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BANKRUPTCY PREDICTION IN THE CONSTRUCTION INDUSTRY OF FINLAND

Bachelor's Thesis

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I declare I have written the bachelor's thesis independently.
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ABSTRACT

The aim of this Bachelor's thesis is to examine whether bankruptcy prediction models can predict bankruptcies for Finnish construction companies. In the research Beaver's five financial ratios, Altman's Z-score and Laitinen's three variable Z-score are presented and applied for Finnish construction companies. The study also tries to find an answer how early the models signals about the coming bankruptcy. The differences in prediction capability of bankruptcy prediction models for non-bankrupt and bankrupt companies are also compared.

The theoretical part of the research is based on earlier literature on bankruptcy prediction and original research of the models. The prediction ability of the models was tested with financial statements of 36 Finnish construction companies. The financial statements were collected from Amadeus-database, and peer group analysis was executed to analyse them. The companies are studied within five years before the bankruptcy between the years 2011 – 2016. The study is completed with a paired-sample method.

The results from this research differ slightly from the original ones. The bankruptcy prediction models had a bit lower classification ability in first two years before the bankruptcy in this research, but the accuracy to predict stayed higher for a longer time. The study shows that some of the prediction models worked five years before bankruptcy in some extent but two years before bankruptcy the classification ability of the models is clearly improved. In general, the models made more errors with bankrupt companies than non-bankrupt companies. With individual financial ratios, the error types varied more. Based on the results of this research all the models worked properly and can be used to predict bankruptcies in the Finnish construction industry.

Keywords: Bankruptcy prediction, Beaver, Altman, Laitinen, Z-score

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INTRODUCTION

Bankruptcy prediction has been and probably will be one of the most important areas of interest in academic research of finance and accounting. The importance of the topic can be seen even more essential in these economically challenging times. When bankruptcy occurs, the company cannot pay its debts for its creditors and loses the possession to its assets. The remaining part of the assets are divided among the creditors legitimately, and the company cannot continue its business since it doesn't have decision-making power over its assets. Bankruptcy means the end of company's activity in the form it operated before. (Laitinen 1992, 339)

Bankruptcy is not painful only for the enterprise but it affects negatively also the company's stakeholders, and the impacts of it can be seen even the whole economy's and society's level. As a result of bankruptcy, the community loses tax revenue, for the creditor's credit losses are accrued, and employees lose their income and job position. Bankruptcy also has a multiplicative effect since company's subcontractors may experience financial difficulties because of their client's problems. Bankruptcy always creates economic losses, and therefore there have been developed a different kind of models to detect and prevent it as soon as possible the prospective bankruptcy to occur. (Wu 2010, 2370)

Several predictive models for bankruptcy have been developed over the years. The two most popular models are William H. Beaver's model which Beaver drafted in 1966 and Edward I. Altman's model which he developed in 1968. Beaver's model that is based on individual financial ratios can be named as a pioneer of predictive models. Beaver used a pair-matched sample to compare corporates' financial ratios which were declared for bankruptcy to companies' financial ratios which were still in business, and found out those ratios that predict the bankruptcy the best. Altman was the first one who used multiple variables when he applied his Z-score formula. The model is based on five financial ratios which combined give the best possible result. Z-score is still widely used today, and many newer multivariate models based on it. As an example of other remarkable prediction models, logit regression, probit model,

linear probability models, and cumulative sum control chart can be mentioned. (Bellovary et al 2007, 1)

Bankruptcy prediction provides valuable information for the company's stakeholders and other people interested in the company. Financial institutions and possible investors can use the methods to examine financial situation of the company and choose right cooperating partners, for example, banks in case of the decision for a loan. Prediction models also help investors to choose healthy and solvent companies for cooperating. Also, viable job-seekers get support for their choice of workplace. (Wu et al 2010, 34)

Construction companies are extra vulnerable for bankruptcies regardless their location, and different reasons for vulnerability can be found from the aspects which are specific to the industry. The vulnerability is caused by the industry's fragmented nature, excessive competition, relatively low entry barrier, high uncertainty and risk involved, and unpredictable fluctuations in construction volume. Arditi et al (2000) found that failure of the companies in the construction industry of USA is mainly caused by budgetary and macroeconomic issues. Over 80 percent of the failures are generated by insufficient profits, industry weakness, heavy operating expenses, insufficient capital, and burdensome institutional debt. In most cases, bankruptcy isn't affected by a single factor but it caused by several previously mentioned causes combined. To detect possible causes for failure, the companies should have an effective alarm system or drift to bankruptcy is imminent. If the company would have the capability to detect a possible bankruptcy early, there is a possibility that the business could be saved and significant damages could be prevented. (Wong et al 2010, 3; Laitinen 1990, 151)

Since the earliest prediction models are very old, it isn't certain if they work for the Finnish construction industry. The prediction models have a possibility for error, and it would be interesting to know how they will work for the construction industry. Attractiveness towards the construction industry increases the fact that it is the third biggest industry in Finland and it is one of the sectors where bankruptcies occur the most (Konkurssien… 2017). Despite the bankruptcy predictions criticalness for academic research of finance and accounting, and high occurrence of bankruptcies in the Finnish construction industry, the construction sector is still under-explored, and studies about the topic are needed.

The research problem of the study is how bankruptcy can be predicted and how predictions models chosen for the research works for the Finnish construction industry. Prediction models aren't perfect even if in most of the cases they provide useful information

about the financial condition of the firm. The main idea of the research paper is to test the most relevant bankruptcy prediction models with the construction companies which have been filed for bankruptcy and compare the results to operating enterprises from the same field. The main research question which the research paper tries to answer are the following one:

Q1. Can the bankruptcy be predicted with Beaver's, Altman's, and Laitinen's model for the Finnish construction companies?

In addition to the main question, the research paper tries to answer following sub-questions:

Q2. Are there any differences in results between companies filed for bankruptcy and operating companies?
Q3. How early the prediction models signal about the bankruptcy?

In the first part of the paper, theoretical research is used, and it is focusing literature that has been written about predicting of bankruptcy. The models chosen for the research are introduced. In the second part of the paper, the research data and method is presented. The second part also presents the main calculations which were concluded during the testing of the prediction models and concentrates answering to the research questions with quantitative analysis. The third chapter presents benchmarking of the case companies to the Finnish construction industry averages, and the comparison of the results got from testing of the predictive models. The section also provides conclusions about the main results and findings and suggestions for further investigations.

1. PREDICTING THE BANKRUPTCY

Predicting of bankruptcy have been under the researchers' scope at least from the 1800's when the size of companies started to increase. At the time, management and ownership were separated, and the owners could not control the company directly anymore. Change of markets to more financing orientated, increased the need for measuring the financial succeeding. However, creditors and owners used financial indicators for different purposes: the creditors wanted to know if they got their money back from the borrowers and the management were interested in the profitability of the firm. (Horrigan 1968, 284)

The great depression in the 1930's increased the need for study of the bankruptcy prediction, and since that point, it has been an interest of academic scholar. At the time, many companies were declared for bankruptcy and creditors, and investors lose their money. The failure of multiple companies got the researchers to interest in a possibility to measure company's financial situation. (Laitinen 1990, 8)

Earlier, companies used univariate models and concentrated to individual ratios to estimate their financial position, but over the years they also started to use multiple different financial ratios for that. Previous studies were also very defective and primary since the same kind of financial statement databases and technology were not available than nowadays. When companies started to use multiple financial ratios more often and understand the meaning of absolute criteria in interpreting of ratios, they noticed that respective comparison between companies' data gave vital information about their solvency and economic sustainability. (Balcaen, Ooghe 2006, 64) As a natural outcome of using multiple different financial ratios the real breakthrough in predicting bankruptcies came in 1966 when William H. Beaver published his classical research.

Predictive models can be divided into three groups. For instance, Aziz and Dar divide the models for statistical models, AIES model or machine learning utilizing models, and theoretical models (2006, 20). Statistical models are the ones which have been used and

concentrated the most in academic research. Statistical models try to find the company's variables from financial statements that predict the bankruptcy best so that the symptoms which lead to failure can be diagnosed. Univariate and multivariate analysis are an example of statistical models. AIES-models (Artificially intelligent expert system) are computer-aided systems that are concentrating the same symptoms of failure that statistical models do but the two models have differences in choosing the variables. With artificial intelligence, the systems try to copy human's intelligence and improve their problem-solving skills. Unlike the two models previously mentioned, theoretical models are concentrating to reasons that led to bankruptcy. In theoretical research, statistical methods are presented to support the theoretic reasons that led the company to bankruptcy. (E. Laitinen and T. Laitinen 2004, 27)

There can be multiple different reasons why a company drifts to bankruptcy, and they can be divided into internal and external factors. Internal reasons for a bankruptcy includes operations inside the enterprise, which are commonly related to management's incompetence to see the field of activity clearly, which leads to wrong decisions. Also, the management's educational background and working experience can impact to company's ability to survive and succeed. Company's size can also influence how well the company will manage in business. Smaller the company is, bigger the risk is to drift to a bankruptcy and vice versa. On the other hand, in some cases, micro companies with under five employees, can use their flexibility to adapt faster to changes in supply which decrease the risk of bankruptcy. (Brüderl et al 1992, 240)

The probability for a company to go bankrupt depends on many factors like the industry company operates, company form, age, and location. For example, in Finland, the biggest probability to be declared for bankruptcy is to the construction industry and retail industry (Konkurssien… 2017). Limited companies have the lowest chance to go bankrupt from all the business forms. Naturally, micro companies with under five employees have the highest risk for going bankrupt because of the size of business. It has been identified that young and newly established companies have a bigger threat to go bankrupt because of the lack of knowledge about industry and management, and a portion of debt in the company. Location can impact indirectly to the threat of bankruptcy via differences in transporting and labour costs in different areas. (Ooghe, De Prijcker 2008, 224; T. Laitinen and E. Laitinen 2014, 144)

There are also external factors that can lead to bankruptcy. These factors occur in business' operational environment, and similarities between each other are that company's

management cannot affect to them. External factors that negatively affects to company's performance are for example changes in legislation, changes in debt collection procedures, changes in companies' financial behaviour, loss of customer and different macroeconomic fluctuations for instance in inflation or economic situation. (Mellahi, Wilkinson 2004, 23) Some of the factors are company specific, but part of the factors affect to whole industry or even to the entire economy. The evidence from high impact of external factors to bankruptcy sensibility is, for example, the financial crisis between 2009 and 2011 when companies were filed for bankruptcy more often than nowadays.

At the next, the models chosen for the research are presented. The models were selected for the study based on their significance for bankruptcy prediction and easiness to apply. Beaver's and Altman's models can be considered as the most remarkable predictive models and especially Altman's Z-score is still in use widely. Different kind of models was also chosen for the research. Beaver's model represents univariate models and Altman's model is a classical multivariate model. The importance of Laitinen's model for the research increases the fact that it is the only model which is estimated with Finnish data and therefore it could be assumed to have the best optimization for the test data. Laitinen's reputation and his numerous published researches about bankruptcy prediction that is publicly available made the model relevant for the research.

1.1 William H. Beaver's Model

William H. Beaver brought something new, already for decades continued research about the bankruptcy prediction. Beaver's research contained features that no one else had ever presented, and for that reason, he is named as a pioneer for an approach which uses individual financial ratios to predict failure. (Laitinen 1990, 40)

Comparing only individual financial ratios with each other is based on the fact that companies' ratios will change on worse when getting closer to bankruptcy. The company's ratios are compared to the critical value and then classified either a healthy company or bankrupt one. The probability of bankruptcy will increase when financial ratios decrease to under of the average level. When ratios drop to a critical level, it can be assumed that bankruptcy is very likely to happen. (Laitinen 1991, 649)

Beaver's primary objective of the research was to find how different financial ratios predict bankruptcy that are possible to conduct from the financial statement. As a secondary goal, he wanted to find the ratio that predicts bankruptcy in the best possible way. Beaver chose for his research 79 companies which were filed for bankruptcy and respectively 79 companies still operating in business. For every bankrupt firm, a similar company was chosen which corresponded the same field of business and size. This way impact of different sizes of companies and different industries was possible to eliminate. This method was Beaver's invention, and the method's meaningfulness underlines the fact that it was used in many bankruptcy prediction researches which have been implemented after Beaver (Keasey et al 1991). Beaver compared both companies' performance with 30 different financial ratios for five years. He chose the financial ratios with following three criterions: frequency of the ratios in literature, ratios' ability to predict bankruptcy in earlier studies, and its connections to cash flows. The ratios were divided into six categories, and from each of them, one ratio was chosen. After that Beaver did profile analysis to calculate the average of financial ratios for each year and both company types. From profile analysis, he found that enterprises still operating and companies in bankruptcy have differences in financial ratios. (Beaver 1966, 73)

In addition to profile analysis, Beaver tested how univariate model can classify companies either to a bankrupt company or to still operating company. Classification generated two different errors. The bankrupt company was either classified as a healthy company which generated error type I or healthy company was classified as a bankrupt company that was named as error type II. When adding error types I and II, the total classification error could be concluded. (Beaver 1966, 88)

To table 1 is listed total classification error rates of the best five financial ratios from five to one year before the bankruptcy.

Table 1. Percentages of total classification errors

The financial ratio	Years before the bankruptcy					
		1	2	3	4	5
Cash Flow/Total Debt		13	21	23	24	22
Net Income/Total Assets		13	20	23	29	28
Total Debt/Total Assets		19	25	34	27	28
Working Capital/Total Assets		24	34	33	45	41
Current Ratio		20	32	36	38	45

Source: Beaver 1966, 85

The averages of chosen financial ratios were calculated for each year, and it was noticed that the best ratio to predict bankruptcy was cash flow over total debt, which measures how much invested liabilities returns on profit. A year before bankruptcy, the ratio classified the companies' 87 percent correct and made a mistake only in 13 percentage of the cases. Five years before going bankrupt error rate for the ratio was 22 percent, so its prediction ability is a rather long range. The second-best ratio was net income over total assets which measures profitability. One year before the bankruptcy the ratio was as accurate as the first ratio, but in a long range, its prediction ability sank in lower level. Other three ratios also had a quite good prediction ability in the short range but in more extended period error rate fluctuated much more than for the first two ratios. (Ibid.)

Prediction models which are based on individual financial ratios have been criticised because of one-sidedness. Company's economic situation relies on many different factors which cannot be evaluated only with one financial ratio. From that reason, different ratios can give various results for the same company. Beaver also chose the financial ratios for the research based on empirical prediction ability and theoretical background of ratios wasn't on priority. From that reason researches which are done with a data consisting different companies can give different results. (Dimitras et al 1996, 264)

Beaver's research was a breakthrough in predicting bankruptcies and his model got praise from easiness to understand, apply, and develop. Based on Beaver's model many

researchers started to form multivariate models of their own which use the results from Beaver's individual financial ratios studies. (Altman and Hotchkiss 2006, 238)

1.2 Edward I. Altman's Model

Edward I. Altman was the first one who developed a multivariate formula in 1968. The idea of the multivariate method is to combine multiple different variables to a linear combination. When a linear combination is developed, it can be used to predict bankruptcy with same principles as individual financial ratios were used. (Laitinen 1990, 49)

As did Beaver also Altman used a similar pair-matched sample for his research which consisted of 66 companies. Half of the companies were filed for bankruptcy between 1946 and 1965, and naturally, other half was non-bankrupt companies. This way non-bankrupt companies corresponded to bankrupt companies in size and industry. The sample consisted only middle-sized companies since large companies went to bankruptcy rarely and from small companies, it was hard to get financial statement data in sufficient size. (Altman 1968, 593)

To preliminary analysis, Altman chose 22 financial ratios which he divided into five different groups to describe liquidity, profitability, leverage, solvency, and activity ratios. The selection was made without theoretical arguments but took into consideration the frequency of ratio in recent studies and possible benefit for the research. To his final function, Altman chose one financial ratio from each group. Each ratio was selected to the formula by examining interdependencies and predictive capabilities of ratios in different models and using personal consideration. The optimal weights for the study he estimated with statistical method of discriminant analysis. Altman highlighted that he didn't choose the best individual ratios for the research but the set of financial ratios which gave the best possible result. (Altman 1968, 594)

Altman's final equation for predicting bankruptcy is the following which is called the Z-score (equation 1):

$$Z = 0{,}012X_1 + 0{,}014X_2 + 0{,}033X_3 + 0{,}006X_4 + 0{,}999X_5$$

where,

X_1 = Working Capital / Total Assets

X_2 = Retained Earnings / Total Assets

X_3 = Earnings Before Interest and Taxes / Total Assets

X_4 = Market Value of Equity / Total Liabilities

X_5 = Sales / Total Assets

The first financial ratio (working capital to total assets) in the equation measures company's liquid assets in relation to the total market capitalisation. Retained earnings over total assets (X_2) describes company's profitability in the long term which reflects the company's age and earning power. That is because young organizations don't have time to accumulate retained earnings as extended period as operating companies does. The meaning of the third financial ratio (X_3) is to measure operating efficiency of the company apart from tax and leveraging factors. Altman emphasised this financial ratio's importance since company's main purpose is to make a profit for equity invested. The fourth part of the equation (X_4) measures company's solvency. The market value of equity over total liabilities describes how much company's equity value can decrease before it is lower than liabilities and it will become insolvent. With the fifth financial ratio (X_5) total asset turnover is measured. The ratio along is not remarkable, and it cannot predict the bankruptcy, but surprisingly with other key ratios, it has the second biggest contribution in predicting bankruptcy. (Altman 1968, 593)

Altman also precisely researched significance of critical values in bankruptcy classification. The results can be read so that bigger the z-score is for the company the healthier it is. Altman noticed that companies which had z-score over the value 2.99 were still operating and located so called safe zone. Correspondingly companies with z-score under 1.81 were bankrupt companies. Between the values (1.81-2.99) companies was located in a grey zone where they were falsely classified either to bankrupt companies or non-bankrupt companies. The best critical value in Altman's research was the value 2.675 which minimized the classification errors. (Altman 1968, 606)

Table 2. Altman z-score's prediction ability from one to five years before the bankruptcy

Years before the bankruptcy	Classified correctly	Falsely classified	Classification accuracy (%)
1	31	2	95
2	23	9	72
3	14	15	48
4	8	20	29
5	9	16	36

Source: Altman, 1968, 604

Table 2 illustrates the ability of Altman Z-score to predict the bankruptcy from one to five years before the occurrence. A year before the bankruptcy, the z-score classified falsely only five percent of the statistical data which means that 95 percentage of classifications between bankrupt and non-bankrupt companies were correct. Respectively, two years before going bankrupt the z-score classified 72 percent of the companies correctly. Therefore, z-score can be said to predict the bankruptcy in two years' time frame more precisely than Beaver's model based on individual financial ratios. Nevertheless, sensitivity can be seen decreasing rapidly before three years and the error rate is for the z-score is 52 percent. Therefore, Altman's function can be used only two years before to predict bankruptcy. (Laitinen 1990, 53)

Even if Altman's Z-score was developed decades ago, it has been discovered to be useful in recent bankruptcy prediction research. Nevertheless, it has been determined that the model is not entirely up to date. Grice and Ingram found out in their research that the Z-score's prediction ability decreased when the model was tested with new data. To get a better result, the Z-score should be re-estimated with current data. The same research revealed that the industry company represents, has its impact how well the model works. Because Altman used in his original research companies from the manufacturing sector, the Z-score doesn't give for other industries as accurate result. (2001, 60) In addition to company's industry, also a size of the company has been detected to affect the result. The model works well for large enterprises, but suitability for small business can't be guaranteed. (Narayanan 2010, 13)

Another Z-score's remarkable weakness is that it doesn't take into account other aspects which will affect to the failure than accounting data. For example, reasons for the bankruptcy are entirely excluded from the analysis. Furthermore, the accounting data represent the results

from the closing day, and therefore the model cannot predict the company's financial development certainly. The use of accounting data exposes for accounting error, which means that the distortions also reflects the results of the model. (Narayanan 2010, 13; E. Laitinen and T. Laitinen 1998, 893)

The way Altman acquired the financial statement data has also been criticized. First of all, the data for the research have been collected from 19 years which means that during the period many changes in economic situations and financial ratios have occurred. Secondly, financial statement data for bankrupt and non-bankrupt companies were collected from different sources. Because of that Altman got financial statements which were published before the company was filed for bankruptcy. That eased Altman's bankruptcy prediction, and the results might become distorted. (Ohlson 1980, 110; Altman and Hotchkiss 2006, 240; E. Laitinen and T. Laitinen 2004, 85)

Altman has updated the Z-score to correspond current business field and has published variations for different company groups with different weights and financial ratios. In 1983 Altman published Z-score for private firms which he re-estimated suitable for the company group by substituting the book value of equity for the market value. In 2012 Altman published model called the Altman Z-score plus that can be used to evaluate public and private companies, non-manufacturing and manufacturing companies, and U.S. and non-U.S. companies. (Altman et al 2014, 8) The equation for non-manufacturing companies is the following (equation 3):

$$Z = 6{,}56X_1 + 3{,}26X_2 + 6{,}72X_3 + 1{,}05X_4$$

where,

X_1 = (Current Assets – Current Liabilities) / Total Assets

X_2 = Retained Earnings / Total Assets

X_3 = Earnings Before Interest and Taxes / Total Assets

X_4 = Book Value of Equity / Total Liabilities

The difference in the model to the original one is that working capital is replaced with a difference of current assets and current liabilities in the first ratio and market value of equity is replaced with book value in the third ratio. Also, the fifth ratio is omitted from the model

entirely. Change of the weight coefficients will affect the result since the ratios are emphasized differently.

1.3 Erkki K. Laitinen's Model

Erkki K. Laitinen is Finnish researcher who has published many researches in the field of solvency and bankruptcy prediction. He has developed the first Finnish bankruptcy researcher Aatto Prihti's z-score further and based on that introduced one of his own. Laitinen's z-score has three variables, and it was published in 1990's. Laitinen's purpose was to develop a model which was easy to use, and it can detect possible bankruptcy before occurrence. To get the best possible result out of his model, Laitinen also used Altman's and Beaver's studies as a reference for his studies. (Laitinen 1990, 194)

Laitinen used as an observation data 40 small and middle sized bankrupt companies and the same quantity of non-bankrupt companies from the same industry. Therefore, a similar pair-matched sample was also in use in his study. The research was carried out from seven to eight years prior the bankruptcy when all the financial statement data was available from the companies included in the research. (Ibid.)

Laitinen chose seven preliminary ratios and five other variables for his research. The variables measure corporates' profitability, liquidity, solvency, and other factors such as growth and the size of a company. (T. Laitinen and E. Laitinen 2014, 218)

The study pointed out that the most notable differences between companies in values of individual ratios can be found statistically from equity ratio, quick ratio, and from the ratio where depreciation and amortization are added to net income and divided by operating revenue. From the all previously mentioned financial ratios, equity ratio is classified as the best individual ratio to predict insolvency. Because of the ratios' good prediction accuracy, Laitinen found it challenging to develop a multivariate model which can increase the prediction accuracy. (Laitinen 1990, 215) Eventually, the best multivariate model was found with stepwise discriminant analysis and the final z-score was the following (equation 2):

$$Z = 1{,}77X_1 + 14{,}14X_2 + 0{,}54X_3$$

Where,

X_1 = Net income + Depreciation & Amortization / Operating revenue

X_2 = Quick ratio

X_3 = Equity ratio

The critical value which classifies the best companies to non-bankrupt and bankrupt companies was 18. If the company got a lower value than 18, the company is classified as a bankrupt company. Respectively if a company got the greater value than 18, it was classified as a healthy company. Laitinen also specified that companies with the value over 40 had excellent result and companies under 5 had very weak result and extremely high risk to go bankrupt. (Ibid.)

Table 3. Laitinen Z-score's prediction ability from one to four years before the bankruptcy

	One year before the bankruptcy	Two years before the bankruptcy	Three years before the bankruptcy	Four years before the bankruptcy
Non-bankrupt companies	72,5%	72,5%	72,5%	72,5%
Bankrupt companies	95%	62,5%	55%	50%
Total classification accuracy	83,75%	67,5%	63,75%	61,25%

Source: Laitinen 1990, 223

The table illustrates the results of Laitinen's studies and the model's ability to classify companies between operating companies and bankrupt companies from one to four years before the bankruptcy. It can be noticed from the table that the model worked well for both groups one year prior the bankruptcy, but for bankrupt companies, the prediction ability decreases heavily after that. Laitinen still reminds that the effect is natural for companies in trouble since the probability for permanent insolvency appears critical just close to bankruptcy. When comparing Laitinen's model to Altman's earlier creation, it can be seen that Laitinen got slightly lower results in error percentage at later stages of going towards bankruptcy. Even if the models can't achieve the prediction ability that Altman's model got, it can be identified that the advantage of the model is that the error percentage doesn't increase over the years as much as Altman's model did. (T. Laitinen and E. Laitinen 2014, 231)

2. TESTING OF THE PREDICTIVE MODELS

This chapter presents the results of testing the predictive models. At first, the data used in the research is introduced. After the introduction, the study tries to answer the central question by testing the chosen prediction models. At first, Beaver's univariate model is tested with quantitative analysis and after that same technique is used for the Z-scores from Altman and Laitinen.

2.1 Introduction of the data

The data was gathered with a peer group analysis. A peer group is set of individual institutions which are grouped by relevant criteria. Depending on certain needs and data availability, different peer groups can be constructed for comparing and analysing purposes. Therefore, this research papers peer group was defined to consists Finnish construction companies which were filed for bankruptcy in years 2015-2016 and their financial statements were available in Amadeus-database. The peer group was also restrained so that companies which had financial statements less than five years available were limited from the group. (Peer… 2017, 161)

The final peer grouping limited the total number of financial statements from Finnish construction companies to 36. Since the research paper uses matched sample and similar pairs are formed with certain criteria, half of the companies are bankrupt and half non-bankrupt companies. That way, industry specific impacts were possible to eliminate. The data was chosen for the research so that, constructing companies which were filed for bankruptcy in recent years was searched from the database. Companies that was meeting the criteria and had the needed financial statement data available totalled 18. For every bankrupt company, a suitable non-bankrupt company was chosen randomly by comparing companies' number of employees and

operating revenue. Respectively the chosen non-bankrupt companies should also have had the required financial statement data available.

Amadeus-database was used to collect relevant data for the research. Correspondingly, Amadeus-database collect their data from Asiakastieto Oy which receive the information from Finnish company register where companies have an obligation based on the law to report their annual reports. The ratios that appear in the research have been calculated from the data in financial statements, or they have been obtained as given from there.

The companies chosen for the research are small from their size. The size of Finnish companies is defined in EU recommendation 2003/361. When a company is defined as small enterprise, it has less than 50 employees and either turnover or balance sheet total is evenly or under 10 million euros (What… 2017). However, the study companies can also be defined as small and medium-sized companies (SMEs) if there is no need to specify them more precisely. SME enterprises have less than 250 employees and either their turnover or balance sheet total doesn't exceed 50 million or 43 million euros, respectively. (Konkurssien… 2017) The companies in this study are categorized to SMEs since Statistics Finland (Tilastokeskus in Finnish) doesn't provide financial ratio averages separately for small enterprises, but the wider definition is used. The amount of balance sheet total varies between 147,000 and 4,595,000 euros and turnover from 671,000 to 1,372,7000 euros for the case companies.

The construction industry is the third largest industry in Finland when the size of an industry is measured by a number of companies and employees, and the industry's total turnover. The profitability of the industry is recovering from the economic crisis in years 2009 and 2013, and the turnover of the industry is increasing all the time commendably. Especially, SME companies have benefited from the growth of turnover and operating margin has increased for them about three percent. New construction companies established is yearly approximately seven percent of the whole number of new businesses launched in Finland. However, companies are quitting in a high percentage in the industry and in some years the number of retired companies have even exceeded the new companies established. Regardless the high number of retiring companies, the number of bankruptcies in the industry is decreasing rapidly and 2016 the decrease was nine percent compared to previous year. (Suhdannekatsaus… 2017)

The strength of Finnish construction industry is that buildings and infrastructure are the largest assets for Finnish people, and a total of 565 billions of Finnish national wealth is tied to it. Because of that, there is always demand for work of construction companies. Another

positive side is that the economic impact of construction is not only limited to the development of the construction sector and its jobs, but the volume of construction reflects heavily to the state's economy, and therefore its multiplicative effect is considerable. (Rakentaminen… 2017)

As the main weakness of Finnish construction industry, its vulnerability to fluctuations in macro economy and manufacturing can be mentioned. Investments in construction are usually scheduled to economically stable times because they aren't at first in priority list when a company is doing badly financially. Also, industrial development and changing business structures have a direct impact on willingness to build. The changes in inflation and interest rates can also affect to desire for new construction investments. Because the costs of building are highly linked to the materials used, the changes in prices of building materials have its correlation in willingness to construction investments. Primarily, the fluctuations in oil prices have impacted to construction costs. (Suhdannekatsaus… 2017)

There are few opportunities that construction industry has in Finland. First, the buildings in Finland have matured to an age when repairing work is needed. Because of late urbanization of Finland, especially state buildings, suburb apartment buildings, and old detached houses requires refurbishment. Also, all buildings need regular and competent maintenance to keep the building usable which naturally increases the demand for construction workers. The second opportunity that construction industry has in Finland is growing urbanization. Finland is in a situation when part of the country is becoming uninhabited because of government's desire to move services to centres of growth. Buildings are needed in the locations where migration waves are directed. Also, in Finnish society and especially in the larger cities it is common that people live in households of one or two. Families with children aren't the most common family form, and demand for these single households must be fulfilled. In a macro level, also the accelerating immigration will increase the need for housing. It is estimated that 760,000 new apartments have to be built by 2040, not to mention constructions that the investments in manufacturing causes. (Asuminen… 2017)

The threats that Finnish construction industry meets are highly related to its weaknesses which were previously presented. The biggest threat is, of course, possible economic recession which will impact negatively to construction investments. Also, the state's decision to restrict the construction will have the same impact. One threat which wasn't previously mentioned is the lack of labour force in particular areas. If the shortage cannot be filled with immigration or other ways, the growth of the industry can start to lag. (Ibid.)

The construction companies have characteristics in their financial statements which are typical for the operators in the industry. The most notable feature which labels construction industry is that it is typically long-term business since the realization of building contracts extends over multiple accounting dates. Therefore, construction companies must practice accounting methods like the Percentage of Completion, but the aspect also creates other problems that the companies have to adapt. (Special… 2017) Usually, construction companies have difficulties to copy in business because of the lack of working capital required to finance long-term projects. Sufficient amount of working capital is crucial to fund existing projects and gain new contracts, and many companies even fail because of the lack of capital regardless the business is profitable (Green 2013). In addition to a reasonable amount of working capital, companies should also be prepared to highly cyclical demand. Like earlier stated, the construction industry is exposed to fluctuations in the economy and the demand is higher in a healthy economy. The vulnerability is actual for construction companies also from the perspective that they are highly linked to a location which they are operating.

To the table 4 is concluded Finnish SME construction companies' averages of financial ratios from the year 2012 to 2015 which are used in later chapters to benchmark companies in this research to the industry. Return on assets was chosen to measure profitability of the companies. Respectively, to measure solvency equity ratio was chosen. Current ratio was chosen to measure liquidity but because of average values wasn't available, the guideline values from Balance Consulting is used to comparison, and they are presented later in the research.

Table 4. Finnish SME construction companies' averages of ROA and Equity ratio from year 2012 to 2015

Year	Return on assets	Equity ratio
2012	8,4 %	37,1 %
2013	6,1 %	37,9 %
2014	6,6 %	38,2 %
2015	6,0 %	36,2 %

Source: Enterprises'… 2017

2.2 Testing of William H. Beaver's Model

Beaver's model tries to predict the bankruptcy with individual financial ratios and in the center of the model is a comparison of the averages of financial ratios between bankrupt and non-bankrupt companies. The usage of the financial ratios is based on the assumption that the indicators of bankruptcy are going to be worse, the closer the bankruptcy is.

The financial ratios were calculated for the companies annually. The critical value for each financial ratio is an average of all the companies' financial ratio in question. Therefore, critical values used in this research differ from the ones that Beaver used. Using the original critical values in Beaver's research would probably give a worse result since financial ratios have very different values nowadays and Beaver used companies from the different industry. From that reason using different critical values can be considered as justified. The most remarkable outliers were removed from the data to get a more reliable result.

When the term "from five to one year before the bankruptcy" is used in the study, it should be noted that non-bankrupt companies continue to operate after this period and only bankrupt companies are filed for bankruptcy. Next, it is examined how Beaver's five best financial ratios can predict the bankruptcy of the case companies.

2.2.1 Comparison of financial ratios between companies

With the comparison of financial ratios between the case companies, it can be detected if the values of financial ratios differ from each other. From the development of the financial ratios, it can also be noticed how early the ratios alarm about the possible bankruptcy. At first, the financial ratio cash flow to the total debt which had the best classification ability in Beaver's research and describes debt repayment capability is presented (see Appendix 1).

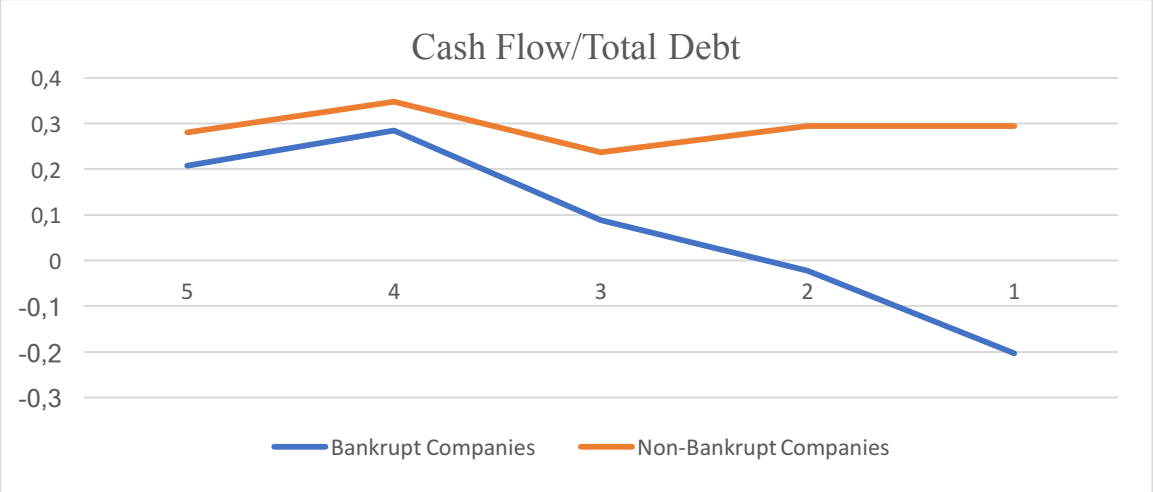

Figure 1. Average of cash flow to total assets from five to one year before the bankruptcy

As the figure above shows, bankrupt companies and non-bankrupt companies didn't have a big difference regarding cash flow over total debt, in four to five years before the bankruptcy but the differences began to appear three years prior the bankruptcy. For bankrupt companies, the ratio turned to negative two years before the bankruptcy and continued its steep decline to one year prior the bankruptcy. For non-bankrupt companies, the curve is very stable except a slight drop in the year three. In general, a declining curve for bankrupt companies can be explained by weakened cash flow and increase in the portion of liabilities as bankruptcy comes closer.

The next financial ratio that is analysed is net income to total assets. In the second figure (see Appendix 1) below is presented how the ratio behaved with the case companies. Return on assets describes the company's profitableness, or how efficiently the company can convert its use of assets into profit.

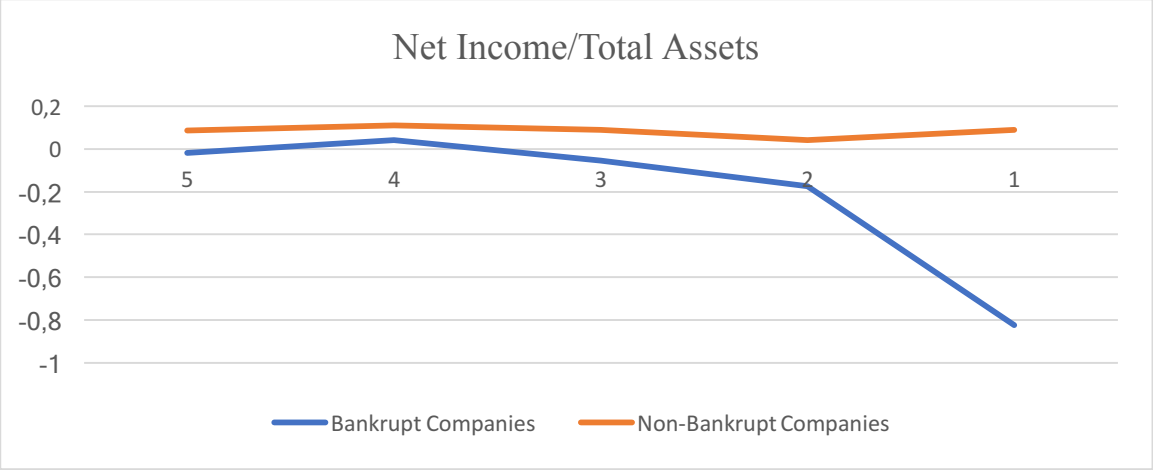

Figure 2. Average of net income to total assets from five to one year before the bankruptcy

Like the previous ratio also differences in return on assets are quite minor in four and five years before the bankruptcy, but three years prior the bankruptcy the differences started to increase little by little. Non-bankrupt companies don't have an excellent return on assets either, but for the bankrupt companies, it starts to be alarming low at the later stages. For bankrupt companies return on assets turned negative already five years before the bankruptcy which can be considered as a major risk when the amount of equity is reducing. The ratio was slightly positive only four years before the bankruptcy.

As the third financial ratio, total debt to total assets is examined which describes company's degree of solvency and at the same time illustrate its capital structure. The development of the bankrupt company and operating company's financial ratio five years prior the bankruptcy is shown in figure 3 (see Appendix 1).

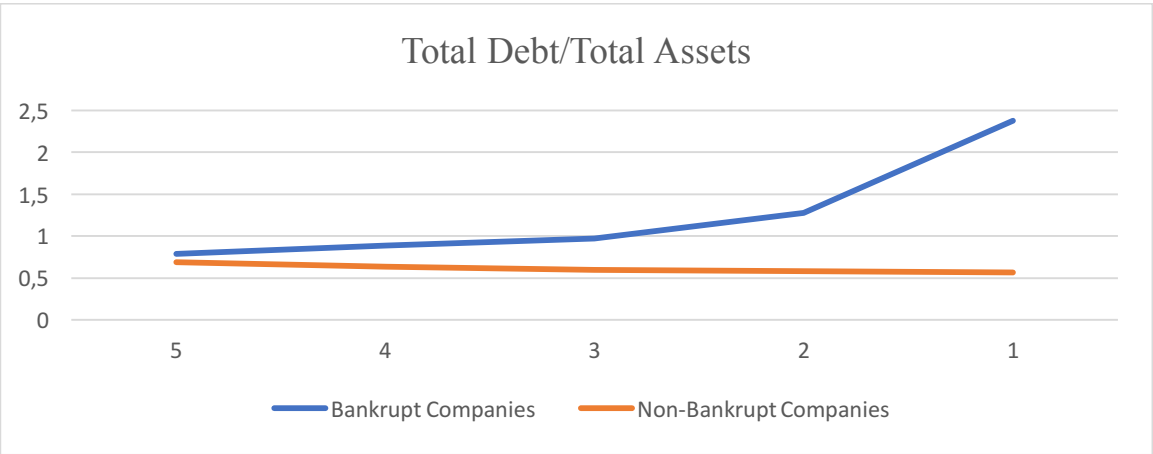

Figure 3. Average of total debt to total assets from five to one year before the bankruptcy

The forth figure describes well how bankrupt companies portion of liabilities increases the closer the bankruptcy comes. Five years before the bankruptcy companies have almost the same amount of debt but bankrupt companies' share increases continuously and is nearly 2,5 times bigger one year before the bankruptcy. When the financial ratio exceeds the value 1, the company has more liabilities than equity. An unusually high amount of debt is likely to increase the risk of bankruptcy. For non-bankrupt companies, the curve is steady as it has been with other financial ratios.

The fourth financial ratio is working capital to total assets, which measures company's liquidity. Figure 4 (see Appendix 1) shows the relation of working capital to total assets for both bankrupt and operating companies from five to one year before going bankrupt.

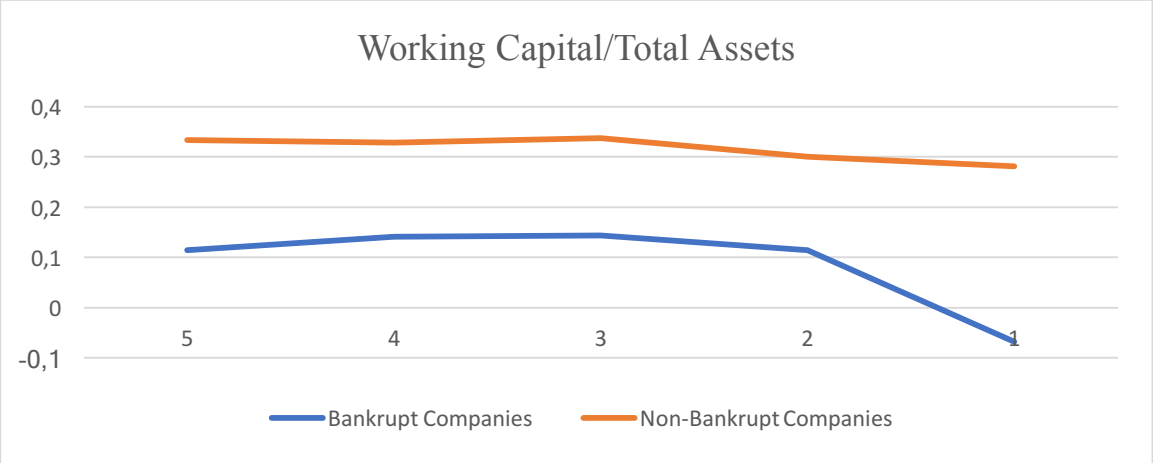

Figure 4. Average of working capital to total assets from five to one year before the bankruptcy

The financial ratio illustrates how companies can survive from their short-term liabilities. The bigger the financial ratio, the better is company's liquidity. The gap between non-bankrupt and bankrupt companies stays the five-year period almost at the same level, but one year prior the bankruptcy, the ratio turns negative for bankrupt companies. Noteworthy is the fact that for the bankrupt companies the ratio is slightly increasing from five to three years before the bankruptcy but for the non-bankrupt companies' curve is decreasing all the time.

The last financial ratio that is covered is current ratio which also measures the company's liquidity. The current ratio is introduced for both companies five years before the bankruptcy in figure 5 (see Appendix 1).

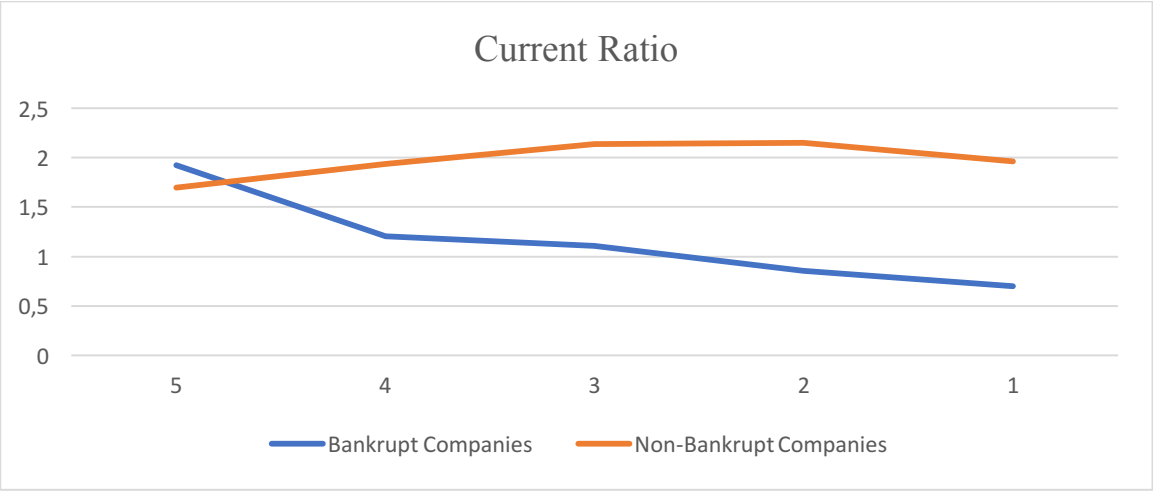

Figure 5. Average of current ratio from five to one before the bankruptcy

Surprising is that the current ratio is even higher for bankrupt companies five years before the bankruptcy. However, after that current ratio starts to increase for non-bankrupt companies and decrease for bankrupt companies like it normally does. For non-bankrupt companies, the ratio stays in the decent level, but bankrupt companies have weak value all years except the fifth. When the current ratio is low, companies have difficulties to survive from short-term liabilities.

As a whole, differences can be detected when comparing averages between company groups. Differences in current ratio were possible to identify four years before the bankruptcy, and net income to total assets gave negative values for bankrupt companies already five years before the bankruptcy. At the next, financial ratios' classification capability is examined.

2.2.2 Classification capability of the model

To calculate the model's classification capability, the critical values (see Appendix 1.) have to be set for every financial ratio for each year. The critical values are averages of all companies' financial ratios, where outliers have been removed.

After setting the critical values, the financial ratio's classification capability can be concluded. The critical values are compared to every company's financial ratios, and when the ratio is lower than the critical value, the company is classified as a bankrupt company. The exception is total debt to total assets where the companies with financial ratios higher than the

critical value are classified as a bankrupt company. Like in the Beaver's research, two kinds of classification errors can occur. When a bankrupt company was classified as a healthy company, the error type I had occurred and when a healthy company was classified as bankrupt company error type II had occurred. In Table 5 is presented the number of different error types in the test data.

Table 5. Classification errors by error type from five to one year before the bankruptcy

Years before the bankruptcy		Cash Flow/Total Debt	Net Income/Total Assets	Total Debt/Total Assets	Working Capital/Total Assets	Current Ratio
5	Error Type I	7	10	7	7	4
	Error Type II	10	4	7	6	13
4	Error Type I	6	8	7	7	3
	Error Type II	8	4	4	7	9
3	Error Type I	6	10	8	7	3
	Error Type II	6	3	2	8	10
2	Error Type I	2	8	6	10	2
	Error Type II	7	4	0	9	9
1	Error Type I	5	7	6	8	2
	Error Type II	2	0	1	6	5

From the table can be perceived that the financial ratios have a different amount of error types I and II. This occurs because some ratios classify bankrupt companies to non-bankrupt companies more often than non-bankrupt companies to bankrupt companies. The most levelled distribution between classification errors is in working capital to total assets. However, the ratio has clearly the greatest amount of total errors from all the ratios. When the ratio's average values are compared to the results from the original research, it can be noticed that different company groups had a larger gap between the values of financial ratios in the Beaver's research. In this research, the gap for working capital to total assets was much smaller which caused the number of errors for the ratio, but smaller gaps probably affected also to result in other ratios.

By adding each financial ratios' error types and dividing the number by the total number of case companies, the total percentage of classification errors can be concluded. The percentage of classification errors illustrates model's classification capability and lower the number of classification errors, the better the financial ratio is to predict the bankruptcy. Table 6 describes the individual financial ratios' prediction ability.

Table 6. Percentages of classification errors

The financial ratio	Years before the bankruptcy					
		1	2	3	4	5
Cash Flow/Total Debt		19	25	33	39	47
Net Income/Total Assets		19	33	36	33	39
Total Debt/Total Assets		19	17	28	31	39
Working Capital/Total Assets		39	53	42	39	36
Current Ratio		19	31	36	33	47

From the table, it can be seen that total debt to total assets managed to predict the bankruptcy the best from the data concerned. From all the financial ratios, its prediction capability stays at a good level for first four years before the bankruptcy. Classification capability is one year before the bankruptcy 81 percent and four years before still 69 percent. The second best financial ratio to predict the bankruptcy is harder to name, but cash flow to total debt can predict the bankruptcy second best in the first three years. However, compared to total debt to total assets its prediction capability decreases faster and five years before the bankruptcy it is close to 50 percent. The only financial ratio that isn't reasonable to use is working capital to total assets. The ratio's prediction capability is already one year before the bankruptcy very low and two years before the bankruptcy it does more incorrect than correct classifications.

Compared to results of Beaver's original research, the financial ratios in this research don't reach the same level of the prediction capability. Some of the ratios (total debt to total assets and current ratio) got slightly better values in first two years before the bankruptcy than in Beaver's research, but their prediction capability decreases much faster and even to lower

level further away from the bankruptcy. Also, the ranking of financial ratios was significantly different between the two studies.

The bankruptcy prediction can be said to be difficult with comparing averages of financial ratios between non-bankrupt and bankrupt companies. Differences in values of bankrupt and non-bankrupt companies' financial ratios can be found, but part of the ratios alarms about the bankruptcy only one or two years before the bankruptcy. Overall, the financial ratios in this research didn't provide adequate classification capability to make clear conclusions about the state of the listed companies. Multivariate models should be used and compared to get as objective result as possible. Since prediction capability does give an objective results only one or two years before the bankruptcy, the financial ratios should be used only as late warning signs.

2.3 Testing of Edward I. Altman's Model

Altman's model is more developed than previously presented Beaver's model, and it uses multiple corporate income and balance sheet values to measure the financial health of a company. With the financial ratios gathered and calculated from the companies' financial statements, the Z-scores are calculated for every company and year. After the calculation, the result is compared to the critical value. The Altman's model doesn't concentrate to a comparison of the financial ratio's averages but rather on the model's classification capability.

It was noticed during the testing of the original z-score that the equation presented in the theory part of the research didn't work very well in a classification of the companies. The Z-score classified bankrupt and non-bankrupt companies incorrectly in the higher percentage than correctly. The reason behind it might be the fact that the original Z-score is for public limited liability companies and market values of equity are needed for calculation of the fourth variable. All the companies in the research are limited liability companies, and therefore only book value of equity is available. Using the market value of equity might distort the result. It was also noticed that the fifth financial ratio, sales to total assets gave relative high value compared to other ratios and it might affect to result negatively. Because of these facts, the results of original Z-score isn't presented. Multiple different variations of Z-score was tested to find the best possible result, and it was noticed that the Z-score Plus updated for non-

manufacturing companies, had the best classification capability and it is therefore used in this research.

With the different model chosen for the research, the prediction capability increased significantly. The values of Z-scores are compared to Altman's defined critical values. For the model, critical values are 2,6 or over for safe zone, between 1,1 and 2,6 for a grey zone, and for distress zone under 1,1. If a company lies on safe zone, it has a small risk to go bankrupt. Correspondingly if a company has value under 1,1, it has an enormous risk to fail bankrupt. When a company is located in a grey zone it is either classified falsely as a bankrupt or non-bankrupt company. To the table 7 is listed distribution of non-bankrupt companies.

Table 7. Altman z-score's prediction ability from one to five years before the bankruptcy for non-bankrupt companies

Years before the bankruptcy	Distress zone	Grey zone	Safe zone
1	2	5	11
2	2	7	9
3	3	3	12
4	4	1	13
5	1	5	12

From the table can be perceived that the model classifies about two-thirds of the companies correctly. The grey zone consists the second largest portion of companies and number of companies in the zone varies from one-third to six percent. Distress zone is the smallest and its totals from six to twenty-two percent of the companies.

For bankrupt companies, the model works way better. For the bankrupt companies, the distribution between safe, grey, and distress zone is listed in table 8.

Table 8. Altman z-score's prediction ability from one to five years before the bankruptcy for bankrupt companies

Years before the bankruptcy	Distress zone	Grey zone	Safe zone
1	16	1	1
2	14	2	2
3	9	4	5
4	7	2	9
5	9	1	8

The model's classification capability is reduced, from five to three years prior the bankruptcy. It classifies only 50 percent or under of the companies correctly. However, two and one years before the bankruptcy the prediction capability increases to a decent level, and it can predict most of the companies correctly.

For the original test data, Altman defined 2,675 as the critical value which minimized the error of companies classified falsely. The same critical value can't be used in this research, but the critical value which classifies companies the best can be defined from the test data. The critical value for this researches' test data is 1,492. Businesses that have the Z-score under that value are defined as bankrupt companies and companies over the value as non-bankrupt companies. Table 9 shows how companies are classified with the defined critical value.

Table 9. Altman z-score's prediction ability from one to five years before the bankruptcy for non-bankrupt companies with the critical value

Years before the bankruptcy	1	2	3	4	5
Correctly classified	15	16	15	14	17
Falsely classified	3	2	3	4	1
Classification accuracy (%)	83%	89%	83%	78%	94%

From the table can be perceived that the model's prediction capability stays in the good level for every year. Its classification capability is particularly good five years before the bankruptcy when it failed in classification only one time out of eighteen. Prediction capability

falls over the years but even the worst it can predict 78 percent of the cases correctly. Declining classification ability can be explained by the fact that the companies were selected randomly and to their financial status wasn't paid attention. Therefore, the data can consist both financially succeeding and weaker companies. Besides, external factors affecting to the financial situation of whole constructing industry can be behind of poorer classification capability in earlier years. The table 10 shows how classification capability succeeds with the bankrupt companies.

Table 10. Altman z-score's prediction ability from one to five years before the bankruptcy for bankrupt companies with the critical value

Years before the bankruptcy	1	2	3	4	5
Correctly classified	17	15	10	8	9
Falsely classified	1	3	8	10	9
Classification accuracy (%)	94%	83%	56%	44%	50%

Before the critical value was defined, the model classified better bankrupt companies. When the critical value is specified, it can be seen that the model doesn't achieve the same kind of stability with bankrupt companies as it reaches with non-bankrupt companies. The reason for this is that there were more non-bankrupt companies in grey-zone which was possible to classify correctly with the critical value. The strength of the model with bankrupt companies is to predict bankruptcy one and two years before it. One year before the bankruptcy, the model fails only six percent of the cases. Two years before the bankruptcy, the model's classification capability is still at a good level and classifies 83 percent of the companies correctly. From three to five years before the bankruptcy, the model's bankruptcy prediction capability drops significantly to near 50 percent. It is not reasonable to use the model since it fails in about 50 percent of the cases and with flipping the coin, it could be possible to get even better result.

With adding the results of non-bankrupt and bankrupt companies, it is possible to get the model's total prediction capability. To table 11 is concluded these numbers.

Table 11. Altman z-score's total prediction ability from one to five years before the bankruptcy

Years before the bankruptcy	Correctly classified	Falsely classified	Classification accuracy (%)
1	32	4	89
2	31	5	86
3	25	11	69
4	22	14	61
5	26	10	72

From the table 11 can be perceived that the model's classification capability is a year before the bankruptcy 89 percent. The model's prediction ability decreases continually, and it is only 61 percent four years before the bankruptcy. Five years before the bankruptcy, the classification accuracy even increases compared to the fourth year. The increase can be explained with non-bankrupt companies' strong result in the fifth year when only one non-bankrupt company was classified falsely.

Compared to Altman's original results, the model can be said to have achieved more steady result with the test data. However, it must be considered that the model used for the research was updated and the critical values were modified suitable for the experimental data. With the same weight coefficients and ratios that Altman used in his original research, the result would be significantly worse. One year before the bankruptcy, the model had six percentage worse classification than in Altman's studies. However, from two to five years before the bankruptcy, the model's prediction capability is stronger than in the original research. The results from 3-5 years in both studies are still too low that the models could be used to alarm about bankruptcy in the early stages.

The model worked well for the constructing industry chosen for the research. The model can classify well companies to non-bankrupt, but the accuracy decreases quickly after two years for bankrupt companies. The reason for that is probably that the ratios don't decrease the same way as the bankruptcy approaches as in the original research. The problem can also exist because of nowadays companies has different capital structures compared to the companies in the Altman's research. Re-estimating of critical value didn't help for the problem because bankrupt companies' Z-score varies in larger range compared to non-bankrupt and for that reason, they cannot be eliminated as efficiently.

2.4 Testing of Erkki K. Laitinen's Model

Laitinen's Z-score is only Finnish model in the research which makes it valuable for it since both researches' data consists only Finnish companies. Like Altman's the Z-score, also Laitinen's model is based on various financial ratios calculated from companies' income statements and balance sheets, but Laitinen's Z-score consists only three different financial ratios. The financial ratios calculated from financial statements are placed in the model presented in the research and compared to given critical value. The Laitinen's model doesn't concentrate to a comparison of the financial ratio's averages either but rather on the model's classification capability. The model doesn't have critical values for distress, grey or safe zone like Altman's model did. The model's only critical value is 18. Companies with lower than the critical value are classified as bankrupt companies and correspondingly companies with the higher value as a non-bankrupt company. At next is presented the model's prediction capability for non-bankrupt companies.

Table 12. Laitinen's Z-score's prediction capability from one to five years before the bankruptcy for non-bankrupt companies with the critical value

Years before the bankruptcy	1	2	3	4	5
Correctly classified	17	16	17	13	16
Falsely classified	1	2	1	5	2
Classification accuracy (%)	94%	89%	94%	72%	89%

From the table can be predicted that the model manages to predict for non-bankrupt companies at a good level nearly every year. One and three years before the bankruptcy the model fails only for one company. Two and five years before the bankruptcy only in two cases. The only unfortunate result occurs in four years before the bankruptcy when the model fails 28 percent of the cases. It had to be also remembered in this occasion that the non-bankrupt companies are still operating and their result can vary widely between years and are vulnerable to external factors in the economy. Table 13 presents the model's prediction capability for bankrupt companies.

Table 13. Laitinen's Z-score's prediction capability from one to five years before the bankruptcy for bankrupt companies with the critical value

Years before the bankruptcy	1	2	3	4	5
Correctly classified	13	12	6	4	6
Falsely classified	5	6	12	14	12
Classification accuracy (%)	72%	67%	33%	22%	33%

The model's prediction ability is in the decent level only one and two years before the bankruptcy. After first two years, the prediction capability declines very fast, and the model cannot be used as an early warning for bankruptcy. When comparing the bankruptcy prediction ability to non-bankrupt companies' ability, the difference is clear. Even at best, the model cannot predict bankruptcy as accurate as it does for non-bankrupt companies. To the table 14 is calculated the model's total bankruptcy prediction capability.

Table 14. Laitinen Z-score's total prediction ability from five to one year before the bankruptcy

Years before the bankruptcy	Correctly classified	Falsely classified	Classification accuracy (%)
1	30	6	83
2	28	8	78
3	23	13	64
4	17	19	47
5	22	14	61

Like the table points out, the overall prediction capability is in the decent level one and two years before the bankruptcy. However, after the first two years, the prediction capability drops to reduced level. Five years before the bankruptcy, the classification accuracy even increases compared to the fourth year. The increase can be explained with non-bankrupt and bankrupt companies' poor result in year four when the result was significantly poorer for some reason.

Compared to Laitinen's original research, the research gives a different result. In this research, the model classifies non-bankrupt companies correctly much better. The model doesn't achieve the same kind of stability as Laitinen's z-score but prediction capability stays higher every year, except the fourth when it is almost at the same level as in original research. On the other hand, the model doesn't predict bankrupt companies as accurately as in the original research. The second year is the only one when the z-score's accuracy is about the same level but every other year it falls behind and even clearly. Total prediction capability instead is in similar level one and three years before the bankruptcy. Two years before the bankruptcy the model achieves a better result and forth year worse. The results pointed out that the z-score works correctly at the two last years before the bankruptcy. Total prediction accuracy is closest to the results from the original research when comparing the results of all the models. That is most probably the case because the model is estimated with Finnish data which increases its optimization.

3. COMPARISON OF THE RESULTS

When the profitability, solvency and liquidity ratios presented earlier in the chapter is benchmarked to industry's averages, the differences between non-bankrupt and bankrupt companies are already visible. Without using bankruptcy prediction models, it can be perceived that the differences are significant between company groups. To the table 15 and 16 is collected the averages of financial ratios from bankrupt companies and non-bankrupt companies respectively. Because the mean values of current ratio weren't available the results are compared to Balance Consulting's guideline values. According to Balance Consulting, the company has weak current ratio when current ratio is under one, good when over two, and tolerable in between those values (Current… 2017). The industry average is informed on the brackets under every years' financial ratio.

Table 15. The average values of bankrupt companies' financial ratios compared to industry average from year 2012 to 2015

Year	Return on assets	Equity ratio	Current ratio
2012	4,2% (8,4%)	12,3% (37,1%)	1,2
2013	-5,4% (6,1%)	3,5% (37,9%)	1,1
2014	-17,4% (6,6%)	-28,5% (38,2%)	0,9
2015	-88,4% (6,0%)	-138,2% (36,2%)	0,7

Table 16. The average values of non-bankrupt companies' financial ratios compared to industry average from year 2012 to 2015

Year	Return on assets	Equity ratio	Current ratio
2012	10,9% (8,4%)	36,4% (37,1%)	1,9
2013	9,0% (6,1%)	40,2% (37,9%)	2,1
2014	4,2% (6,6%)	42,1% (38,2%)	2,1
2015	8,8% (6,0%)	43,0% (36,2%)	2,0

When comparing the tables, it can be noted that bankrupt companies differentiate from industry averages from every ratio type. Profitability ratio ROA doesn't achieve values even close to the industry average and negative values are huge close the bankruptcy. The same trend occurs with the equity ratio which measures solvency. The current ratio doesn't differentiate as plainly as the other ratios but the values are every either weak or just above the weak level. Non-bankrupt companies have opposite result. ROA and equity ratio is higher than the average for the case companies most of the years. Also, current ratio is in good level every year expect on 2012 when it is just slightly below the good value.

Even if the benchmarking of the results gave vital information about companies' situations, it would be rational to look closer the comparison of different bankruptcy prediction models. Although the results of different bankruptcy prediction models are based on the ratios calculated from companies' financial statements, it can be noticed that there are some slight differences in the results between different models. Individual financial ratios work differently compared to multivariate models and the financial ratios and the weight coefficients chosen for research affects to the result got. The most clearly the effect was experienced when Altman Z-score's weights and financial ratios were changed to get a better result. To the table 17 is summarised accuracies of the models used in this research got.

Table 17. Accuracy of the prediction models and financial ratios as percentage from five to one year before the bankruptcy

	Years before the bankruptcy				
	1	2	3	4	5
Cash Flow/Total Debt	81	75	67	61	53
Net Income/Total Assets	81	67	64	67	61
Total Debt/Total Assets	81	83	72	69	61
Working Capital/Total Assets	61	47	58	61	64
Current Ratio	81	69	64	67	53
Altman's Model	89	86	69	61	72
Laitinen's Model	83	78	64	47	61

From the table can be perceived that the three best bankruptcy predictors in first two years before the bankruptcy are Altman's model, Laitinen's model and total debt to total assets. Clearly, the worst predictor is working capital to total assets which prediction capability differentiates especially one year before the bankruptcy. The critical values were estimated for every prediction model based on the research data, except Laitinen's model where the original critical value from Laitinen's research was used. On the other hand, Laitinen's model was the only model which was estimated with Finnish company data so the result probably wouldn't be so much different with the critical value determined from the research data.

One year before the bankruptcy, the difference in prediction accuracy isn't high but for already mentioned working capital to total assets. Every model except one has the prediction accuracy of over 80 percent which can be considered as a good result. Two years before the bankruptcy, the three best predictive models manage to keep their prediction accuracy in decent level, and total debt to total assets even increases its accuracy. Three years before the bankruptcy, the prediction accuracies drop remarkable, and the best model isn't as easy to name as before. Four and five years before the bankruptcy accuracies continues to decline evenly close to 50 percent where the models are pointless to use.

When comparing prediction accuracies between z-scores and univariate models, it can be easily perceived that z-scores manage to predict correctly with a higher percentage than individual financial ratios. In addition to higher prediction percentage, Altman's and Laitinen's models have still two years before the bankruptcy high accuracy when for individual ratios it

starts to decline steeply already. As an exception, total debt to total assets and cash flow to total debt have constant enough prediction accuracy from individual financial ratios but as high as Z-scores the financial ratios doesn't reach.

CONCLUSIONS

In this research paper, it was studied how Beaver's, Altman's, and Laitinen's bankruptcy prediction models work for the Finnish construction companies. In the study, a pair-matched sample was used to compare companies similar size and from the same industry. To the test data, 18 bankrupt companies and 18 non-bankrupt companies were chosen. The financial statement data and financial ratios were collected five years before the bankrupt for both operating and bankrupt companies.

The first sub-questions which the research tries to answer was: are there any differences in results between companies filed for bankruptcy and operating companies. There can be found plenty of differences in the results between predicting bankruptcy for non-bankrupt and bankrupt companies. In general, the Z-scores worked better for operating companies and for bankrupt companies the accuracy remained lower. For the financial ratios, the result variated depending the ratio concerned. Three out of five from financial ratios worked better for non-bankrupt companies (Net Income/Total Assets, Total Debt/ Total Assets, and Working Capital/Total Assets, and correspondingly two of the ratios managed to predict bankruptcy better for bankrupt companies (Cash Flow/Total Debt and Current Ratio).

The second sub-question was the following: how early the prediction models signal about the bankruptcy. Five years before the bankruptcy, the prediction models indicate about the coming bankruptcy, but only Altman's model has the accuracy so high that it can be considered as reliable. The models' prediction capability improves clearly not earlier than two years before the bankruptcy. An only financial ratio that doesn't have reliable prediction ability one or two years before the bankruptcy is working capital to total assets but part of other ratios and models can be used to prediction even earlier.

The main question which the research tries to answer was: how the chosen prediction models work for the Finnish construction companies. Already benchmarking the companies to the industry average gave valuable information but prediction models should be used to get a

more comprehensive image. As the research pointed out, the models chosen for the research worked properly for construction firms. The best predictive models reached the prediction accuracy between 89 and 78 in first two years before the bankruptcy. When comparing the results from this research to original outcomes that researchers got from their studies, it can be noticed that the models don't reach as high accuracy in this research as in original ones. At least in the first two years' prediction ability is slightly lower for some ratios and part of the ratios even remarkably. The differences are, however, becoming closer the years are going further from the bankruptcy. Some ratios like for instance Altman's model had even higher prediction accuracy in this research further away from the bankruptcy.

The result evidence that all the models can be used to predict bankruptcies in Finnish construction industry. To get a trustful result, it would be recommended to use all the prediction models and compare the results with each other. However, it would be desirable to be critical towards the bankruptcy prediction models. It should also be kept in mind that particularly low or high value of one financial ratio in a multivariate model can distort the value of the whole model, and can lead to wrong conclusions. The backgrounds of the results could be wise to investigate with data from financial statements or other information of the company.

The research carried out can be considered as valid since the models used for it was developed specifically to predict bankruptcies and are based on earlier scientific research. In addition, the reliability of the research increases the fact that many different financial ratios and models were used to a prediction of bankruptcy and all the models gave similar results. The fact that data was quite small and consisted only 36 companies affects to the reliability of the research negatively. The reliability could be improved with the larger sample size when also the statistical analyse would be more comprehensive, and it would improve the generalizability of the result considerably.

The topic would be possible to study more carefully if, for example, a later model would be applied, the models used in the research would be re-estimated to suitable for Finnish companies, or look closer to factors which will impact on results of prediction models. In addition, the models would be possible tested with different industries, company forms or different sized companies. The study could be possible to expand in such a way that the reasons behind the bankruptcy would be taken under consideration in bankruptcy prediction. Most of the models are based on data from financial statement so for further investigations it could also be possible to include early warnings signs which are the reasons that cause bankruptcies.

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Non-bankrupt companies: Kvr-Rakennus Oy, Rakennusliike Kemppe Oy, Rakennus Furure Oy, Europinta Oy, Ab Heikius Woodconstruction Oy, Keanic Oy, Taratsa Oy, Suomen Pumpputasoite Oy, Rakennusespo Oy, Finn-Bois MTR Oy, Rakennus-Korpela Oy, Tupocon Oy, Kaj Häggblom Ab, Asennustiimi Karhula & Niemelä Oy, Jami Rakennus Oy, Järvenpään Purema Oy, Jivaco Oy, Rakennusliike Leimarakentajat Oy

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APPENDICES

Appendix 1. Average and Critical Values of the Financial Ratios from One to Five Years Before the Bankruptcy

Non-bankrupt companies	Years before the bankruptcy				
	1	2	3	4	5
Cash Flow/Total Debt	0,295	0,294	0,237	0,348	0,281
Net Income/Total Assets	0,088	0,042	0,090	0,109	0,085
Total Debt/Total Assets	0,567	0,579	0,598	0,636	0,690
Working Capital/Total Assets	0,282	0,300	0,338	0,329	0,333
Current Ratio	1,961	2,148	2,136	1,938	1,698

Bankrupt companies	Years before the bankruptcy				
	1	2	3	4	5
Cash Flow/Total Debt	-0,204	-0,022	0,088	0,285	0,208
Net Income/Total Assets	-0,825	-0,174	-0,054	0,042	-0,018
Total Debt/Total Assets	2,373	1,274	0,971	0,884	0,785
Working Capital/Total Assets	-0,067	0,115	0,144	0,141	0,114
Current Ratio	0,697	0,852	1,105	1,202	1,921

Critical values for both companies	Years before the bankruptcy				
	1	2	3	4	5
Cash Flow/Total Debt	0,045	0,136	0,162	0,317	0,244
Net Income/Total Assets	-0,369	-0,066	0,018	0,076	0,033
Total Debt/Total Assets	1,470	0,927	0,785	0,760	0,737
Working Capital/Total Assets	0,107	0,207	0,241	0,235	0,223
Current Ratio	1,329	1,500	1,621	1,570	1,809