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Assessing the bankruptcy risk of Finnish construction companies using financial statement data

Empirical study into Finnish construction industry companies

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Abstract

In a time of ever-changing economic conditions, complex financial arrangements, and fierce competition in the marketplace, the prospect of corporate bankruptcy is a shadow that both businesses and stakeholders must contend with. Corporate bankruptcy has far-reaching effects on suppliers, creditors, the government, and the general economy in addition to its effects on shareholders and employees. A number of economic and social problems, including job losses, supply chain disruptions, and a decline in investor confidence, can be brought on by financial crisis and bankruptcy.

In this paper I analyse Finnish construction industry companies using two most well know bankruptcy forecasting models Beaver's and Altman's. Using these models and samples for bankrupt and non-bankrupt companies, I calculate and analyse financial ratios using 2017 to 2022 as the period.

The study finds that both Beaver's and Altman's models show financial distress not only in the bankrupt companies' years prior to failure but also effects of covid, inflation and Ukraine-Russia conflict on the whole industry.

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Keywords Bankruptcy forecasting, Beaver, Altman, Construction industry.

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1. Introduction

In a time of ever-changing economic conditions, complex financial arrangements, and fierce competition in the marketplace, the prospect of corporate bankruptcy is a shadow that both businesses and stakeholders must contend with. Corporate bankruptcy has far-reaching effects on suppliers, creditors, the government, and the general economy in addition to its effects on shareholders and employees. A number of economic and social problems, including job losses, supply chain disruptions, and a decline in investor confidence, can be brought on by financial crisis and bankruptcy.

It is essential to anticipate and prevent financial difficulties in order to lower the frequency of company bankruptcy. Forecasting bankruptcy accurately and promptly is important for firms, creditors, investors, and governments. Stakeholders have a window of opportunity to take remedial action, restructure financial operations, and lessen the severity of financial distress when they proactively identify the signs and symptoms of financial instability. Being able to predict bankruptcy is more important than ever in the setting of today's linked and volatile global economy, which is the business landscape.

Finnish construction industry has been in a difficult position for some time already. First covid virus made big problems to the supply chains which grew the prices of many materials used in the construction business which led to higher costs for the companies. Rising inflation influenced the prices of supplies which also led to higher costs of building. Construction industry has also notoriously been using foreign professionals on their construction sites to lower the costs. Covid policies for some time disrupted the possibility to use this cheaper work force since Finnish borders were closed for a while, heightening costs even more. Covid hit the economy and there was already a decrease to be seen in the orders of housing from these companies but steadiness in the commercial real estate sector had given these companies optimistic views of the future.

Construction industry had not even got over the problems covid had brought when Ukraine-Russia crisis started. This had a big effect on the industry. Many Finnish construction businesses had expanded to Russia or were doing business with Russian companies and when EU set its sanctions and prohibited doing business with

Russians. This hit many of these businesses hard. Companies had to close down their Russian businesses and revenues from the east discontinued.

Now in the past year construction industry has met yet another challenge. Rising interest rates have declined the orders of new housing projects which has been a really big hit on the industry. On the third quarter of 2023 we had already seen multiple bankruptcies in the industry and forecasts said there is more to come. Already these bankruptcies have had an awful impact on smaller communities in Finland since these bankrupt companies have been significant employers in certain regions.

Historically, the development of bankruptcy prediction models has prioritized versatility rather than tailoring them exclusively for the examination of companies within a particular industry. While models have been crafted based on diverse datasets representing various business types, there are specialized prediction models designed for small and large enterprises in both industrial and commercial sectors (Mossman et al., 1998). Nevertheless, there has been limited dedicated academic research specifically evaluating the performance of these models within individual industries. Studies assessing the accuracy of these models are often characterized as generalized, deliberately incorporating companies from different sectors as part of the research methodology.

The main objective of this thesis is to evaluate the bankruptcy risk of Finnish construction companies through an in-depth analysis of their financial statement data. This research aims to develop a comprehensive understanding of the factors contributing to bankruptcy in this specific industry.

The method for the research is taking archival data of Finnish construction companies from Orbis financial data archive. Orbis, a product of Bureau van Dijk, is my chosen data source for this research due to its comprehensive data archives and reliable corporate information. Orbis includes critical data points such as company financials, ownership structures, and industry classifications, among other details, that are essential for a nuanced analysis of business entities. Using Orbis the sampling frame was confined to companies registered in Finland under the NACE Rev. 2 classification code 41, which pertains to the construction sector. Under construction companies, medium, large, and very large companies were chosen for the sample. From the data,

financial ratios were calculated, and the results were compared to ones in previous research.

This thesis is systematically organized into four main chapters: the Introduction, which sets the context and importance of bankruptcy forecasting, Bankruptcy Forecasting, which provides historical insights into the development of forecasting models, and detailing the methodologies of Beaver's and Altman's models, Empirical Research, the core analysis of data from the Orbis database to assess bankruptcy risks, and the Conclusion, which summarizes findings and discusses their implications.

2. Bankruptcy forecasting

2.1. Bankruptcy forecasting

History of bankruptcy forecasting is said to be starting from the 1960's when William H. Beaver published his research on bankruptcy forecasting (Beaver, 1966). And after that Researchers like Edward Altman began experimenting with financial ratios and statistical methods to predict corporate bankruptcy. Altman's Z-Score model(Altman, 1968), developed in 1968, was one of the pioneering models in this era. It used a combination of financial ratios, including working capital, total assets, retained earnings, EBIT, and market value of equity.

Throughout this history, bankruptcy forecasting models have been applied in various industries, including banking, finance, retail, and manufacturing. They are used by financial institutions, credit rating agencies, investors, and creditors to assess the financial health and creditworthiness of companies. These models have played a critical role in risk management, particularly in times of economic uncertainty and financial crises. As technology and data availability continue to advance, bankruptcy forecasting models are likely to become even more accurate and nuanced in their predictions.

The analysis of financial ratios has likely been in practice since businesses began maintaining accounting records. The initial research on using ratio analysis to forecast bankruptcy was conducted using univariate analysis. These studies concentrated on specific ratios and occasionally contrasted the ratios of successful businesses with those of unsuccessful ones. The foundation for multivariate bankruptcy prediction

models was established by the univariate investigations, which had significant ramifications for the creation of subsequent models. In contrast to the subsequent four decades (1965–present), there were comparatively few studies released between 1930 and 1965. In the early days, there was considerable variation in the methods used to calculate ratios, and their interpretation often relied on situational judgment. The initial studies, conducted during the Great Depression (Ramser J.R., Foster L.O. in 1931, and P.J. Fitzrick in 1932), tested the accuracy of ratios in predicting bankruptcies and their typical differences between bankrupt and other companies based on the data available at that time. The development of bankruptcy prediction models started when Beaver, in his recommendations for further study, suggested that multiple ratios taken into consideration at the same time would be more predictive than single ratios.

The first researcher to create a multivariate statistical model to separate failing companies from those that are not failed was Altman (Altman, 1968). He employed multivariate discriminant analysis (MDA), with 66 enterprises making up the first sample. comprising 33 businesses in each of the two categories (failure/non-failure). Since its initial use in the 1930s, MDA has been applied in many fields, albeit not being as widely used as regression analysis. MDA was mostly applied in the biological and behavioral sciences in those earlier days. This method has grown in popularity recently both in academia and in the real-world of business (Altman, 2013).

Multivariate discriminant analysis and neural networks appear to be the most viable approaches for developing bankruptcy prediction models, according to an analysis of the models' accuracy. The results also imply that adding more components does not always translate into a higher model accuracy. Certain two-factor models can't predict outcomes with the same accuracy as those with 21 factors(Bellovary et al., 2007). In my research I wanted to concentrate on the first two studies, Beaver’s ratio analysis and Altman’s Z-score. Although old, research has shown these models to have been accurate in predicting bankruptcies and are simple to adapt to different industries.

2.2. Forecasting models

2.2.1 Beaver

Studies before World War II are considered somewhat repetitive and incomplete by today's standards due to limited data availability and the lack of unified accounting

standards. William H. Beaver's research in 1966 is widely recognized as a groundbreaking modern study. Beaver's study utilized a comprehensive dataset, tracked trends over several years, and introduced an innovative matching procedure, comparing each bankrupt company to the most similar non-bankrupt company in the same industry. In my own research, I plan to adopt a similar matching procedure as in Beaver's study and focus on the same ratios he investigated.

Beaver's bankruptcy prediction model is easy to apply to company financial data because it is a reasonably simple model. But it's important to take this model's shortcomings into account. It is predicated on the premise—which might not necessarily be accurate in all situations—that declining financial ratios are the main markers of financial hardship. Macroeconomic variables and industry-specific dynamics that can have a big impact on a company's financial health might not be taken into consideration by the model. Advanced statistical and machine learning methods, which are frequently employed in more recent bankruptcy prediction models, are not included in this model.

Beaver's bankruptcy forecasting model, developed by William H. Beaver in 1966, used 30 financial ratios to be tested on 79 pairs of companies. To make the testing simpler I have chosen five ratios to be calculated and analysed, these ratios being the most significant according to Beaver(Beaver, 1966). Beaver's model has been widely utilized by financial analysts, creditors, and investors for its simplicity and effectiveness.

Cash flow is important in evaluating company’s ability to generate cash for various financial obligations. This includes debt repayments, need for working capital, investments and for private withdrawals to owners and other profit sharing (Heikkinen J. 2020). Cash flow is one of the most used ratios when analysing company’s financials and when analysing company’s risk for defaulting. The continuity of cash generation is seen as a crucial factor for the overall continuity of the business. Cash flow itself while meaningful ratio needs to be related to the company’s total debt to get a more comparable ratio. Cash flow to total debt provides insight into company’s capacity to manage its financial obligations.

The previously discussed cash flow represents the amount remaining for a company after impact of operational expenses and the crucial distinction between the cash flow and net income is that depreciation and impairments are considered in the later ratio.

Although the cost of depreciation and impairments doesn't require immediate cash payment, these expenses must be covered in some way unless the intention is to wind down operations. Large depreciation-prone balance sheet items are usually financed externally, and after acquisition, acquired assets may require substantial post-acquisition maintenance expenses. Assuming that the company under examination has no plans to scale down its activities, it is acceptable to conclude that future investments and depreciation cannot be disregarded in the company's overall evaluation. Compared to the cash flow, net income offers a more prospective view of the profitability and viability of the business. In addition to evaluating the company's capacity to pay its debts, net income also tries to gauge the company's sustainability and capacity to distribute profits to shareholders. Consequently, it is not appropriate to assess net income exclusively considering the company's debt financing. To provide a more accurate evaluation of the business, it should instead be contrasted with the total assets to provide more comparable view of the company.

An increase in debt is a common outcome of profitability concerns, as was covered in the preceding paragraphs about profitability ratios. On the other hand, increased investment activity or the owners' wish to distribute a higher share of operating profits as dividends may also lead to an increase in debt. It's important to remember that borrowed capital limits the company's flexibility, regardless of the cause of the increasing debt. Although it has its limitations, debt can be a helpful tool for funding expansion or giving profits to shareholders. There is a chance that suitable finance won't be available to fulfil financial responsibilities if the terms for the agreed-upon debt repayment worsen. Bankruptcy is a common result of a corporation not fulfilling its agreed-upon responsibilities; this is typically triggered by the company's creditors seeking repayment. In summary, while though debt can have a variety of uses for a business, it also has hazards that need to be carefully managed. The company's capacity to pay off its debt is essential to preserving its financial standing and averting possible legal repercussions like bankruptcy in the event of failure.

Efficient management of working capital is crucial. It's critical to strike a balance between maximizing cash flow and making sure the business has enough liquidity to meet its obligations. A company's working capital status is mostly determined by factors including inventory management, customer credit policies, and supplier payment periods. Working capital is a fundamental ratio when analysing company’s

short term financial health. Consisting of current assets subtracted by current liabilities. Beaver's studies found that working capital to total assets was the best discriminant factor, which correctly identified 90 percent of the companies one year prior to failure(Beaver, 1966). Like in other sectors, a decline in sales can potentially threaten cash flow, necessitating the pursuit of other sources of funding in order to maintain operations. Researchers (C.H. Winakor and R.F. Smith, 1935) found that the ratio of working capital to total assets on the balance sheet is a more reliable indicator of future payment issues than the other 21 ratios they looked at. Given the importance of inventory, it makes sense that working capital analysis would be useful in predicting bankruptcy in construction companies.

Current ratio is among the oldest tools for predicting bankruptcy. Ratio is still widely used both independently and as component of various ratios for bankruptcy predicting. Predictive ability of current ratio is considered reasonable despite its simplicity. Early academic research on liquidity ratios such as current ratio suggested that they predict bankruptcies with better accuracy than many other commonly used financial ratios (Merwin, 1942).More recent research has challenged the predictive power of these liquidity ratios citing these ratios to ultimately represent a snapshot of liquidity on specific date of analysis and not capture the dynamic nature of a company's financial health fully (Gallinger, 1997).Current ratio is determined by current assets divided by current liabilities.

The model examines trends in these financial ratios over time, assessing whether they are increasing or decreasing. The basic idea behind Beaver's model is that deteriorating financial ratios are early warning signs of potential financial distress and bankruptcy.

2.2.2 Altman's Z-score

After Beaver's research (Beaver, 1966) Edward I. Altman argued in 1968 that multiple discriminant analysis would perform better than previously used traditional ratio analysis (Altman, 1968) stating that traditional ratio analysis might not consider a company's situations serious if the company has an above average liquidity. Meanwhile the company's poor profitability or solvency records could regard potential bankruptcy, and this is why Altman suggested a model combining financial ratios with

weights could be better suited to predict bankruptcy. Altman's Z-score model takes five financial ratios weights them with coefficients to produce one numerical value. Altman's In his testing Altman's model covered public manufacturing companies from the United States but in his later work he also expanded the model to work with private manufacturing, non-manufacturing and service companies.

Here are the five components of Altman's Z-score:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5. \quad (1)$$

X_1 = ratio of working capital to total assets.

X_2 = ratio of retained earnings to total assets.

X_3 = ratio of earnings before interest and taxes to total assets.

X_4 = ratio of book value of equity to book value of total liabilities.

X_5 = ratio of sales to total assets.

For the five financial ratios Altman chose for the model: *Working Capital/Total Assets* is chosen to measure net liquid assets of the company relative to total capitalization. Variable is consistent with the study of 1942 by C. Merwin comparing discontinuing firms with continuing ones. (Merwin, 1942).

Retained Earnings/Total Assets measures cumulative profitability over time and discriminates young firms compared to older ones due to the fact that younger firms haven't had the time to cumulate profits which leads to incidence of failure being higher in earlier years. A higher value suggests greater profitability and financial stability.

Earnings before interest and taxes/Total Assets ratio measures true productivity of firm's assets, abstracting from any tax or leverage factors. Insolvency on a bankruptcy sense occurs when total liabilities exceed a fair valuation of firm's assets with value determined by the earning power of the assets. A higher value indicates higher profitability.

Market value of Equity/Book Value of Total Debt ratio shows how much the company's assets can decrease in value before the liabilities exceed the assets. The

ratio adds a market value dimension to the model and also spears to be more effective predictor of bankruptcy than more commonly used ratio: Net Worth/Total debt. A higher value suggests that the market values the company positively.

Sales/Total Assets, as a standard financial ratio to illustrate the sales generating ability of company's assets the capital-turnover ratio is used. Capital-turnover ratio on its own is the least significant on individual basis but because of its relationship with other variables its contribution to the overall discriminating ability of the model is significant. A higher value indicates better asset turnover.

As in equation (1) all firm's that did not show any signs or low signs of bankruptcy had Z-score greater than 2.99. Firm's that had Z-score below 1.81 on the other hand were all bankrupt and firms that had Z-score between 1.81 and 2.99 were on the grey area suggesting potential financial distress or risk (Altman, 1968).

Altman tested his model by finding out how well the model predicted from 66 manufacturing companies' bankrupt firms to be bankrupt and non-bankrupt companies to be non-bankrupt. From the testing Altman found out that one year prior to bankruptcy the model is extremely accurate in classifying 95 percent of the total sample correctly. Test showed that the model made The Type 1 (classifying bankrupt company as a non-bankrupt) error to be only 6 percent while the Type 2 (classifying non-bankrupt company as a bankrupt) error was even better at 3 percent. Altman also tested the model for testing for two years prior to bankruptcy and find out the model to be 72 percent accurate.

Altman's Z-Score model, developed by Edward I. Altman in 1968, is a widely recognized and time-tested financial formula used to predict the likelihood of bankruptcy for a company. It provides a single numerical score that assesses a company's financial health and bankruptcy risk. The Z-Score model is particularly useful for creditors, investors, and financial analysts when evaluating the creditworthiness and financial stability of a firm. It has been applied across various industries and geographical regions.

2.2.3 Z-score plus

After inquiries for revised model to work with private sector Altman completely re-estimated the model in 2002 (Altman, 2002). Private companies do not have publicly traded equity, and thus lack market data that was a critical component in the original Z-score formula. The capital structure and financing sources for private companies can be quite different from those of public companies. Private firms may rely more on private debt and internal financing, and less on equity markets, altering the relevance of some financial ratios used in the original Z-score. The original model used stock price data to calculate market capitalization and other market-based inputs, which are not available for private firms. In the re-estimation Altman substituted the market values of equity with the book value in X_4 to get the model work with private companies with no market value of equity available. Changing variable made the all of the coefficients to change in the model and so the new revised Z-score model is:

$$Z = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.420X_4 + 0.998X_5. \quad (2)$$

Looking at the coefficients we can see that in equation (2) Working Capital/Total Assets and Retained Earnings/Total Assets have smaller emphasis to the Z-score, changing from 1.2 to 0.717 and 1.4 to 0.847. Also X_4 Which now is Book Equity/Total Liabilities has a slightly smaller coefficient decreasing from 0.6 to now 0.42.

3. Empirical Research

3.1. Data

For data for the research, Orbis data bank was used to find financial statements for Finnish construction companies. I chose companies that were registered in Finland and that were in the industry of Construction of buildings. To get more valid data I chose to include companies with size classification of medium, large, or very large and excluded small companies although further research could be carried out on forecasting bankruptcies in smaller companies as well. Orbis data base offered financial statements of 2,419 companies from which I excluded companies with financial statements that lacked data for some years. I chose to perform temporal data analysis to find out how much of an impact covid, Ukraine-Russia conflict and growing interest rates had on the industry and thus chose the time frame from 2017 to 2022. Interesting changes for the industry started from 2020 with covid and the most recent financial statements are from 2022 and to see changes in the figures research included three years from 2017 to 2019 as base line to analyse the impact of the changes in the market. After establishing base line for the whole industry, smaller sample of bankrupt companies was chosen to see differences in these two samples. Orbis provided 28 Finnish medium, large and very large companies in the construction sector. Again, from the data companies that lacked values for analysed years on the period were excluded, leaving with 14 companies establishing the sample to use to analyse bankrupt companies. Same ratios from Beaver's research were used to analyse the financials of these companies.

For Altman's Z-score comparison of nine bankrupt and non-bankrupt companies was used. For the bankrupt sample nine companies were chosen so that each firm had 2022 financial statement available, and the company had seized to exists because of bankruptcy. Period from 2019 to 2022 was used to get more up to date data and considering Altman's Z-scores weaker ability to predict bankruptcy multiple years ahead of time longer analysed period was not seen as important. Nine non-bankrupt companies were chosen to match the bankrupt companies. To pair up the bankrupt companies to similar non-bankrupt ones, companies with similar revenues and equity structures were found.

3.2 Method used

The method for the research is taking archival data of Finnish construction companies from Orbis financial data archive. Orbis, a product of Bureau van Dijk, is my chosen data source for this research due to its comprehensive data archives and reliable corporate information. Orbis includes critical data points such as company financials, ownership structures, and industry classifications, among other details, that are essential for a nuanced analysis of business entities. Using Orbis the sampling frame was confined to companies registered in Finland under the NACE Rev. 2 classification code 41, which pertains to the construction sector. Under construction companies, medium, large, and very large companies were chosen for the sample.

To analyse the data for each ratio average, standard deviation and variance was first calculated. At this point it was apparent that some more excluding of companies was necessary since the data showed to include some extreme values which distorted the findings. To exclude these extreme values statistical outlier test was used to test individual values to determine if they differed too much from the rest. On the Excel spreadsheet "Data outliers" is included z score, not to be confused with Altman's Z-score

$$Z = \frac{Value - Mean}{Std} \quad (3)$$

Z score now tells how many standard deviations away the individual score is from the sample mean. As a rule of thumb values with z score greater than 3 or less than -3 is determined to be outliers. To simplify the findings, excel table highlights outlier values as red. Companies with extreme values were excluded to provide more concurrent sample to used as a benchmark for the whole industry.

3.3 Results

3.3.1 Cash Flow/Total Debt - Beaver

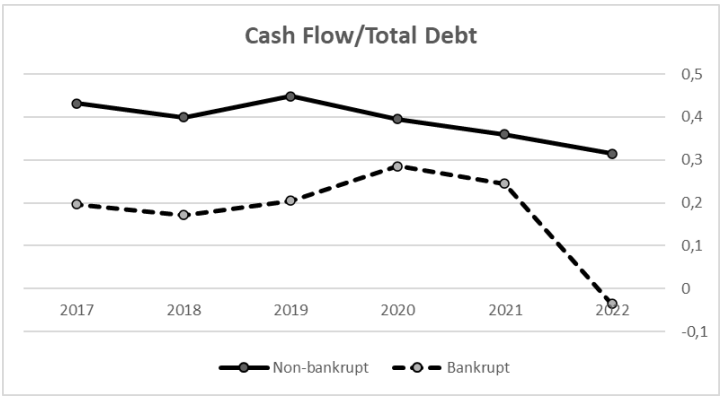

Figure 1 Cash Flow/Total Debt

When reviewing cash flow to total debt it is clear to see that the non-bankrupt sample has a lot more positive values throughout the period when comparing to the bankrupt companies. As non-bankrupt companies are used as a benchmark for the whole industry it clear to see that the values are more stable before 2020 and start of covid. It is apparent that from 2020 to 2022 this ratio is declining.

For the bankrupt companies this ratio has a lot more variance and over all values are much lower but still increasing until 2020. 2020 to 2021 there is a slight decrease to be seen but when forecasting bankruptcy this isn't yet on an alarming level. The real change is in 2022 one year before bankruptcy when the average ratio abruptly decreases significantly reaching negative value and thus implying significant struggle in the financials of the sample companies. Once company experiences negative cash flows bankruptcy probability increases significantly. When comparing the ratio with the findings of Beaver's research it is apparent that bankrupt companies' ratio indicates declining financial health much earlier than the ratio of Finnish construction industry. Beaver's sample shows much lower ratio compared to that of non-bankrupt sample already five years before bankruptcy and the ratio is declining throughout the period.

3.3.2 Net income/Total Assets - Beaver

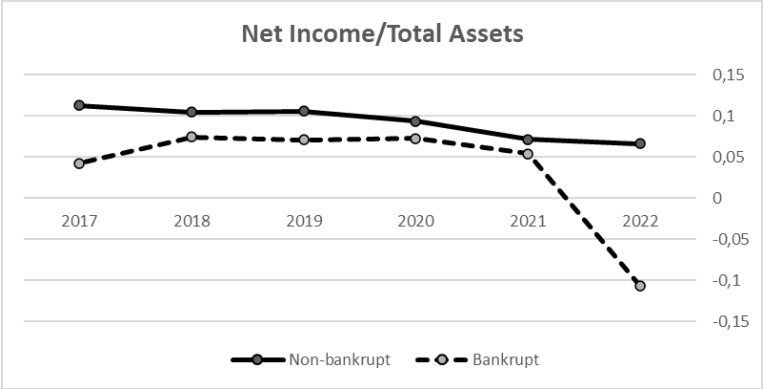

Figure 2 Net income/Total Assets

The Net Income to Total Assets ratio, is a financial metric that measures how efficiently a company is utilizing its assets to generate net income. Essentially, it shows how effectively management is using its assets to produce profit.

The most crucial aspect in interpreting the ratio, much like with the finance result in relation to external liabilities, is whether the figure is negative or at risk of turning negative in the future. If the company operates at a loss for an extended period, it will need to seek financing from external sources. When external financing concludes, the natural outcome is the company facing bankruptcy (A. Prihti, 1975). Average of net income to total assets throughout the period is much closer to each other between bankrupt and non-bankrupt companies. It isn't until 2022 when average of bankrupt companies' ratio value surges into negative. Negative net income to total assets ratio implies that on average one year prior to failure sample companies experienced negative net income and the continuity of the bankrupt sample was in fact to be questioned one year before bankruptcy.

Beaver's research showed bankruptcy sample to reach negative values for net income to total assets ratio already three years before failure. Bankruptcy sample reached more significant changes one year prior to failure compares to bankruptcy sample of my research and this can be partly explained by the different industries the samples are taken from.

3.3.3 Total Debt/Total Assets - Beaver

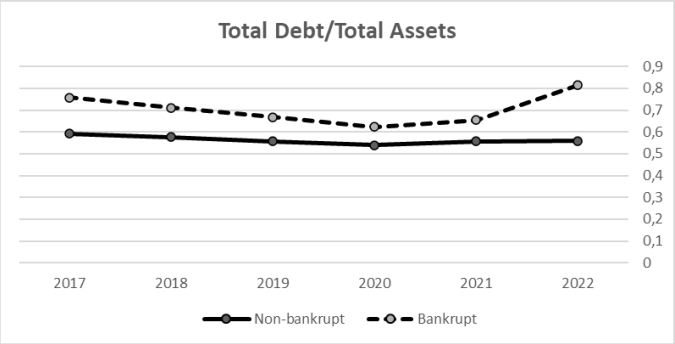

Figure 3 Total Debt/Total Assets

The Total Debt to Total Assets ratio is a financial metric used to assess a company's financial leverage. This ratio provides insight into the proportion of a company's assets that are financed through debt. It is a key indicator of the financial health and risk profile of a company.

Total debt to total assets ratio findings are fairly similar to Beavers (Beaver, 1966) findings. Ratio is declining for both samples until 2020. Followed by slight increase in the ratio for non-bankruptcy sample and significant increase for the bankruptcy sample. A key difference between this and Beaver's outcome is that construction industry's total debt to total assets ratio is higher by default. Whereas Beaver's non-bankruptcy sample ratio values are under 0.4 are construction industry's' between 0.5 and 0.6. The particularly noticeable aspect in the average leverage ratio of my own data is the amount of a bankrupt company's external liabilities surpassing the total assets on the balance sheet. A ratio exceeding one indicates that the company's equity is negative, likely resulting from losses in previous years.

3.3.4 Working Capital/Total Assets - Beaver

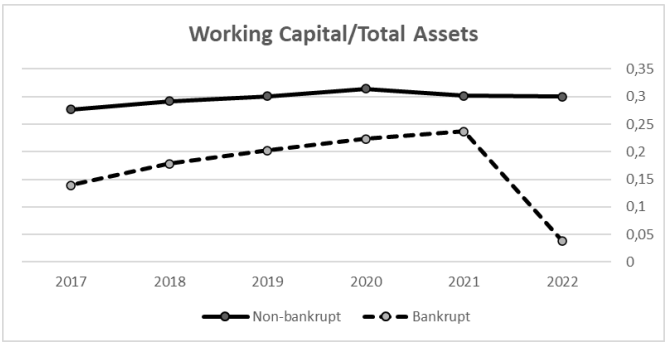

Figure 4 Working Capital/Total Assets

The Working Capital to Total Assets ratio is a financial metric that measures the proportion of a company's total assets that is funded by working capital. Working capital is crucial for day-to-day operations, reflecting a company's operational efficiency and short-term financial health.

It's interesting to see that the bankruptcy sample's working capital to total assets ratio was improving faster than non-bankruptcy samples until 2021 when bankrupt companies experience significant decrease of working capital. Beaver's analysis for working capital to total assets found changes for the ratio be similar as to previous total debt to total assets. Ratio stays stable until three years before failure for bankruptcy sample and around 0.4 for non-bankruptcy companies. Bankrupt companies experience huge decrease in working capital dropping the ratio approx. to 0.05 which is like the one for construction companies.

3.3.5 Current Ratio - Beaver

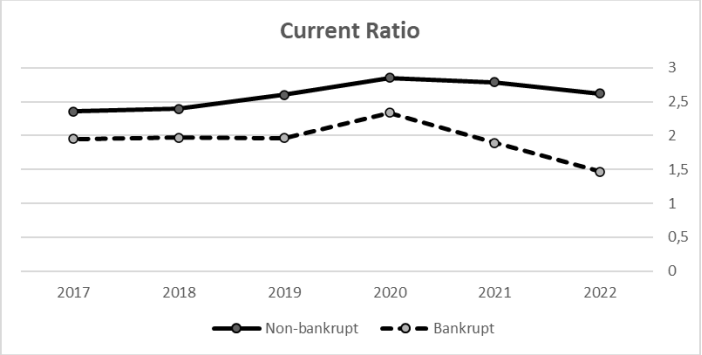

Figure 5 Current Ratio

For current ratio industry differences are significant between Beaver's sample and mine. Construction industry's non-bankrupt companies' ratios after 2019 stayed over

2.5 but under 3.0 whereas Beaver's non-bankrupt firms had ratio over 3.0 throughout the period. Differences between the two samples are clear in both studies but more so in Beaver's. Beaver's study's changes one year prior to failure are more apparent than in construction companies but also in those these is clear decrease in the ratio values after 2020.

3.4 Altman's Z-score

	Company Name	Z-Score			
	Bankrupt companies				
		2019	2020	2021	2022
1	VISURA OY	1,768	4,509	3,998	2,141
2	MACRA OY	7,262	5,423	4,369	2,118
3	SB RAKENNUS OY	6,985	6,220	5,512	4,224
4	TEH-UUSIMAA OY	-0,146	8,848	5,830	-1,580
5	EMTEBIOTEC OY	5,205	3,482	2,244	2,443
6	VANA VALMISNAVETTA OY	2,057	5,142	0,879	1,218
7	RAKSA KERANEN OY	2,425	2,154	0,275	0,058
8	BB-RAKENNUS OY	8,104	7,455	6,655	-10,747
9	BG-VOIMA OY	6,124	3,796	10,005	7,809
	Average	**4,420**	**5,226**	**4,418**	**0,854**

Figure 6 Z-score bankrupt companies

	Company Name	Z-Score			
	Non-Bankrupt companies				
		2019	2020	2021	2022
1	SIEVI HYVINVOINTITILAT OY	4,193	2,183	4,930	4,095
2	TAMPEREEN TALOTEKO OY	3,290	4,531	4,039	3,430
3	MINOREX OY	5,449	5,005	6,286	5,626
4	TARKKA KATTO OY	6,250	8,148	6,513	8,759
5	MURTO & KALLIO OY	8,927	5,230	5,079	2,968
6	RAKENNUS M. KARJALAINEN OY	2,100	3,112	3,080	3,357
7	RAKENNUSTYOT RATILAINEN OY	1,041	0,694	2,210	1,353
8	ASK-RAKENTAJAT OY	3,795	2,940	2,204	3,408
9	RBR RAKENNUS OY	6,997	7,918	7,170	11,874
	Average	**4,671**	**4,418**	**4,612**	**4,986**

Figure 7 Z-score Non-bankrupt companies

Figures 6 and 7 above show the Z-scores for both nine bankrupt and nine non-bankrupt companies. Green values signify that the Z-score is over the limit of 2.99 resulting in classification of no significant assumptions of bankruptcy. Orange values signify Z-score of under 1.81 which classifies companies to have significant financial

distress. Grey values are in in the grey zone which implies that the company is showing signs of financial distress.

When comparing the values for bankrupt and non-bankrupt firms it is clear that the z-score is forecasting the problems the bankrupt firms were having although not as well as Altman's own studies showed(Altman, 1968). At the best only two of the bankrupt companies had Z-scores below 1.81 two years prior to failure. One year prior to bankruptcy the Z-score is much more accurate, seven of the nine firms get z-score implying significant or slight financial distress.

The weaker predictive ability of the model when evaluating contemporary Finnish construction companies is likely a result of the data used in E. Altman's research. Altman's study was based on financial data from U.S. industrial companies during the years 1946-1965. When assessing individual Z-score components, it is observed that the poor predictive accuracy of one specific ratio, X5 (Sales divided by Total Assets), for example companies, is mainly due to the large values of this ratio in the sample companies.

4. Conclusion

The research provided particularly valuable insights into the development of construction industry in Finland. During the formulation of the research plan, I anticipated that combination ratios would effectively differentiate between bankrupt and viable companies to a greater extent than individual ratios following Beaver's model. As highlighted in the preceding section on ratios, it is emphasized that making conclusions about a company's risk of bankruptcy should not rely solely on a single ratio. Combination ratios are specifically crafted for this purpose, leveraging information from multiple ratios to offer a more holistic perspective on a company's financial condition. Still, the Beaver's model displayed insightful view into the trends of the industry and as anticipated showed that covid and Ukraine-Russia conflict seemed to effect companies' financial distress in both samples.

One point regarding the findings of this study is what Beaver (Beaver, 1966) concluded his research with. There is uncertainty around the findings for example in the fact that there might be many firms that detected "illnesses" within the company before the failure and were able to treat those and the firms did not fail. Also, there is possibility

that the sample contains companies with “illnesses” not visible through financial ratios.

In the preliminary evaluation, the Altman Z-score demonstrated a 72% accuracy rate in forecasting bankruptcy two years prior to the occurrence, with a Type II error rate of 6% (Altman, 1968). Over three distinct periods spanning 31 years until 1999, subsequent assessments reported an increased accuracy of approximately 80-90% in predicting bankruptcy one year ahead, accompanied by a Type II error rate of about 15-20% (Altman, 2000). However, the findings from my research present a nuanced view. Within a sample of nine companies deemed bankrupt, the Altman Z-score accurately predicted bankruptcy for four companies, indicated financial distress for another four, and suggested healthy financial conditions for two, all one year before the actual bankruptcy. Two years prior to the bankruptcy, the model only identified signs of financial distress in three out of the nine companies. These observations suggest that the model's predictive capability, particularly two years preceding bankruptcy, may not be as robust as initially indicated by Altman, though it remains reasonably effective one year prior to the event.

During the course of this research, datasets from previous studies on bankruptcy prediction that were analysed often covered tens or hundreds of organizations. This research included 1172 viable companies in my own investigation, which is in line with other researchers' sample sizes. However, there were only 14 bankrupt companies in Beaver’s models and nine in Altman’s models datasets, which is notably fewer than in other studies. The average ratios for bankrupt companies may be distorted by individual values, deviating from reality due to the short sample size.

To test more complex combination ratios, I decided to further limit the analysis to a smaller subset of nine companies. This precise restriction was justified in terms of the research process because, as mentioned earlier, the study was intended as a broad test for model evaluation. On the other hand, it can reasonably be argued that, due to the small sample size, strong conclusions about the effectiveness of combination models cannot be drawn based on this research. In the course of this study, the consideration of employing a matching procedure for the larger dataset was contemplated. However, the lack of data available from bankrupt companies restricted the sample size of viable companies to fourteen, leading to the abandonment of the matching procedure in Beaver’s model to get view into construction industry trends as whole. For future

research, the inclusion of construction companies, perhaps from the Nordic region, could be explored. Implementing matching counterparts from a similar business environment could not only expand the dataset but also enhance the comparability between the two categories of companies substantially.

At the time of the research newest 2022 financial statements were used to get as insightful and up to date data as possible but as many sources have shown bankruptcies in the construction industry have sprung during 2023. Follow up research could be conducted once 2023 financial statements are available to get more data on how rising interest rates have had an impact on the industry. This would make debt ratios have an even more impactful meaning for the future of sample companies. Also it is to be noted that we can see the complete significance of this time frame to the industry only after couple years from now and further research could be contacted on the same area in the future to see the bigger picture.

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