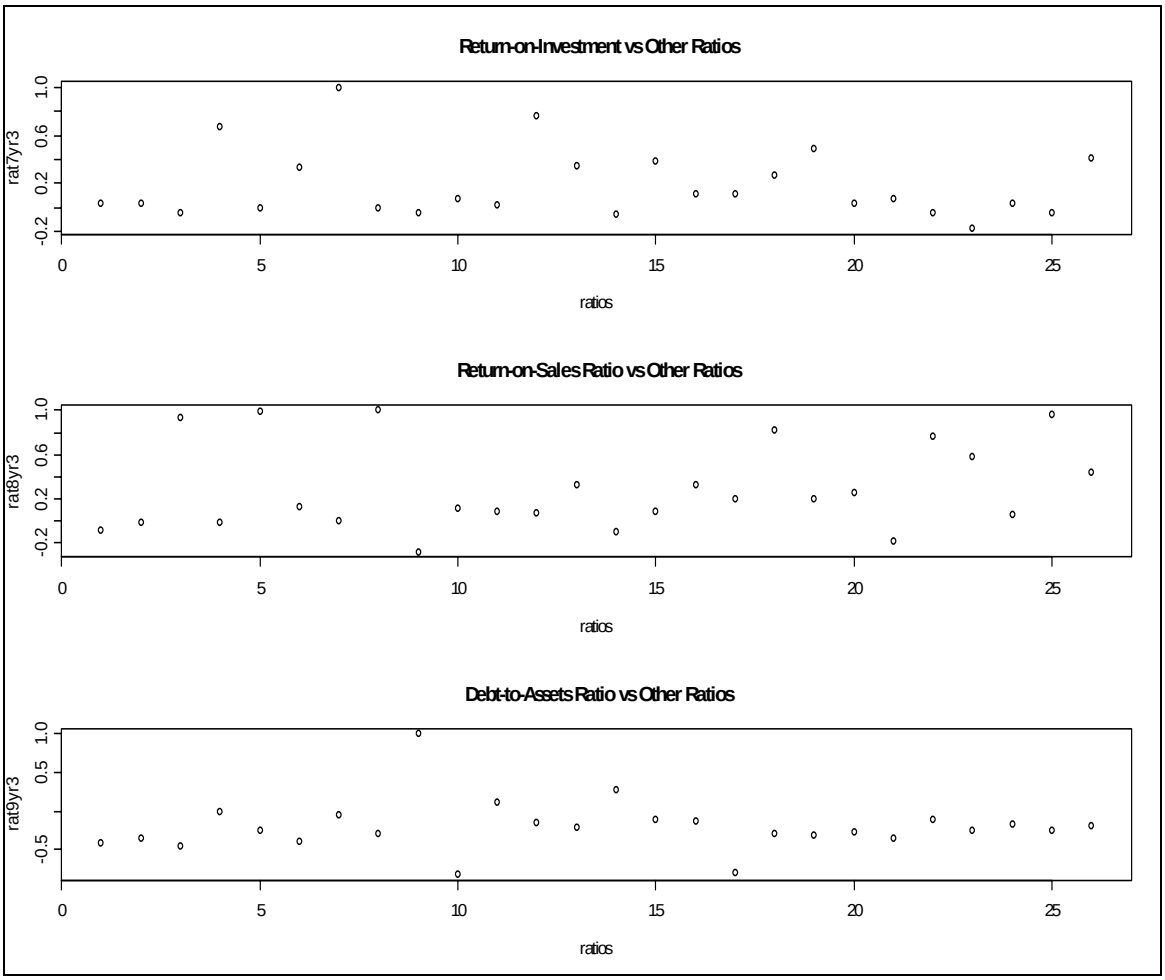
```
par(mfrow = c(3,1))
plot(ratios, rat1yr3, main=" Quick Ratio vs Other Ratios")
plot(ratios, rat2yr3, main=" Current Ratio vs Other Ratios")
plot(ratios, rat3yr3, main=" Return-on-Assets Ratio vs Other Ratios")
```



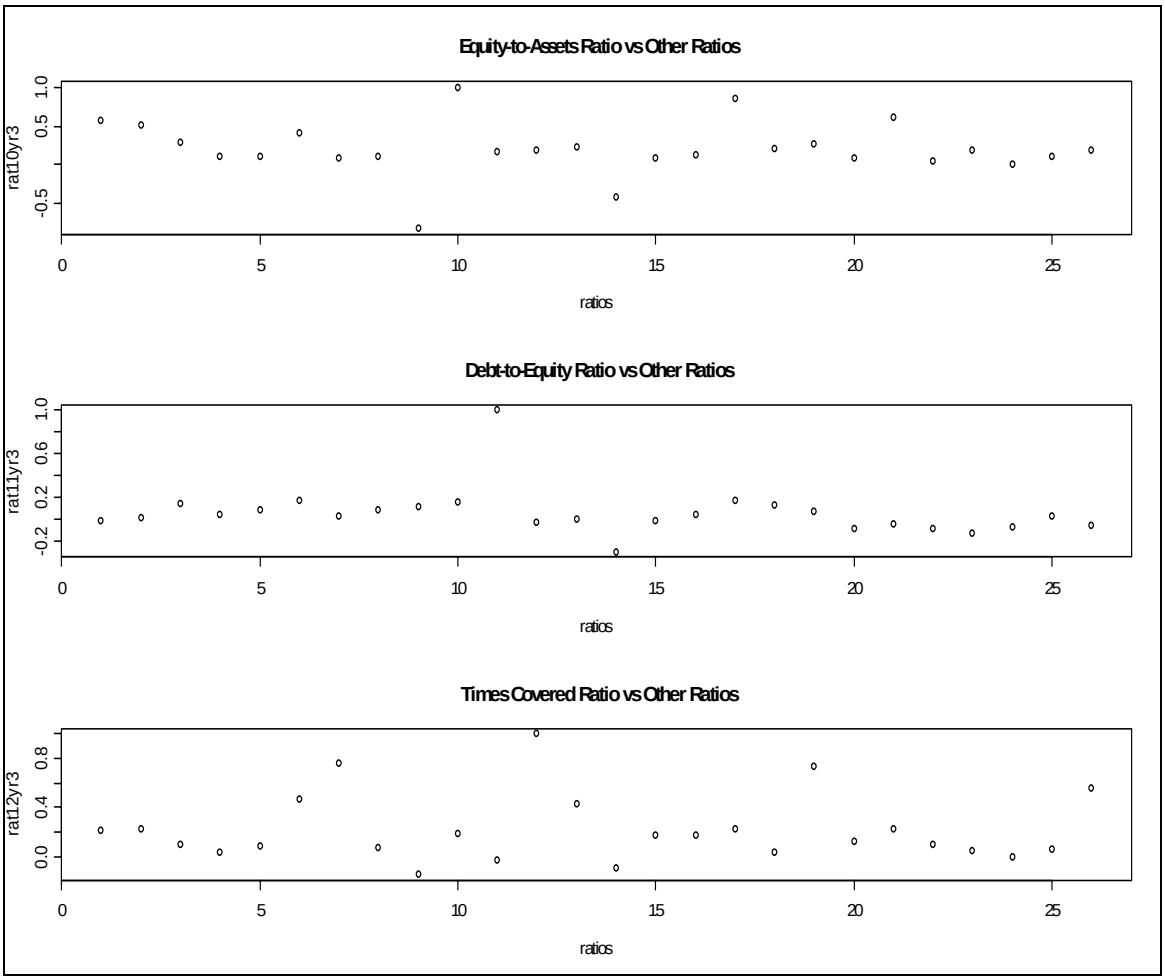
```
par(mfrow = c(3,1))
plot(ratios, rat4yr3, main=" Return-on-Equity Ratio vs Other Ratios")
plot(ratios, rat5yr3, main=" Net Profit Margin Ratio vs Other Ratios")
plot(ratios, rat6yr3, main=" Gross Profit Margin Ratio vs Other Ratios")
```



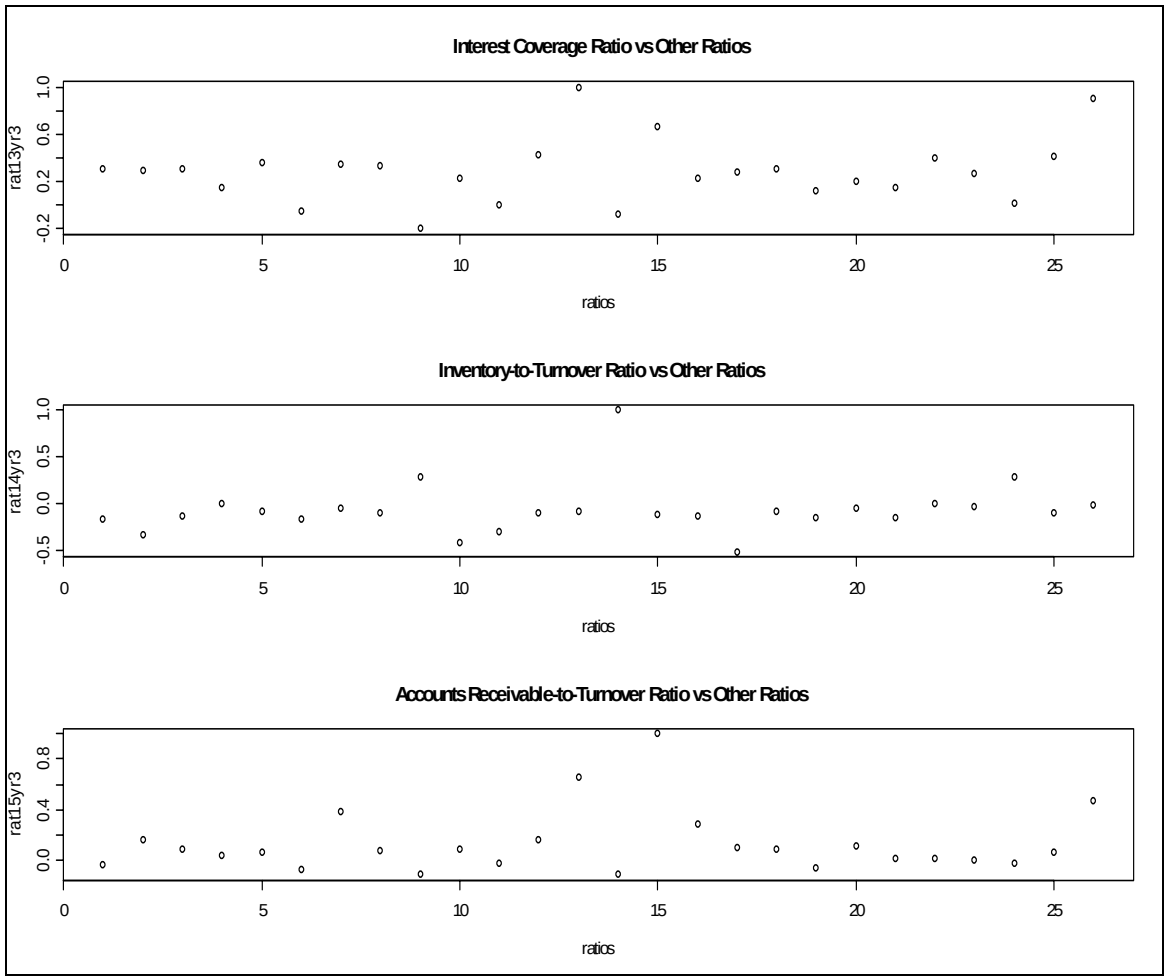
```
par(mfrow = c(3,1))
plot(ratios, rat7yr3, main=" Return-on-Investment vs Other Ratios")
plot(ratios, rat8yr3, main=" Return-on-Sales Ratio vs Other Ratios")
plot(ratios, rat9yr3, main=" Debt-to-Assets Ratio vs Other Ratios")
```



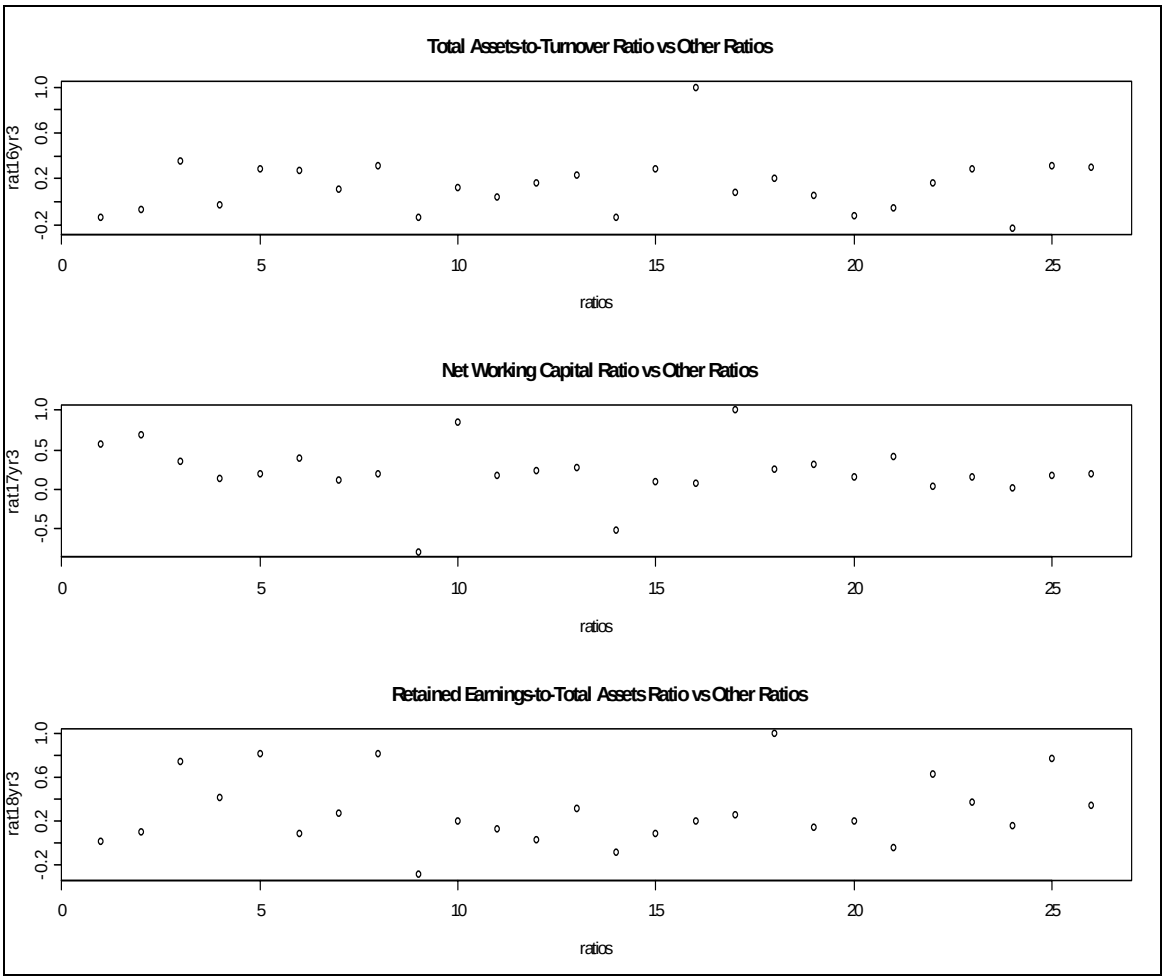
```
par(mfrow = c(3,1))
plot(ratios, rat10yr3, main=" Equity-to-Assets Ratio vs Other Ratios")
plot(ratios, rat11yr3, main=" Debt-to-Equity Ratio vs Other Ratios")
plot(ratios, rat12yr3, main=" Times Covered Ratio vs Other Ratios")
```



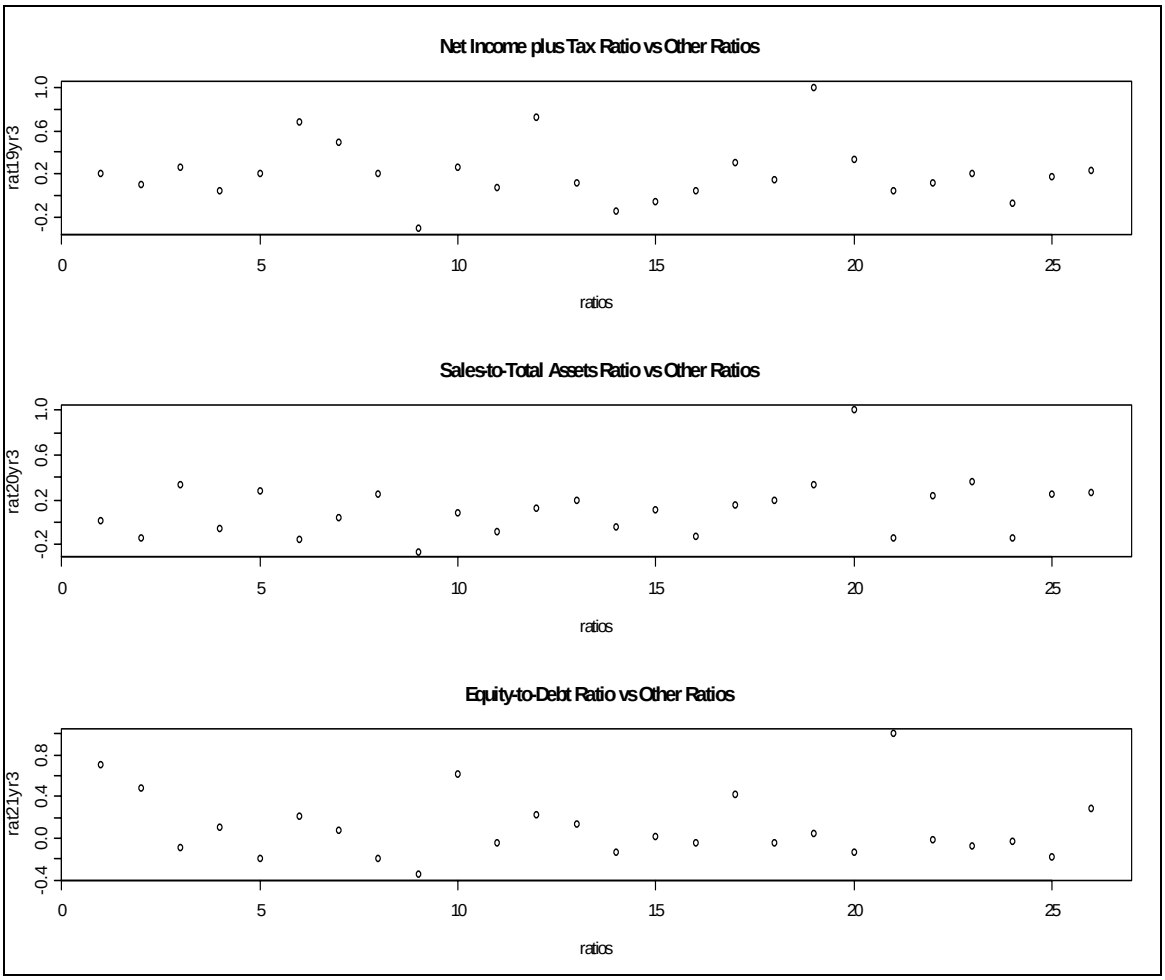
```
par(mfrow = c(3,1))
plot(ratios, rat13yr3, main=" Interest Coverage Ratio vs Other Ratios")
plot(ratios, rat14yr3, main=" Inventory-to-Turnover Ratio vs Other Ratios")
plot(ratios, rat15yr3, main=" Accounts Receivable-to-Turnover Ratio vs Other Ratios")
```



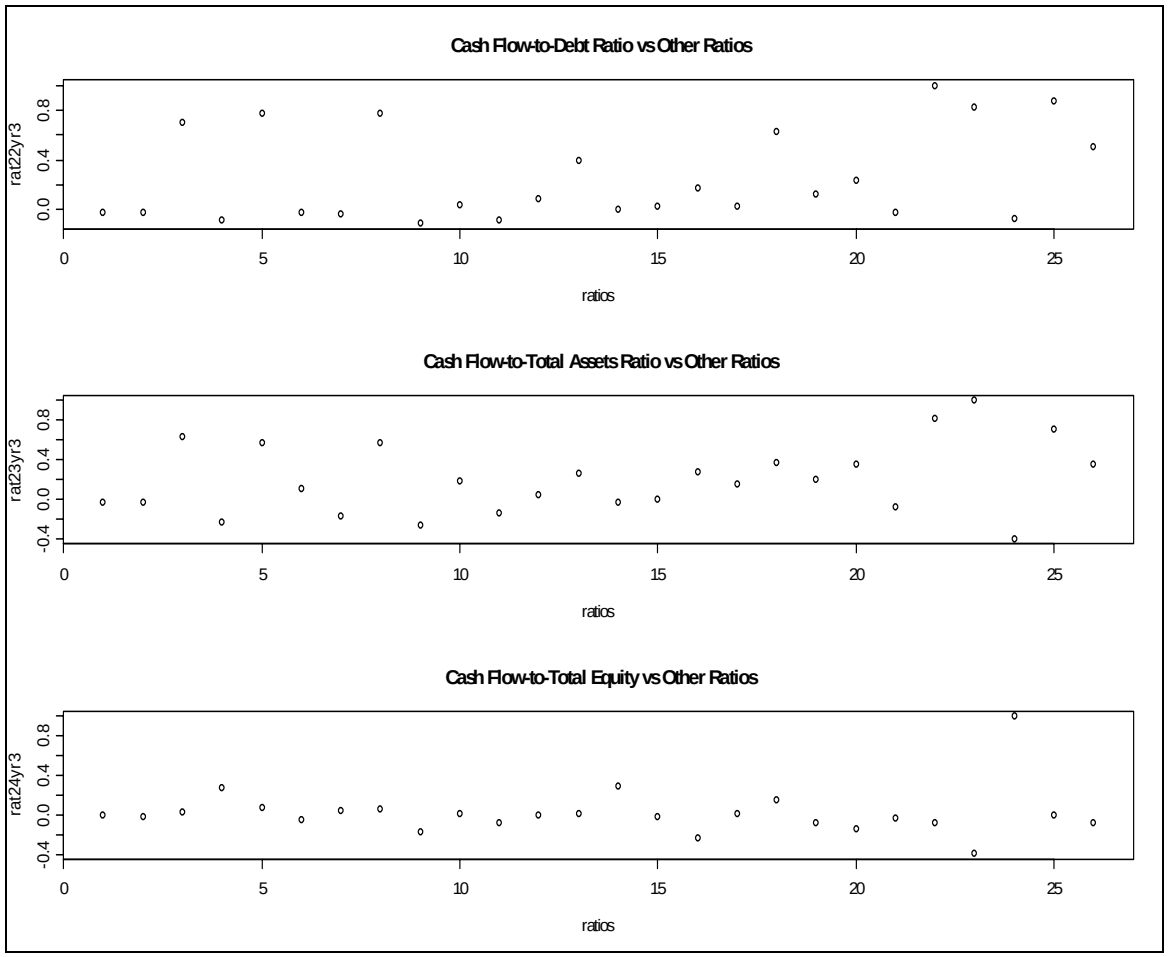
```
par(mfrow = c(3,1))
plot(ratios, rat16yr3, main=" Total Assets-to-Turnover Ratio vs Other Ratios")
plot(ratios, rat17yr3, main=" Net Working Capital Ratio vs Other Ratios")
plot(ratios, rat18yr3, main=" Retained Earnings-to-Total Assets Ratio vs Other Ratios")
```



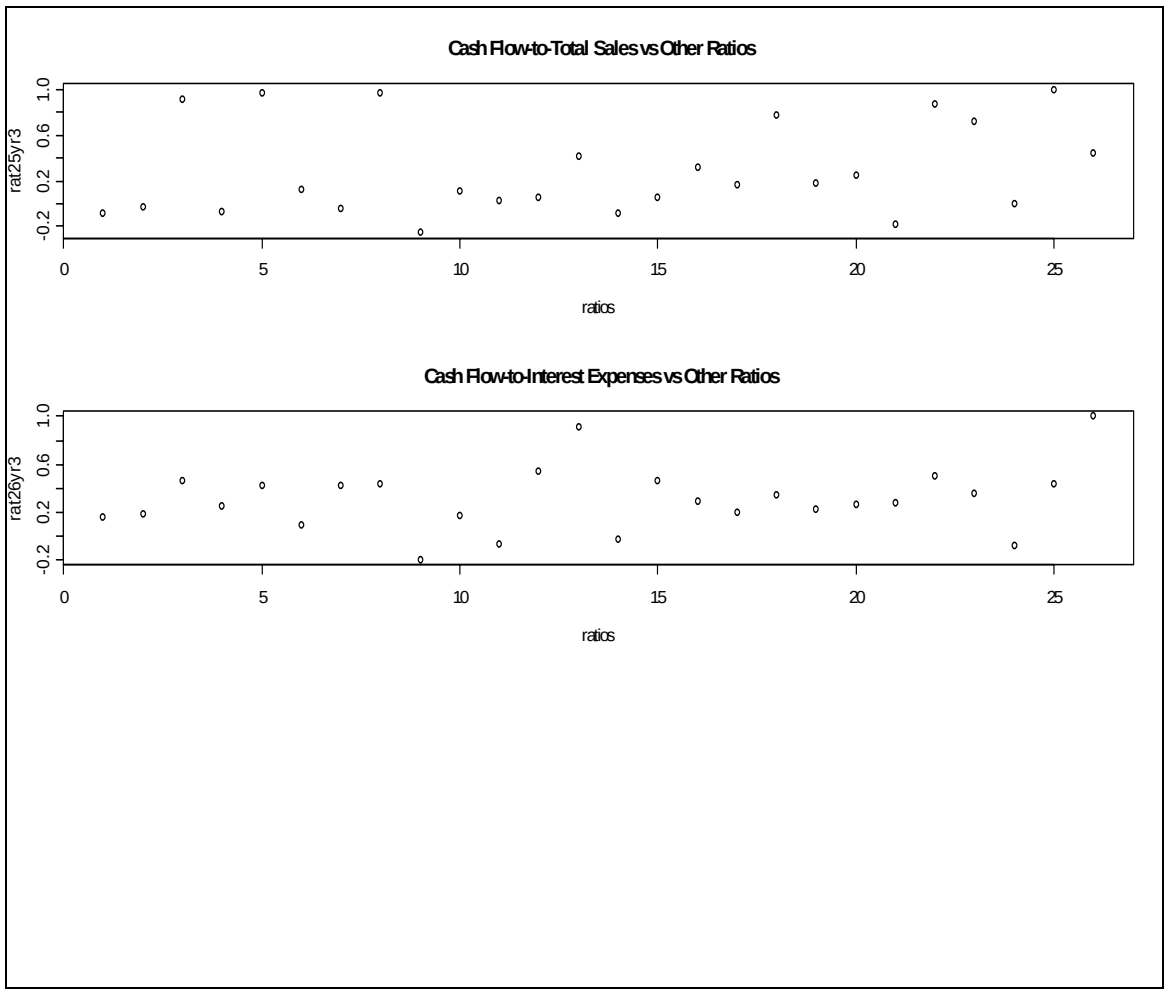
```
par(mfrow = c(3,1))
plot(ratios, rat19yr3, main=" Net Income plus Tax Ratio vs Other Ratios")
plot(ratios, rat20yr3, main=" Sales-to-Total Assets Ratio vs Other Ratios")
plot(ratios, rat21yr3, main=" Equity-to-Debt Ratio vs Other Ratios")
```



```
par(mfrow = c(3,1))
plot(ratios, rat22yr3, main=" Cash Flow-to-Debt Ratio vs Other Ratios")
plot(ratios, rat23yr3, main=" Cash Flow-to-Total Assets Ratio vs Other Ratios")
plot(ratios, rat24yr3, main=" Cash Flow-to-Total Equity vs Other Ratios")
```



```
par(mfrow = c(3,1))
plot(ratios, rat25yr3, main=" Cash Flow-to-Total Sales vs Other Ratios")
plot(ratios, rat26yr3, main=" Cash Flow-to-Interest Expenses vs Other Ratios")
```



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BIOGRAPHICAL SKETCH

Juan Jose Suarez was born in Ibague, Colombia, on May 19, 1974. He graduated from Colegio Virrey Solis in Bogotá, in 1991. The first three years of his college career, Juan studied electronic engineering at the Javeriana University in Bogotá. In 1995, Juan transferred to the Colombian School of Engineering and received a Bachelor of Science degree in civil engineering in 1999.

After more than a year of experience working as a civil engineer in Colombia, Juan decided to increase his knowledge in construction management. He joined the construction management team in fall 2001 and received his Master of Engineering degree in Summer 2002. After completing the doctoral program, Juan will join a construction firm in South Florida.