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Distress Induced Leverage Adjustments

An empirical analysis on the impact of bankruptcy costs and probabilities on leverage decisions for listed Norwegian firms approaching bankruptcy

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Exploring bankruptcy costs, bankruptcy probability and leverage decisions in Norway has not only deepened our understanding of the complexities regarding financial stability and bankruptcies, but has also reminded us of our motivations for studying financial economics.

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Abstract

This thesis addresses two key questions: 1) How do bankruptcy costs and probabilities in Norway compare to existing studies, and 2) how do they affect capital structure in the final years before bankruptcy? Our findings reveal that Norway exhibits similar results as the United States, regarding bankruptcy costs and probabilities, averaging 18 to 25 percent and 27 to 34 percent, respectively. This suggests comparable risk profiles between Norwegian firms and their counterparts in terms of financial distress. Additionally, we found that both bankruptcy costs and probabilities have a positive and significant effect on leverage, while firm size exhibits a negative and significant effect on leverage.

Table of Contents

1. Introduction

Corporate bankruptcy represents a critical turning point for firms, incurring implications for stakeholders, financial markets and the broader economy. Bankruptcy costs – both direct and indirect – are central to understanding these implications while playing a pivotal role in shaping firms' financial decisions, particularly as they approach insolvency. While the trade-off theory of capital structure states that firms balance the tax benefits of debt against the costs of potential bankruptcy, understanding how these costs influence financial decision-making remains complex. Beyond the easily measurable direct costs – such as legal and administrative fees – the indirect costs – stemming from lost business opportunities, reputational damage and strained relationships with creditors – are harder to quantify but often more substantial, resulting in the significant undermining of a firm's value.

The indirect bankruptcy costs often start accruing years before the formal declaration of bankruptcy, potentially influencing financial decisions related to leverage and other financial policies. Furthermore, as it becomes increasingly apparent that a firm is nearing bankruptcy, the likelihood of bankruptcy itself could influence a firm's financial decisions in the critical years leading up to insolvency. This thesis seeks to quantify these effects and explore the extent to which they shape firms' capital structures as they navigate financial distress. We will investigate the interplay between bankruptcy costs, bankruptcy probability and leverage decisions, with a focus on publicly listed Norwegian firms. By studying firms nearing insolvency, we aim to uncover the strategic financial adjustments – or lack thereof – made in response to escalating bankruptcy risks, contributing to a deeper understanding of the financial behaviors leading to insolvency.

Focusing on Norwegian cases provides a compelling context for this study. Firstly, the number of Norwegian bankruptcies has been steadily increasing in recent years (see Appendix 10.3). This trend reflects both macroeconomic pressures and firm-specific vulnerabilities, raising important questions about financial resilience and risk management. Furthermore, Norwegian firms operate within a legal and economic framework that differs from many other countries, particularly the United States, where much of the existing bankruptcy research has been conducted. For instance, Norwegian bankruptcy proceedings primarily involve liquidation over reorganization and give creditors more power in voluntary reorganization compared to a Chapter 11 proceeding. These nuances make Norway an ideal setting to explore how local economic conditions and regulatory frameworks influence bankruptcy.

The importance of this research lies in its dual focus with the economic rationale that the costs and likelihood of bankruptcy incur poor financial decisions for the capital structure, ultimately causing the firms to file for bankruptcy. Existing studies, such as those by Altman (1984) and Ohlson (1980), have provided valuable estimates of bankruptcy costs and probabilities, but their applicability to Norwegian firms has not been thoroughly examined. Similarly, the effect of these costs, alongside the probability, on leverage decisions are seemingly unexplored. By incorporating these variables into the analysis, this thesis offers a more comprehensive understanding of the trade-offs involved in leverage decisions as firms approach insolvency.

The motivation for this research stems from the need to identify if there are major differences between Norwegian bankruptcies compared to existing studies on bankruptcies, such as Altman (1984) and Ohlson (1980). A major difference could indicate a different risk profile for Norwegian firms when it comes to bankruptcy cost and with predicting bankruptcy. This could lead to suboptimal capital structures and not reflect the actual risk of owning, managing and lending to a Norwegian firm. Consequently, this can lead to premature liquidation because of management making uninformed decisions, as well as incurring unexpected losses for owners and lenders.

Specifically, this thesis seeks to address the following questions: 1) How do bankruptcy costs and probabilities in Norway compare to existing studies, and 2) how do they affect capital structure in the final years before bankruptcy?

This thesis employs a mixed-method approach to analyze the relationship between bankruptcy costs, bankruptcy probability and leverage decisions. Direct bankruptcy costs are derived from the legal and administrative expenses documented in bankruptcy reports, while indirect bankruptcy costs are estimated using Altman’s (1984) methodology, comparing expected profits with actual profits over a three-year period prior to bankruptcy. This method captures the economic losses incurred due to financial distress. Additionally, a logistic regression is utilized to estimate bankruptcy probabilities based on a set of financial ratios with significant predictable power. These estimates are then integrated into an analysis of firms’ financial behavior, examining how firms adjust their leverage in response to bankruptcy becoming imminent. A key feature of our methodology is that each firm-year is treated as an observation. Consequently, this captures time-varying covariates and allow for dynamic evolution of how bankruptcy costs and probabilities influence firms’ leverage adjustments over the critical three-year period prior to bankruptcy. Hence, this approach allows us to move beyond the static analyses that appear common in the literature, only accounting for the year of bankruptcy.

We investigate 33 publicly listed Norwegian firms that filed for bankruptcy between 2000 and 2022. This period encompasses diverse economic conditions, including both growth and recessionary phases, while the firms represent diverse industries and firm-sizes, providing a robust basis for analysis. Given Norway's financial infrastructure and regulatory environment, this context offers valuable insights into the local context while contributing to global discussions on bankruptcy dynamics. Furthermore, the analysis captures the three-year period leading up to bankruptcy, a critical window during which distress signals typically emerge. This time frame allows for an in-depth exploration of how firms respond to escalating financial challenges, particularly in terms of leverage adjustments and financial strategy. Moreover, the data were sourced from Norwegian Corporate Accounts (NCA), Brønnøysundregistrene and Eikon, ensuring a high degree of reliability.

Our findings reveal that indirect bankruptcy costs are significant, averaging between 18 to 25 percent of firm value. This is comparable to previous findings from the US where Andrade and Kaplan (1998) estimated averages from 10 to 20 percent and Korteweg (2010) estimated 15 to 30 percent. Moreover, the probability of bankruptcy is seen to vary across firms and industries, averaging 34 percent just prior to bankruptcy. This is also comparable to existing studies where Ohlson (1980) found an average of 39 percent just prior to bankruptcy. Consequently, we conclude that the risk profiles appear similar between Norway and the US. Furthermore, from the regression we find that firms with higher bankruptcy cost often increase their leverage as insolvency approaches. Compared to previous findings, such as Reindl, Stoughton and Zechner (2017), this is a counterintuitive result suggesting moral hazard or debt-overhang behavior. We also find that firms with higher probability of bankruptcy often increase their leverage in the final years. Moreover, we find that larger firms tended to have more conservative leverage positions in the final years compared to smaller firms.

This thesis makes several contributions to the current body of literature on bankruptcy and capital structure. Firstly, it provides empirical evidence on the magnitude and variation of indirect bankruptcy costs and probabilities in a Norwegian context, filling a gap in existing research. Secondly, it highlights the relationship between bankruptcy costs, probability and leverage decisions, offering insights into the financial behaviors that precede bankruptcy.

Reindl et al. (2017) was the first to include bankruptcy costs in a leverage regression, while we are the first to include both bankruptcy costs and probabilities, to the best of our knowledge. Thirdly, as noted by Altman (1984), the three years that precede bankruptcy are often most critical as this is when distress signs usually emerge. Consequently, when investigating bankruptcies, accounting for this entire time-period should be intuitive. Although several studies, such as Altman (1984) and Ohlson (1980), include multiple time-periods in their estimations of bankruptcy costs and probabilities, respectively, no existing literature is yet to account for more than the year of bankruptcy in a regression on leverage. Hence, by including all three critical years that precede bankruptcy, along with the year of bankruptcy, our regression provides a novice and comprehensive evaluation of the determinants of leverage adjustments in a firm's final years.

The remainder of this thesis is organized as follows: Section 2 reviews the literature on bankruptcy costs, bankruptcy probability and capital structure. Section 3 specifies the differences between bankruptcy proceedings in Norway and the United States. Section 4 describes the dataset and key descriptive statistics. Section 5 and 6 outlines the methodology used to estimate bankruptcy costs and bankruptcy probabilities, and present the empirical findings. Section 7 contains the leverage regression's methodology and results. Finally, section 8 concludes the thesis with a summary of the main insights and recommendations for future research.

2. Literature Review

2.1 Bankruptcy Costs

The literature on bankruptcy costs is comprehensive. Initially, the literature only accounted for the direct costs of bankruptcy as indirect costs were regarded as inevitably hard to measure (Warner, 1977). Warner (1977) studies 11 bankrupt railroads and finds average direct costs ranging from 2.5% to 5.3% of firm value. Weiss (1990) evaluates 37 Chapter 11 bankruptcies between 1980 and 1986 and finds direct costs averaging 3.1% of firm value. Altman (1984) considers the bankruptcies of 19 retailers and industrial firms and finds that direct bankruptcy costs average 4.3% to 6.2% of firm value.

Furthermore, Altman (1984), along with a series of other papers, also attempt to measure the indirect costs of bankruptcy. One difficulty lies in distinguishing actual distress costs from the economic factors ultimately responsible for the firm becoming insolvent. Altman (1984) deals with this by quantifying indirect costs as the difference between expected and actual profits and finds averages ranging from 8.1% to 10.5% for the three years preceding bankruptcy. However, when utilizing security analyst estimates, he received averages of 18% to 22% and aggregated averages of 21% to 30%. Moreover, Andrade and Kaplan (1998) consider 31 firms that became financially distressed after management buyouts or leveraged recapitalizations and find indirect costs averaging 10% to 20% of firm value. Korteweg (2010) estimates the net benefits to leverage and attempts to extend this to measure bankruptcy costs for a small subset of firms that are at or near distress from 1994 to 2004. He finds indirect bankruptcy costs of 15% to 30%. Furthermore, Glover (2016) argues that a sample of exclusively observed bankruptcies understates the true expected cost of bankruptcy due to selection bias. Consequently, he utilizes a dynamic capital structure model to estimate firm-specific expected bankruptcy costs. Glover (2016) finds indirect costs averaging 45% of firm value for his sample, while the average costs for actual bankruptcies are 25%. Davydenko, Strebulaev and Zhao (2012) estimates bankruptcy costs from market value changes upon the bankruptcy filing and find average indirect costs of 21% of asset value. Moreover, Reindl et al. (2017) use a pricing model that allows for debt refinancing to estimate bankruptcy costs from market prices of equity and put options during the financial crisis from 2008 to 2010. They use all firms in the S&P500 with only two bankruptcy cases, and find average costs of 20% of asset value with a wide variation across and within industries. There seems to be empirical consensus that bankruptcy costs vary across industries and firm-sizes. Bris, Welch and Zhu (2006) even find that bankruptcy costs may exceed the entire firm value in 68% of liquidation cases, considering 300 cases of mostly smaller nonpublic firms from 1995 to 2001.

2.2 Bankruptcy Probability

The prediction of financial distress has been a key focus in corporate finance research, where several econometric techniques have been utilized to continuously evolve prediction models for bankruptcy of publicly traded firms. Beaver (1966) contributed early employing univariate analysis to evaluate the predictive power of accounting ratios. Building on this, Altman (1968) introduced multiple discriminant analysis (MDA) to create his widely recognized bankruptcy prediction tool, the Z-score. MDA combines multiple financial ratios to differentiate between solvent and insolvent firms but is constrained by certain assumptions like multivariate normality and the exclusion of non-continuous variables. Altman further utilized the Z-score in his paper on bankruptcy costs from 1984 with a sample of 19 firms, finding average bankruptcy probabilities of 58% two years prior to bankruptcy and 82% one year prior, for his sample.

Ohlson (1980) advanced this field by calculating the probability of bankruptcy using a logistic regression framework, introducing the logit model. This approach is known for its flexibility while addressing some limitations of MDA by accommodating non-linear relationships and dummy variables. In his paper, Ohlson found lower average bankruptcy probabilities than Altman (1984), estimating 20% two years prior to bankruptcy and 39% one year prior, for his sample of 105 bankrupt firms. Furthermore, Zmijewski (1984) explored probit models, while Lau (1987) utilized a multinomial logit model to predict varying degrees of financial distress.

Shumway (2001) criticized traditional models for overlooking time dynamics and introduced a discrete hazard model that treats each firm-year as an observation, marking a significant evolution in bankruptcy prediction literature. This approach allows bankruptcy probabilities to evolve dynamically, capturing time-varying covariates. The work of Chava and Jarrow (2004) and Bharath and Shumway (2008) extended this model to reveal how stock market information enhances prediction accuracy by incorporating market-based variables.

2.3 Capital Structure

The determinants of capital structure have been a central focus in corporate finance literature for decades. Early contributions were Modigliani and Miller with the irrelevance theorem, where several new theories have emerged such as the tradeoff theory, pecking order theory, agency theory, etc. More recent contributions have emerged where the effect of firm-specific characteristics on capital structure is analysed. Titman and Wessels (1998) found that tangible assets positively correlate with leverage, while profitability negatively correlates with leverage. Rajan and Zingales (1995), investigating firms across G7 countries, found that leverage is positively related to tangibility and firm size and negatively related to profitability.[1] Furthermore, Frank and Goyal (2009), looking at which factors are reliably important on capital structure, found that the key determinants of leverage include profitability, market-to-book ratio, firm size, tangibility and industry median leverage. The first two variables relate negatively to leverage, while the last three relate positively. Moreover, Reindl et al. (2017)

[1] G7 refers to The Group of Seven which is an informal grouping of seven of the world's advanced economies: Canada, France, Germany, Italy, Japan, the United Kingdom, the United States and the European Union.

estimated bankruptcy costs and asset volatilities for a sample of S&P 500 firms during the financial crisis. They further explore the determinants of leverage ratios via a cross-sectional analysis and are the first to include bankruptcy cost directly in a leverage regression. Their results show that bankruptcy costs and asset volatilities negatively correlate with leverage at a 1% significance level.

3. Bankruptcy Laws

Since the majority of previous literature on bankruptcies uses American (US) firms and this thesis uses Norwegian firms, it is important to outline the differences with a Norwegian bankruptcy procedure. The bankruptcy process has implications for our sample and how we can generalize it.

Norwegian bankruptcy and reorganization legislation comprises of the Debt Reorganization and Bankruptcy Act and the Creditors Recovery Act (Sætermoe, 2022). The US have two main types of corporate bankruptcies: Chapter 7 and Chapter 11. Chapter 7 involves liquidation and Chapter 11 involves reorganization (United States Courts, 2024). In Norway there are three types: voluntary reorganization, forced reorganization and liquidation. However, Norwegian courts emphasise liquidation over forced reorganization since restructuring options are limited and rarely used. In essence, bankruptcies in Norway typically always involve liquidation when firms are insolvent.

The Norwegian bankruptcy proceedings and Chapter 7 in the US are somewhat similar as both start with the creditors or the management filing for a petition to the courts. If the petition is accepted by the courts, a trustee or a creditor committee is appointed to handle the liquidation of the assets. If the petition is from creditors, the management could contest the petition and the courts determine if the debtor is insolvent. In Norway the contest of the bankruptcy has three outcomes: liquidation if insolvent, the management regains control if not insolvent or forced reorganization (Konkursrådet, 2024). Regarding forced reorganization, there are some criteria the debtor must meet. The debtor must be able to cover 25% of the creditors’ debt and this must be approved by the creditors with a super majority (Konkursrådet, 2024). In the cases where the firm is solvent, voluntary restructuring is commonly used over forced reorganization because the creditors have the option to cooperate with the business to restructure. In the US, the companies are either acquitted or liquidated in chapter 7 cases, where chapter 11 is used to restructure the business to continue the operations.

When collecting our data, it is much easier to identify liquidation cases, rather than reorganization cases, as they are the result of bankruptcies when firms are insolvent. Hence, our sample consists of exclusively liquidations, for ease of computation, being comparable to chapter 7 cases in the US. Overall, we conclude that there are enough similarities between the bankruptcy laws to make our findings applicable to existing studies which makes it possible to draw comparisons to empirical findings.

4. Data

4.1 Data collection and sample selection

In our study we have used data on 33 listed Norwegian firms from different industries. Our data was collected from Norwegian Corporate Accounts (NCA), Brønnøysundregistrene and Eikon, all deemed to be highly credible. NCA is SNF's database of accounting and corporate information on Norwegian companies (Mjøs & Selle, 2022).[2] Brønnøysundregistrene is a governmental agency that manages the majority of Norway's most important registers, like the LLC register and the bankruptcy register (Brønnøysundregistrene, 2024). Lastly, the Eikon database is an open-technology solution providing access to industry-leading financial data, capturing more than 99% of the global markets and with over 65 years of information (LSEG, 2024).[3]

We used NCA to identify all reported bankruptcy filings for listed firms in Norway during the period 2000-2022. In total, there were 33 firms traded on Oslo Stock Exchange that had filed for bankruptcy during this period. Due to the small number of filings, we decided to disregard any further filtering of the data selection, such as filtering by industry, size, etc. However, the sample size appears to be empirically sufficient since Warner (1977) had a sample size of 11 bankrupt firms, Altman (1984) had 19 and Andrade and Kaplan (1998) had 31. Further discussion of the robustness of our sample is presented in Appendix 10.4.

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[2] SNF is NHH's (Norwegian School of Economics) center for applied research and is one of Norway's leading research environments within applied economic administrative research.

[3] To access Norwegian Corporate Accounts and Eikon we applied for, and were granted, access to the databases for a limited period.

Table 1: *Sample Information*

Company	**Industry**		**Year**	**Duration in Years**
	Code[1]	*Sector*[2]	*Bankruptcy Filing*	*From Est. to Bankrupt*
Ability Drilling ASA	11	Offshore/Shipping	2009	3
Alvern ASA	74	Holding	2003	11
Cecon ASA	74	Consulting	2015	30
Cellcura ASA	73	Research	2017	19
Choice Hotels Scandinavia ASA	55	Holding	2013	34
Conseptor ASA	52	Wholesale/Retail	2019	23
Customax ASA	72	Telecom/IT/Tech	2001	5
Dolphin Drilling ASA	11	Offshore/Shipping	2019	22
Dolphin Group ASA	74	Telecom/IT/Tech	2015	13
Enitel ASA	74	Telecom/IT/Tech	2001	5
Evercom Network ASA	74	Holding	2002	14
Exense ASA	72	Telecom/IT/Tech	2009	17
Faktor Eiendom ASA	70	Construction	2011	10
Fesil ASA	24	Manufacturing	2017	32
Frontier Drilling ASA	11	Offshore/Shipping	2018	21
Hjellegjerde ASA	70	Construction	2014	68
IMSK SE	61	Offshore/Shipping	2018	22
Infostream ASA	72	Telecom/IT/Tech	2009	20
Intellinet ASA	72	Telecom/IT/Tech	2002	3
Invivosense ASA	74	Consulting	2010	12
Linde-Group ASA	21	Wholesale/Retail	2010	21
Noral ASA	74	Holding	2005	90
Nordic Water Supply ASA	51	Wholesale/Retail	2003	24
Norse Energy Corp. ASA	11	Offshore/Shipping	2014	17
Norske Skogindustrier ASA	21	Manufacturing	2017	144
Petrojack ASA	11	Offshore/Shipping	2010	6
Petromena ASA	71	Offshore/Shipping	2009	4
Reservoir Expl. Tech. ASA	74	Research	2013	11
Scan Geophysical ASA	74	Research	2009	7
Tandberg Data ASA	30	Telecom/IT/Tech	2009	30
Tandberg Storage ASA	73	Consulting	2009	6
Telecast ASA	74	Holding	2002	32
Tordenskjold ASA	61	Offshore/Shipping	2003	7

[1] *Industry is reported in two-digit industry code version SN2002 for consistency since many were unidentified with version SN2007. Information obtained from NCA.*

[2] *Sectors represent common industry groups, divided into ten groups. Sector 10 is "other services" usually divided into holding, consulting and research. Information obtained from NCA.*

NCA was further utilized to extract accounting and corporate information for our sample, where data was available from 1992-2022. There was an average gap of 2 years without information prior to the firms' reported judicial bankruptcy-year. This is justified by Balcaen, Buyze, Manigart and Ooghe (2012) as an occurrence due to firms not providing financial information as they exit the market. Lukason (2013) states that pre-insolvency non-submission of annual reports is common which according to Courtis (1998) may be a strategy to hide bad performance. Darrough and Stoughton (1990) refers to this phenomenon as selective disclosure in the context of financial distress. Consequently, for our study we consider the last year with reported income to be the year of insolvency or bankruptcy.

To obtain data on direct bankruptcy costs we had to access the bankruptcy reports for our sample. We accessed these reports through a transaction with the bankruptcy register from *Brønnøysundregistrene*.[4] Moreover, to calculate the enterprise values for our sample we obtained the respective share prices from the Eikon database.

5. Measuring Bankruptcy Costs

5.1 Enterprise Value

The firms' enterprise values will be used throughout our paper. To calculate the firm values for our sample we utilized the following formula:

$$Enterprise\ Value\ =\ Market\ Capitalization\ +\ Net\ Debt,$$

where $Market\ Capitalization$ is the firm's share price multiplied by the firm's number of outstanding shares. The $Net\ Debt$ is the firm's book value of debt less the firm's total cash.

Firstly, the firm's closing share price was extracted from Eikon. Number of outstanding shares was extracted from NCA and cross-checked with the values presented in Eikon. Additionally, book value of debt and total cash was extracted from NCA. All information was obtained for each year up to three years prior to the firm's forecasted bankruptcy year. Share price was multiplied by the number of outstanding shares plus book value of debt less total cash to obtain the enterprise value of the firm. For 10 of the firms, share prices were displayed in USD in Eikon, while the others were displayed in NOK. For consistency, all enterprise values were

[4] Bankruptcy reports are available for the public for a fixed price for up to 5 years after the finalization of the bankruptcy procedure (Brønnøysundregistrene, 2024).

computed in NOK. Consequently, for the 10 firms mentioned above, values were converted into NOK using the appropriate NOK/USD exchange-ratio for the given year. The average and median firm values of our entire sample for up to three years prior to bankruptcy are presented in Table 2. Specific values for each entity can be found in Appendix 10.5.

Table 2: *Enterprise Values for Sample in BNOK*

	t - 3	***t - 2***	***t - 1***	***t***
Average	9.44	17.55	3.57	2.34
Median	0.50	0.60	0.50	0.35

5.2 Direct Costs

The direct costs of bankruptcy (BCD) are the ex post costs, i.e. the costs incurred after the filing. Similar to previous literature, these costs are the explicit administrative costs paid by the debtor in the bankruptcy process, including filing, legal and accounting fees and compensation paid to third parties involved in the dissolution of the bankrupt firm. These costs are documented in the bankruptcy reports of individual firms. Previous literature, like Warner (1977) and Altman (1984), encountered problems collecting information on these costs as there were no aggregate records kept in America. This is not a problem in Norway as aggregate records of direct costs are kept in the bankruptcy register in Brønnøysundregistrene. For our study, however, a problem of collecting this information arose as in Norway these records are discarded after 5 years of finalization of a firm's bankruptcy procedure. For this reason, we managed to obtain the final bankruptcy reports for six out of our 33 firms from the bankruptcy register from Brønnøysundregistrene. Additionally, we managed to obtain the reports for two not fully completed bankruptcies. Consequently, we can only compute direct bankruptcy costs for eight of 33 firms in our sample.

Firstly, we will present the absolute costs extracted from the bankruptcy reports, cumulated over the entirety of the bankruptcy procedure. Secondly, the direct costs will be compared with the enterprise value of the firm for up to three years prior to bankruptcy.

$$\frac{BCD_i}{EV_{i,t}} \qquad t = -3, -2, -1, 0,$$

where BCD_i is absolute direct bankruptcy costs for firm i over the four periods, $EV_{i,t}$ is enterprise value of firm i in year t and $\frac{BCD_i}{EV_{i,t}}$ is relative direct bankruptcy costs of firm i in year t. The findings are presented in Table 3 and interpreted in section 5.4.1.

Table 3: *Absolute and Relative Direct Bankruptcy Costs*

Company	**Years** *in Bankruptcy*	**BCD** *MNOK*	**BCD / EV (%)** *t - 3*	*t - 2*	*t - 1*	*t*
Cellcura ASA	6	0.07	0.02	0.01	0.18	0.13
Choice Hotels Scandinavia ASA	9	22.74	0.36	0.33	0.87	6.41
Conseptor ASA	4	0.53	1.05	0.03	0.08	0.42
Dolphin Drilling ASA	5	2.37	0.01	0.02	0.02	0.02
Dolphin Group ASA	6	2.12	0.05	0.02	0.02	0.02
Fesil ASA	4	0.63	0.04	0.15	0.08	0.22
IMSK SE *	6	56.30	3.04	4.27	5.70	4.88
Norske Skogindustrier ASA *	7	68.06	0.40	0.47	0.81	2.06
Average			0.62	0.66	0.97	1.77
Median			0.20	0.09	0.13	0.32

* *Bankruptcy proceeding not fully completed*

5.3 Indirect Costs

The indirect costs of bankruptcy (BCI) are the ex ante costs, i.e. the costs incurred before the filing. Previous literature, such as Warner (1977) and Altman (1984), describes these costs as lost opportunities, including lost sales and profit. Warner (1977), among others, argues that the indirect costs are inevitably difficult to measure as they will only be estimates of lost opportunities which is hard to quantify. Furthermore, Altman (1984) notes that when approaching bankruptcy firms experience a complexity of factors occurring at the same time making it difficult to completely isolate the indirect bankruptcy costs. However, Altman provides a methodology to estimate indirect costs of bankruptcy. This methodology estimates expected profits which is then compared to the actual profits to determine the amount of indirect costs. This is done for the period up to three years prior to bankruptcy, with the assumption that the prospect of bankruptcy will lead to lower earnings than expected.

We reason with Altman's approach to use sales and profit to estimate indirect costs as these costs are deemed as lost opportunities due to lost sales and profit. Moreover, lost opportunities could refer to loss of customers or suppliers which arguably would incur reduction in earnings. White (1983) further describes indirect costs as increased interest expenses due to increased firm leverage or due to creditors attempting to reduce their potential losses. This will arguably decrease profits which further supports Altman's approach. Furthermore, Altman's use of a three-year time-period prior to bankruptcy, to find an absolute value of indirect costs, fit our sample well. From the accounting data we identified that our firms' sales and profits began decreasing, or majorly fluctuating, on average 3.0 and 3.5 years prior to bankruptcy, respectively. Consequently, Altman's method for calculating the indirect costs over three years prior to bankruptcy will be applied to our sample.

Firstly, the bankrupt firm's sales are regressed on the aggregate industry sales for the 10-year period prior to the year of estimation. Industry sales are estimated each year by summarizing the sales of all firms in the bankrupt firm's given industry code. In our sample, nine out of 33 firms have less than 10 operating years before filing for bankruptcy. However, these firms were included to increase the sample size. Furthermore, Altman (1984) implied that when applying a four-year and 10-year average profit margin, they yielded the same results. This was also the case for our firms, which is why we decided to also include firms with short lifespans. Thus, the same approach was used for these firms, only differentiated with the number of years included in the estimation.

Regress: $S_{i,t} = a + b\, S_{I,t}, \qquad t = 10\, years,\;\; e.g.\;\; t-11 \;\rightarrow\; t-2,$

where $S_{i,t}$ is sales of firm i in period t and $S_{I,t}$ is aggregate sales for industry I in period t.

Secondly, firm sales for the forecasted year are estimated by inserting the aggregate industry sales for the forecasted year alongside the values of *a* and *b*, found in the first step.

$$\hat{S}_{i,t} = a + b\, S_{I,t}, \qquad t = -3, -2, -1, 0,$$

where $\hat{S}_{i,t}$ is estimated sales of firm i in year t.

Thirdly, expected profits are found by applying the average 10-year profit-margin on sales to the expected sales figure found in the second step. For firms with shorter lifespans, an average profit margin for the entirety of the firms' existence was applied. Profit margins for the majority of the firms had some significant outliers. To ensure that our estimate for an average profit margin remained realistic and not biased by a few years of extremely poor or good performance, we winsorized the values. However, this had little to no effect on the results, even testing for different levels. Therefore, we decided to remove the profit margin values for the years with the most significant outliers.

$$\hat{P}_{i,t} = \hat{S}_{i,t} \cdot \overline{PM}_i \qquad t = -3, -2, -1, 0,$$

where $\hat{P}_{i,t}$ is expected profits for firm i in year t and $\overline{PM}_i$ is average historical profit margin for firm i.

Fourthly, to determine the forecasted year's indirect costs, the expected profits are compared with the actual profits. If the result is negative, this indicates that there are indirect bankruptcy costs for that given year. On the other hand, positive results indicate zero costs.

$$\Delta P_{i,t} = P_{i,t} - \hat{P}_{i,t}, \qquad t = -3, -2, -1, 0,$$

where $P_{i,t}$ is actual profits of firm i in year t and $\Delta P_{i,t}$ is unexpected profits/losses of firm i in period t, indicating indirect costs of bankruptcy.

Fifthly, all observations of indirect costs are summarized and represent the absolute indirect costs of bankruptcy for the given firm. Similar to direct costs, the indirect costs are compared with the enterprise value of the firm for up to three years prior to bankruptcy.

$$\frac{BCI_i}{EV_{i,t}} \qquad t = -3, -2, -1, 0,$$

where BCI_i is absolute indirect bankruptcy costs for firm i for the four periods, $EV_{i,t}$ is enterprise value of firm i in year t and $\frac{BCI_i}{EV_{i,t}}$ is relative indirect bankruptcy costs of firm i in year t.

Lastly, like Altman (1984), the R^2 was extracted from the sales regression form the first step – for obtaining indirect costs for the *last year* prior to bankruptcy – to briefly assess the relationship between firm and industry sales over time and the overall fit of the estimation method. The findings are presented in Table 4 and interpreted in section 5.4.2.

5.4 Results of Bankruptcy Cost Estimation

5.4.1 Direct costs

The absolute and relative direct bankruptcy costs are presented in Table 3. Initially we observe that the average duration of bankruptcy procedures for our selection is six years.

For the entire sample the average direct costs ranged from 0.6% to 1.8% of firm value for the four periods prior to bankruptcy, which is lower than empirical findings. Warner (1977) found costs ranging from 2.5% to 5.3% of firm value, Altman (1984) found 4.3% to 6.2% and Weiss (1990) found 3.1%. However, the three papers all use different methods of calculating firm value. The papers use market value of equity and include only market value of debt, both book and market value of debt and only book value of debt, respectively. The differences in valuation methods will slightly bias the estimated results.

Table 4: *Absolute and Relative Indirect Bankruptcy Costs*

Company	BCI		BCI / EV (%)			
	MNOK	R^2	*t - 3*	*t - 2*	*t - 1*	*t*
Ability Drilling ASA	2.57	-	-	-	1.03	3.39
Alvern ASA	10.42	0.95	6.97	10.87	6.79	8.71
Cecon ASA	478.21	0.91	94.73	*	98.56	*
Cellcura ASA	201.99	0.53	69.54	33.41	*	*
Choice Hotels Scandinavia ASA	728.80	0.93	11.55	10.47	27.80	*
Conseptor ASA	51.02	0.18	2.57	7.83	40.02	31.46
Customax ASA	247.97	0.96	66.95	68.80	73.52	*
Dolphin Drilling ASA	289.84	0.35	1.79	2.14	2.73	2.73
Dolphin Group ASA	352.16	0.05	8.00	2.67	2.77	3.43
Enitel ASA	1121.19	0.92	*	*	26.02	27.44
Evercom Network ASA	11.95	0.96	9.36	12.46	6.79	30.87
Exense ASA	0.00	0.90	-	-	-	-
Faktor Eiendom ASA	1229.73	0.23	2.49	24.33	7.35	6.50
Fesil ASA	484.56	0.28	32.41	*	61.66	*
Frontier Drilling ASA	0.00	0.25	-	-	-	-
Hjellegjerde ASA	41.61	0.31	93.93	5.80	8.28	11.06
IMSK SE	1130.84	0.03	61.01	85.84	*	97.93
Infostream ASA	89.17	0.25	9.33	48.58	68.87	5.95
Intellinet ASA	23.84	-	-	14.36	12.52	10.58
Invivosense ASA	0.00	0.77	-	-	-	-
Linde-Group ASA	104.86	0.78	-	*	*	90.98
Noral ASA	96.89	0.44	*	*	61.90	57.97
Nordic Water Supply ASA	65.43	0.59	40.71	29.63	13.94	25.32
Norse Energy Corp. ASA	524.40	0.35	1.28	1.69	7.49	*
Norske Skogindustrier ASA	1043.39	0.80	6.18	7.23	12.42	31.51
Petrojack ASA	319.53	0.47	4.04	3.97	3.34	8.94
Petromena ASA	2755.50	-	31.56	8.57	16.17	57.16
Reservoir Expl. Tech. ASA	611.02	0.87	0.49	0.15	29.22	53.94
Scan Geophysical ASA	37.49	0.90	*	12.89	2.11	1.48
Tandberg Data ASA	310.99	0.73	1.30	1.16	1.88	3.59
Tandberg Storage ASA	5290.84	0.97	*	*	*	*
Telecast ASA	90.54	0.70	5.40	10.31	4.45	8.03
Tordenskjold ASA	71.09	0.26	2.64	4.33	5.64	4.59
Average		0.59	24.53	17.74	23.21	25.38
Median		0.65	8.00	10.31	10.35	10.58

- *Observations excluded due to value equals zero*

* *Observations excluded because they exceed 100%*

Empirical evidence suggests that our estimates are low in comparison, which may be a result of several factors. Firstly, we only have eight observations, where more firms could increase the average. Secondly, the two not fully completed bankruptcies recorded the highest aggregate direct costs of our observations, where completed records for these two would lead to a higher average. Thirdly, international differences may bias our estimates to be lower as Norway may have smaller fees compared to America. Furthermore, the direct bankruptcy costs will incur variations depending on industry, size and complexity of bankruptcy procedure. Due to the limitations in observing direct bankruptcy costs for our sample of 33 firms, it provides further motivation to estimate the indirect costs of bankruptcy. Consequently, direct costs will be neglected in further analysis in this paper.

5.4.2 Indirect costs

The absolute and relative indirect bankruptcy costs are presented in Table 4. From the R^2, a rather simple, linear association was specified between firm and industry sales over time. Note that some fits were excellent ($R^2 > 0.9$), some were good ($R^2 > 0.5$) and some were poor ($R^2 < 0.5$). In most cases, however, the fit was a rather good one with the average and median R^2 of the entire sample equal to $R^2 = 0.59$ and $R^2 = 0.65$, respectively. Note that the poorer fits were usually young firms or firms in larger industries. Perhaps the fit could be improved upon by using a different method for estimating indirect costs, by excluding young firms or by including less firms in the aggregate industry sales figures. Nevertheless, the average fit provides confidence for the accountability of our cost estimates.

Furthermore, for three firms the indirect costs of bankruptcy were negligible for the four periods prior to bankruptcy, indicating no unexpected losses. Contrarily, in many cases the indirect costs were very large relative to firm value, i.e. over 50%. This indicates the magnitude of distress certain firms are facing as they approach bankruptcy. Moreover, Altman (1984) acknowledges the difficulty of isolating indirect costs for volatile firms. Hence, some costs may appear disproportionately high due to the firms' declining operational performance and potential inability to stabilize operations, retain customers or manage supply chains before insolvency. Furthermore, for some cases the indirect costs even exceeded firm value, i.e. over 100%, thus being excluded from the table to not distort the overall findings (see Appendix 10.6). Bris et al. (2006) justifies this occurrence stating that bankruptcy costs exceed the entire firm value in 68% of liquidation cases. These extreme values likely reflect unique circumstances or measurement anomalies that could obscure broader patterns in the dataset.

For the entire sample the average indirect costs ranged between 17.7% to 25.4% of firm value for the four periods prior to bankruptcy, receiving support from empirical evidence. Using the same method, Altman (1984) estimated values ranging from 8.1% to 10.5% using a slightly higher estimate of firm value, including both market and book value of debt. However, when using security analyst estimates he received averages of 18% to 22% and aggregated averages of 21% to 30%. Furthermore, Andrade and Kaplan (1998) got 10% to 20%, Korteweg (2010) got 15% to 30%, Glover (2016) got 25%, Davydenko et al. (2012) got 21.7% and Reindl et al. (2017) got 20%, where the two latter compared costs exclusively to asset value. The empirical support provides confidence that our results can be interpreted as reasonable, strengthening the generalizability of our findings, dependent on the notion that empirical findings incur slight variations due to sample selection, estimation method and value estimate. Further discussion on the robustness of our indirect cost estimates are presented in Appendix 10.6.

The indirect costs found in our estimation are quite sizable and cannot simply be dismissed as trivial. As noted by Altman (1984), these results could have considerable relevance for capital structure policy of firms approaching bankruptcy.

6. Bankruptcy Costs to Tax Benefit Tradeoff

6.1 Comparison of costs and benefits

The tradeoff theory states that the maximized firm value can be obtained by determining an optimal mix of debt and equity to balance the costs of financial distress and the benefits of interest tax shield. To determine whether the firms in our sample were overleveraged in the period leading up to bankruptcy, we will in this section compare bankruptcy costs and tax shield benefits. If costs exceed benefits, the firms will be deemed overleveraged. This section will provide reason to further examine how firms act when entering financial distress eventually leading to bankruptcy, namely their leverage decisions.

The comparison of bankruptcy costs and tax benefits will follow the notations of Altman (1984). However, as direct costs are excluded, future expected tax shield benefits will accordingly be excluded. Moreover, we see no reason to downscale the present values by dividing the present values by the firm values, like Altman, as this will have no effect on the outcome of the comparison. Consequently, the comparison can in an absolute sense be specified as follows:

$$PVBC_{i,t} = PV_t \cdot BCI_{i,t} \cdot P_{B,i,t} \quad vs \quad PVTS_{i,t} = PV_t \cdot T_{C,i,t} \cdot D_{i,t} \cdot r_{D,i,t} \cdot (1 - P_{B,t}),$$

where $PVBC_{i,t}$ denotes present value of bankruptcy costs for firm i in period t, $PVTS_{i,t}$ denotes present value of interest tax shield for firm i in period t, PV_t is present value adjustment back to period t, $P_{B,i,t}$ is probability of bankruptcy for firm i in period t and $BCI_{i,t}$ is indirect costs of bankruptcy for firm i in period t. Furthermore, $T_{C,i,t} \cdot D_{i,t} \cdot r_{D,i,t}$ shows interest tax shield for firm i in period t, where $T_{C,i,t}$ is marginal corporate tax rate for firm i in period t and $D_{i,t} \cdot r_{D,i,t}$ denotes interest expense for firm i in period t, where $D_{i,t}$ is interest bearing debt for firm i in period t and $r_{D,i,t}$ is cost of debt for firm i in period t.

To adjust costs and benefits to present value, we used the cost of debt, where both sides of the equation were adjusted with the same factor for consistency. Interest bearing debt was used, as other debt would not yield interest tax shield benefits. Furthermore, marginal corporate tax rates were collected from the third chapter of the Norwegian parliamentary resolution on tax, for each year. The probability of bankruptcy and non-bankruptcy is included because firms can only enjoy the tax benefits from leverage if they continue operations, whereas in liquidation, these benefits are lost completely. Consequently, a presentation of our bankruptcy probability estimation will follow.

6.2 Estimating bankruptcy probability: Logit estimation

To estimate the probability of bankruptcy for our sample we stray away from Altman's notations. Altman (1984) utilizes his well-known Z-score to estimate bankruptcy probability. This method, however, is constrained by certain assumptions like multivariate normality and the exclusion of non-continuous variables. Hence, the use of logistic regression has gained increasing recognition in the field of bankruptcy prediction, where new versions continuously emerge. This approach is known for its flexibility while accommodating non-linear relationships and dummy variables. Consequently, we will follow the notations of Ohlson (1980) and use a logit model. The formula is as follows:

$$P_{i,t}(Y_{i,t} = 1) = \frac{1}{1+e^{-(\beta_0+\beta_1 X_1+\beta_2 X_2+\cdots+\beta_n X_n}},$$

where $Y_{i,t}$ is the dependent variable which takes the value of one if the firm is bankrupt and zero otherwise. Furthermore, β are the coefficients found from the logit estimation and X are the independent variables. The coefficients obtained from the regression, along with the set of independent variables for bankrupt firm i in year $t,$ will be inserted into the function to obtain a percentage probability of the firm going bankrupt in the given year.

Recognizing that our sample is not completely homogenous, due to variations in size and industry, we attempted to carefully select non-bankrupt firms. Similar to Beaver (1966) and Altman (1968), we limited the selection for each bankrupt firm to exclusively include publicly listed non-bankrupt firms from the same year, sector and with similar firm size, determined by asset size. Sector was chosen over industry classification since some bankrupt firms were the only publicly listed firms in their industry. To determine the non-bankrupt firms, we chose the four non-bankrupt firms that were closest in asset size in the given sector and year for each corresponding bankrupt firm. This resulted in a sample of 33 bankrupt firms and a sample of 132 non-bankrupt firms. The reason for not having a larger selection of non-bankrupt firms was due to the limited publicly listed firms present in Norway. Including unlisted firms, would distort the results due to the differences in metrics. Furthermore, we created a dummy variable for each sector. This dummy variable will equal to one if the observation is in the given industry and zero otherwise. This was to account for sector-specific events and changes. In the case of extending the horizon of bankruptcy, the independent variables are lagged by a year.

When selecting independent variables for the logit regression, we reviewed several studies. Variables were extracted from mainly Altman (1968), Beaver (1966) and Ohlson (1980), as many variables were consistent over several studies. Consequently, the variables were chosen based on their popularity in the literature and their potential relevance to this study. To determine which variables to select we conducted a few tests (see Appendix 10.7). We first ran a t-test to check for differences between the variables' means for the bankrupt and non-bankrupt sample. This resulted in eight of 15 variables having significantly different means between the two samples at a 5% and 10% level. This indicates that they have significant influence in predicting bankruptcy. To finally determine which ones to use, we conducted a VIF-test to check for multicollinearity. The optimal set of variables included four of the eight statistically significant variables, showing no signs of multicollinearity. Ultimately, the following independent variables were selected to use in the logistic regression:

Table 5: *Independent Variables for Logit Estimation*

Variable	Formula	Source
RETA	Retained Earnings / Total Assets	(Atlman, 1968; Correia et al., 2022)
ROA	Net Income / Total Assets	(Altman et al., 2020)
TLTA	Total Liabilities / Total Assets	(Beaver, 1966; Charalambakis & Garrett, 2019; Ohlson, 1980)
WCTA	Working Capital / Total Assets	(Atlman, 1968; Beaver, 1966; Ohlson, 1980)

6.3 Results

6.3.1 Logit Estimation

The results of the logit estimation are listed in Table 6. As bankruptcy approaches, one would expect the probability to increase. For some firms, this is the case as the likelihood of bankruptcy is seen to increase for each year leading up to bankruptcy. However, for others the likelihood fluctuates from one year to another. Reasons for this could be poor selection of independent variables, industry shocks that affect all firms in the industry or preventive measures made by the firms approaching bankruptcy. On the other hand, the average bankruptcy probability of the whole sample can be seen to steadily increase from year *t-3* to year *t*, going from 27% to 34%, respectively. For the two last years prior to bankruptcy, Altman (1984) received average estimates of 58% and 82%, compared to our averages of 31% and 34%. We see that we receive smaller estimates than Altman. This can be credited to the differences in samples, variables, historical time-period or estimation method as Altman's method has limitations that the logistic regression addresses. For the same period, Ohlson (1980) – using the same method – received 20% and 39%, which is comparable to our results. The robustness of our variables and findings are further discussed in Appendix 10.7.

6.3.2 Cost-benefit tradeoff

We are primarily interested in observing whether or not the present value of bankruptcy costs exceeds the present value of the interest tax shield. If bankruptcy costs exceed tax benefits of leverage, we will conclude that the firm had too much leverage in its capital structure and its optimum point was at a lower leverage level. Note that although the trade-off theory relies primarily on marginal analysis, we follow Altman's notations to specify the comparison in absolute terms since we only seek to observe the overall impact of the firms' financing decisions. However, Altman (1984) implies that a marginal analysis could detect overleverage

Table 6: *Bankruptcy Probabilities – Logit Estimates*

Company	Year	Bankruptcy Probability			
	of financial distress	*t - 3*	*t - 2*	*t - 1*	*t*
Ability Drilling ASA	2008	-	-	13%	36%
Alvern ASA	2001	7%	20%	99%	65%
Cecon ASA	2014	42%	17%	37%	16%
Cellcura ASA	2015	30%	28%	64%	18%
Choice Hotels Scandinavia ASA	2012	19%	12%	37%	45%
Conseptor ASA	2018	75%	45%	72%	39%
Customax ASA	2001	24%	23%	23%	38%
Dolphin Drilling ASA	2017	32%	26%	24%	29%
Dolphin Group ASA	2015	12%	28%	18%	28%
Enitel ASA	2001	21%	23%	12%	32%
Evercome Network ASA	2001	29%	11%	8%	5%
Exense ASA	2008	9%	11%	-	24%
Faktor Eiendom ASA	2011	20%	36%	29%	33%
Fesil ASA	2016	20%	23%	10%	25%
Frontier Drilling ASA	2013	-	38%	-	26%
Hjellegjerde ASA	2014	42%	18%	42%	23%
IMSK SE	2017	14%	24%	12%	68%
Infostream ASA	2007	99%	99%	99%	93%
Intellinet ASA	2002	-	59%	11%	19%
Invivosense ASA	2007	13%	16%	9%	5%
Linde-Group ASA	2008	-	26%	23%	37%
Noral ASA	2004	41%	25%	46%	31%
Nordic Water Supply ASA	2002	37%	60%	22%	31%
Norse Energy Corp. ASA	2013	22%	4%	42%	99%
Norske Skogindustrier ASA	2016	29%	27%	38%	34%
Petrojack ASA	2009	10%	38%	35%	35%
Petromena ASA	2009	84%	38%	36%	31%
Reservoir Expl. Tech. ASA	2012	17%	20%	35%	18%
Scan Geophysical ASA	2008	69%	24%	22%	28%
Tandberg Data ASA	2008	9%	18%	43%	22%
Tandberg Storage ASA	2008	24%	17%	32%	16%
Telecast ASA	2001	27%	13%	11%	41%
Tordenskjold ASA	2001	14%	14%	14%	21%
	Mean	**27%**	**28%**	**31%**	**34%**

- *Observations excluded due to the firm being reportedly inactive*

Table 7: *Comparison of Present Value of Bankruptcy Costs & Present Value of Tax Shield Prior to Bankruptcy*

Company	**PVBC / PVTS**			
	t - 3	*t - 2*	*t - 1*	*t*
Ability Drilling ASA	>	>	>	>
Alvern ASA	0,64	2,09	850,62	<
Cecon ASA	10,12	2,02	7,92	0,17
Cellcura ASA	42,24	39,95	311,99	45,07
Choice Hotels Scandinavia ASA	>	>	>	>
Conseptor ASA	544,72	>	-	-
Customax ASA	78,43	72,48	100,87	>
Dolphin Drilling ASA	0,31	0,29	0,48	<
Dolphin Group ASA	3,29	10,43	6,19	>
Enitel ASA	>	>	>	>
Evercom Network ASA	2,59	76,09	>	>
Exense ASA	<	<	<	<
Faktor Eiendom ASA	5,82	29,11	24,88	59,96
Fesil ASA	>	>	>	-
Frontier Drilling ASA	<	<	<	<
Hjellegjerde ASA	6,46	0,86	<	<
IMSK SE	1,86	4,34	3,23	124,73
Infostream ASA	2418,78	1682,04	1448,07	155,97
Intellinet ASA	<	32,42	2,69	<
Invivosense ASA	<	<	<	-
Linde-Group ASA	<	37,36	>	>
Noral ASA	18,92	7,09	37,22	>
Nordic Water Supply ASA	56,63	128,77	2,15	8,02
Norse Energy Corp. ASA	4,92	1,25	21,54	2110,12
Norske Skogindustrier ASA	0,88	<	<	<
Petrojack ASA	0,21	1,09	1,15	<
Petromena ASA	65,81	7,68	8,11	7,71
Reservoir Expl. Tech. ASA	>	>	-	-
Scan Geophysical ASA	12,70	1,77	0,73	<
Tandberg Data ASA	2,29	5,07	16,95	4,56
Tandberg Storage ASA	807,02	545,32	1187,80	776,41
Telecast ASA	>	>	>	>
Tordenskjold ASA	2,69	2,66	3,41	7,88
Over-leveraged	0,73	0,82	0,77	0,66

- *Observations excluded due to unavailability or value equal to zero*

< *Observations excluded since PVBC equals zero → not over-leveraged*

> *Observations excluded since PVTS equals zero → over-leveraged*

at lower levels than using the absolute tradeoff, hence obtaining more conservative results for our method.

The comparison of costs and benefits is listed in Table 7, where the input for the calculations is presented in Table A23 in Appendix 10.8. The third column (*t - 3*) measures the tradeoff for the sample from three financial statements prior to bankruptcy, whereas the fourth (*t - 2*) and fifth (*t - 1*) column measures the tradeoff for respectively two and one financial statements prior. Lastly, the sixth column (*t*) measures the tradeoff for the last reported financial statement, i.e. the year of bankruptcy. In essence, the indirect costs and tax shields are for the periods *t-3, t-2, t-1,* and *t* in the third column, *t-2, t-1* and *t* in the fourth column, *t-1* and *t* in the fifth column and *t* in the sixth column. If the tradeoff ratio, *PVBC / PVTS,* exceeds 1.0 then the firm's leverage appears to have been excessive.

As seen in Table 7, 73% of the firms had the present value of bankruptcy costs exceeding the present value of tax shield benefits, in period *t-3*. In the periods *t-2* and *t-1,* respectively 82% and 77% of firms had costs exceeding benefits, compared to Altman's (1984) 57% and 86%. Seeing the increase in overleveraged firms from *t-3* to *t-2* although indirect costs from previous periods are excluded, can be attributed to the increasing bankruptcy probability and the accordingly exclusions of tax benefits from the same periods. For the last period, *t*, we see a slight reduction in excessively leveraged firms as 66% of firms have ratios exceeding 1.0. Seeing the gradual decrease in overleveraged firms from period *t-2* to *t*, can be attributed to the increased tax benefits from increased leverage while the firms seemingly also do preventive measures to reduce indirect bankruptcy costs.

Furthermore, some observations of *PVBC* majorly exceed *PVTS* which could be caused by several factors. Firstly, the estimation of indirect bankruptcy costs is undoubtedly imperfect, providing some observations of extreme values with the given parameters of the estimation. Secondly, as insolvent companies, the reported interest expenses may not reflect the actual interest expenses expected to be paid by the firms. From the accounting we see that 20% of observations, for all firms over the four periods prior to bankruptcy, have reported no interest-bearing debt and 40% of observations have reported no interest expenses (see Appendix 10.8 Table A24). One could argue that this seems unlikely and thus the tax shield should be higher in some observations. Ultimately, this further showcases how distressed the firms are and the major fluctuations apparent in their final period.

Since the majority of our sample has excessive leverage approaching bankruptcy, it is reasonable to assume that this, among other factors, is the cause of them entering financial distress and eventually end up filing for bankruptcy. We will further examine how these firms react to entering a state of financial distress, by analyzing how bankruptcy costs and the likelihood of bankruptcy affect the firms' capital structure decisions in their final years.

7. Leverage Regression

7.1 Assumptions and filtrations

In this part of the study, we look at how indirect bankruptcy cost and bankruptcy probability affect leverage year by year in the four years prior to bankruptcy. We made a dataset with our sample of 33 firms with all four periods prior to their respective bankruptcies. We did this so we could use a regression on all the companies as if the bankruptcies happened the same year.

From testing and working with the sample we conducted a few further filtrations of the data. Firstly, some firms were reportedly inactive in some years, thus having no available financial information for those years. This reduces the total observations of our dataset. Secondly, we decided to exclude observations with extreme values of leverage and indirect costs, as these distorted the regression results and greatly impaired the fit. Consequently, we are left with a dataset of 113 observations across 31 firms.

Furthermore, we tested seven assumptions to determine the best linear unbiased estimators (BLUE) to use in our multiple linear regression (MLR) (see Appendix 10.2). The first six are classical linear model assumptions when using an MLR model and the seventh assumption accounts for when time series are utilized. This resulted in the exclusion of the liquidity variable – current ratio – because of non-linearity with leverage. When testing for multicollinearity a few variables were further excluded. Moreover, the test results and discussion of the MLR assumptions provided evidence of breach of the following assumptions: homoscedasticity, autocorrelation, non-linearity in indirect bankruptcy costs and minor breach of normality.

We choose to use a fixed effects (FE) estimation method because of its dependency on less restrictive assumptions, thus being more fitting for the nature of the research question. We also found from the Hausman test that a fixed effects model was more suitable than a random effects model. Moreover, Hoechle (2007) recommends employing robust standard errors to ensure reliable inference when one or more MLR assumptions are violated. We therfore use standard robust error to mitigate the indication of heteroscedasticity. Furthermore, we choose to use book value of leverage and other variables because of extreme fluctuation in the market values of assets. This does not weaken our results as both Frank and Goyal (2009) and Reindl et al. (2017) have done regressions on both market and book value, making it possible to compare our findings to empirical findings. Frank and Goyal (2009) also states; "Book leverage is also preferred because financial markets fluctuate a great deal, and managers are said to believe that market leverage numbers are unreliable as a guide to corporate financial policy."

Alternative to the fixed effects model we could have used a Generalized Methods of Moments (GMM) system to mitigate the non-linearity relationship between indirect cost of bankruptcy and leverage. The reason we choose to continue using the fixed effects estimation method is that robust standard errors help mitigate the impact of minor violations of assumptions. Comparability with existing studies is critical to ensure the validity of our findings within the broader literature. Moreover, introducing a GMM model would add complexity without necessarily improving the insights, especially given our relatively small sample size. It is also worth noting that minor violations of non-linearity are common in small-sample analyses and do not invalidate the use of fixed effects regression.

Furthermore, year dummies are included to account for year-specific events and changes. Additionally, a time dummy – accounting for whether the observations are one, two or three years prior the year of bankruptcy – is included to capture the trends for each of the four periods preceding bankruptcy. The main regression is as follows

$$y_i = \beta_0 + \beta_n X_{n,i} + \gamma_i + \alpha_i + u_i,$$

where y_i denotes the dependent variable for firm i, β_0 is the intercept, β_n is the coefficients for the independent variables and $X_{n,i}$ is the vector of independent variables for firm i. Furthermore, γ_i captures time-varying effects for firm i (i.e. for each of the four periods prior to bankruptcy), α_i captures time-invariant fixed effects for each firm i and u_i is the idiosyncratic error term for firm i. With our set of variables, satisfying the seven assumptions, the formula is more specifically (see Appendix 10.1):

$$\begin{aligned} LEVERAGE_i = {} & \beta_0 + \beta_1 BCI_i + \beta_2 PROB_i + \beta_3 EBITDA_i + \beta_4 DEPR_i + \beta_5 TANG_i \\ & + \beta_6 YEAR_i + \gamma_j + \alpha_i + u_i \end{aligned}$$

Table 8: *Leverage Regressed on Bankruptcy Costs, Probabilities and Other Determinants*

	Dependent variable:			
	LEVERAGE			
	(1)	(2)	(3)	(4)
BCI	0.308***		0.367***	0.269***
	(0.089)		(0.040)	(0.060)
PROB	1.419*	1.508***		1.323***
	(0.775)	(0.397)		(0.384)
SIZE		-0.153***	-0.196**	-0.145***
		(0.055)	(0.081)	(0.049)
EBITDA		0.183*	0.381***	0.332***
		(0.095)	(0.134)	(0.085)
DEPR		11.072***	10.000*	9.878***
		(2.884)	(5.127)	(3.473)
TANG		0.439	0.719*	0.437
		(0.274)	(0.410)	(0.266)
Observations	113	113	113	113
R^2	0.544	0.748	0.656	0.806
Adjusted R^2	0.369	0.497	0.312	0.605
F Statistic	48.272*** (df = 2; 81)	6.171*** (df = 27; 56)	3.958*** (df = 27; 56)	8.163*** (df = 28; 55)
Note:				*p**p***p<0.01

7.2 Results of leverage regression

The results of the leverage regression are presented in Table 8. In the first column, we exclusively regress leverage on indirect bankruptcy costs and bankruptcy probabilities. In the second and third column we include only bankruptcy probability or indirect bankruptcy costs, respectively, along with the set of other variables. For the fourth column, we present the full regression of leverage on indirect bankruptcy costs, bankruptcy probabilities and the set of other variables. Our full regression in column four showcases five of six of the independent variables being statistically significant at a 1% level. This regression also has the best fit with an R^2 of 0.81, compared to Reindl et al. (2017) with an R^2 of 0.45, which strengthens the accountability of the findings while also specifying the linear association between leverage and the determinants.

As we can see from the results in Table 8, we find a positive relationship between bankruptcy cost and leverage. This indicates that as the bankruptcy costs occur in a given year, the leverage increases, which can be interpreted by multiple factors. One explanation can be that this proves the traditional tradeoff theory that when a firm passes its optimum point, leverage and bankruptcy costs increase accordingly, while bankruptcy costs exceed tax benefits of added debt and firm value decreases. This fits our findings in Table 7, where the majority of firms are overleveraged which might be a result of increasing leverage to mitigate the effects of lost expected earnings. Furthermore, it is also in line with current studies on financial distress where management implements all-in strategies to save the company, as in the downside shareholders lose everything regardless (Altman, 1984. Andrade & Kaplan, 1998. Glover, 2016). Indirect cost of bankruptcy is significant with a positive coefficient which is different from existing studies on bankruptcy cost as Reindl et al. (2017) got a negative coefficient. This difference can be attributed to their different estimation of bankruptcy costs, the fact that only two firms in their sample went bankrupt, and our focus on the four final periods prior to bankruptcy compared to one period.

Furthermore, we find that bankruptcy probability has a positive and significant effect on leverage in the final years before bankruptcy which can also be explained by all-in strategies to save the company. As bankruptcy becomes increasingly imminent, firms tend to increase their borrowing in hopes to mitigate further loss. Moreover, firm size has a negative and significant coefficient in our analysis, which contrasts with findings from previous studies on leverage like Frank and Goyal (2009) and Rajan and Zingales (1995). However, this aligns with the argument above about firms passing their optimum point according to the tradeoff theory where firm value decreases as leverage increases. Furthermore, a potential explanation is that smaller firms may secure loans more readily because they require smaller amounts, which lenders might perceive as less risky. On the contrary, smaller firms are often viewed as riskier and may exhibit higher leverage due to risk-shifting behavior, where they take on more debt to finance their operations despite greater uncertainty. Another possibility lies in information asymmetry where lenders lack sufficient insight into smaller firms' risk profiles, leading to loan approvals that would not be extended to larger firms under similar circumstances. The regression results indicate that larger firms tend to adopt more conservative leverage positions in the final years prior to bankruptcy, as smaller firms often displayed riskier financial behaviors. It is challenging to determine whether this behavior is driven by lending practices or deliberate strategic decisions. Finally, we also observe that observations during the financial crisis and the oil crisis indicate higher leverage.

8. Conclusion

This thesis set out to examine how bankruptcy costs and probabilities in Norway compare to existing studies. Furthermore, it had the added objective to investigate the interplay between bankruptcy costs, bankruptcy probability and leverage decisions in publicly listed Norwegian firms, focusing on the critical years leading up to bankruptcy. By exploring the relationships among these variables, the study aimed to provide a deeper understanding of the financial behaviors that precede insolvency. The unique context of Norway, with its legal emphasis on liquidation over reorganization and its increasing trend in corporate bankruptcies, offered a compelling backdrop to explore these phenomena.

Our findings confirm that indirect bankruptcy costs are both significant and economically relevant, averaging between 18% and 25% of firm value in the years prior to bankruptcy. These costs align with previous international studies, suggesting similar risk profiles for Norwegian firms when it comes to financial distress. Indirect bankruptcy costs positively correlated with leverage at a 1% significance level.

When examining bankruptcy probabilities, the study found considerable variation across firms and industries, with an average probability of 34% just prior to bankruptcy. This was also comparable to existing studies on the topic, indicating that there are only small differences between predicting bankruptcies in Norway and the US. Like bankruptcy cost, bankruptcy probability positively correlated with leverage at a 1% significance level.

The thesis also highlights differences in leverage strategies between firms. While larger firms tended to adopt more conservative leverage positions in the final years before bankruptcy, smaller firms often displayed riskier financial behaviors. These patterns suggest that firm size and access to capital markets play critical roles in shaping responses to financial distress.

This thesis makes several contributions to the current body of literature on bankruptcy and capital structure. Firstly, it provides empirical evidence on the magnitude and variation of indirect bankruptcy costs and probabilities in a Norwegian context, filling a gap in existing research. Secondly, it highlights the relationship between bankruptcy costs, probability and leverage decisions, offering insights into the financial behaviors that precede bankruptcy. Our novel way of including both bankruptcy costs and probabilities as determinants of leverage adjustments, enriches the current literature. Thirdly, when investigating bankruptcies, accounting for the critical four periods prior to bankruptcy petition, instead of exclusively the year of bankruptcy, broadens the understanding of how capital structure is affected leading up to bankruptcy.

While this thesis has shed light on the complex relationships between bankruptcy costs, probability, and leverage decisions, several questions remain open for future research. For instance, further studies could explore how these dynamics evolve across different economic cycles. Additionally, analyzing the role of corporate governance and managerial incentives in shaping financial decisions during distress could provide valuable insights. Finally, expanding the sample to include non-public firms or comparing Norwegian firms with those in other jurisdictions could enhance the generalizability of these findings.

In conclusion, this thesis advances our understanding of the determinants of capital structure and implications of bankruptcy costs and probabilities, providing a nuanced view of the financial behaviors that precede insolvency. By integrating firm-specific and country-specific insights, the study offers a comprehensive framework for analyzing financial distress and its impact on capital structure decisions.

Declaration on the use of AI tools in the work on this master's thesis

Name (and version) of the AI tool: ChatGPT 3.5
Purpose of using the tool: Used for creating code for data analysis

We are aware that we are responsible for all content of this master's thesis, including the parts where AI tools are used. We are responsible for ensuring that the thesis complies with ethical rules for privacy and publication.

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10. Appendices

10.1 Variables

Table A1: *Variable Definitions – Leverage Regression*

Variable	Description
LEVERAGE	Defined as the book value of total debt divided by the book value of total assets. Components are obtained from NCA.
BCI	The estimate of the firm-specific indirect bankruptcy costs for each year quantified as unexpected lost profits using the method of Altman (1984). The variables is expressed as a percentage of the book value of total assets in the case of default.
PROB	The estimate of the firm-specific probability of bankruptcy for each using a logistic regression following Ohlson's (1980) method. The variable is expressed in percentage.
SIZE	Represents the size of each firm for each year. Measured as the natural logarithm of book value of total assets.
EBITDA	Represents earnings before interest, taxes, depreciation, and amortization, obtained from NCA, scaled by book value of total assets.
DEPR	Represents the total depreciation of tangible and intangible assets, i.e. property, machinery, plant, ships, rigs, planes, equipment, furniture, tools, research, development, patents, consessions, licenses, trademarks, deferred tax assets and goodwill. The variable is obtained from NCA and is scaled by book value of total assets.
YEAR	Represents a dummy variable for each year in the period from 1997 to 2017. Dummy variable equals one if observation is in the given year and equals zero otherwise. Used to account for year-specific events and changes, e.g. macroeconomic conditions.
TANG	Tangibility is quantified by the measure from Berger et al. (1996) and Almeida & Campello (2007). The measure is defined as: $Tangibility = 0.715 \cdot Receivables + 0.547 \cdot Inventory + 0.535 \cdot Capital,$ where receivables represent the sum of all outstanding claims and receivables and inventory represents raw materials, purchased semi-manufactured goods, goods under production, finished products, and goods for resale. Capital represents the value of all physical assets intended for long-term operations, including property, machinery and plant, ships, rigs, planes and alike and operating movable equipment, furniture, tools and alike. Lastly, cash holdings are added to tangibility, representing the value of cash and cash equivalents, e.g. bank deposits. The sum is scaled by book value of total assets. All components are obtained from NCA.
Current Ratio	A measure of liquidity, calculated as current assets divided by current liabilities, obtained from the firms' balance sheets from NCA.
Total Assets	We use the balance sheet (book) value of total assets from NCA.

10.2 Assumptions For Leverage Regression

Here we will present the six classical linear model assumptions when using an multiple linear regression model (MLR), and an additional assumption for when time series are utilized. Under the first five classical assumptions, the estimators are considered to be the best linear unbiased estimators, or BLUE (Wooldridge, 2019).

This appendix presents the relevant test results and discussion for the MLR estimation model from the regression. Probability and indirect cost of bankruptcy are the main variables in the regression but we will use indirect cost of bankruptcy in the illustration as this was the only one of the variables used that showed signs of non-linearity, all the other variables have been tested. The test is also done on the main regression including all the variables to establish a more holistic image.

10.2.1 Assumption 1: Linearity

The assumption of linearity requires linearity between the unknown parameters $\beta 0, \beta 1, \ldots, \beta k$ and the dependent variable y (Wooldridge, 2019). To test for linearity, we used augmented component-plus-residual plots to observe the degree of linearity between independent and dependent variables. From this we observed the presence of non-linearity. We then tested the different variables and found current ratio breaking the assumption and indirect cost of bankruptcy somewhat broke it. From this we choose to exempt current ratio from our regression and choose to keep indirect cost of bankruptcy because of the minor breach of the assumption. The figure is the ACPR plot for indirect cost of bankruptcy, and from this it narrowly breaches the assumption.

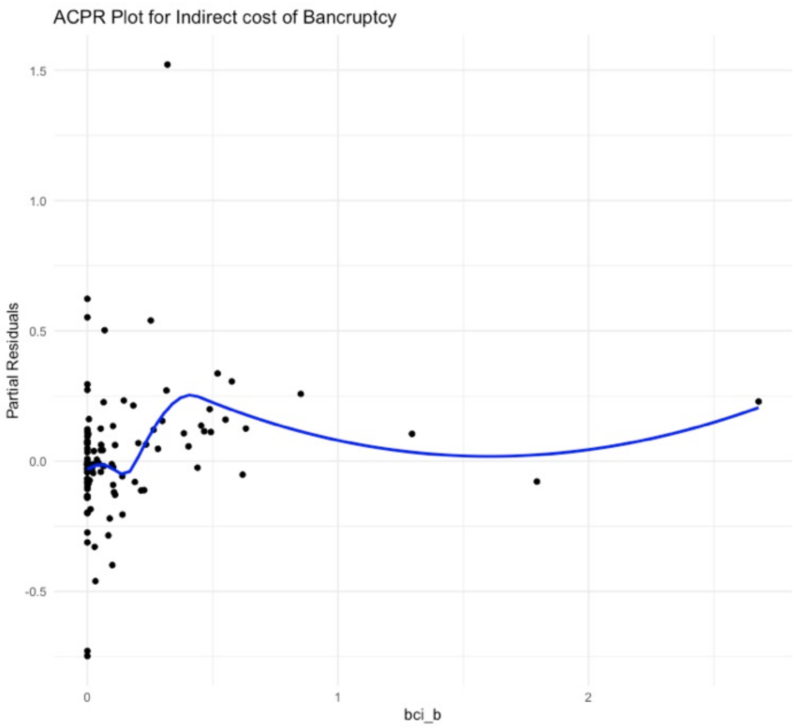

Figure 1: *ACPR Plot for BCI Checking for Linearity*

10.2.2 Assumption 2: Random Sampling

The assumption of random sampling requires the data sample to be randomly selected from the total population of firms to make statistical inferences. As mentioned in the robustness of our sample selection (Appendix 10.4), we confirmed that our sample varies in industries and sectors, asset sizes and lifespans, i.e. represents broad inclusion. This indicates that the assumption is satisfied. However, the assumption may be violated if we consider the exclusion of unlisted firms. This will depend on the understanding of what the total population of firms refers to – either refering to both listed and unlisted firms or exclusively listed firms in our case. Therefore, assuming the selected sample is representative of the total population, the assumption of random sampling holds.

10.2.3 Assumption 3: No Perfect Collinearity

The assumption of no perfect collinearity implies no perfectly linear relationship between any independent variables (Wooldridge, 2019)

We have tested this by utilizing a VIF test. The VIF test suggests harmful multicollinearity when a VIF-value is greater than 5, while values under 5 suggest moderate to no multicollinearity (Mason & Perrault, 1991). Both the VIF test and the correlation matrix presented in Table A2 and A3 shows no harmful multicollinearity between the variables.

Table A2: *VIF-Test – Main Regression Variables*

BCI	PROB	SIZE	EBITDA	DEPR	TANG	Mean VIF
1.238659	1.146976	1.396585	1.446935	1.128623	1.251558	1.268223

Table A3: *Correlation Matrix – Main Regression Variables*

	BCI	PROB	SIZE	EBITDA	DEPR	TANG
BCI	1.0000					
PROB	0.2709	1.0000				
SIZE	-0.1430	-0.1053	1.0000			
EBITDA	-0.3764	-0.2097	0.4017	1.0000		
DEPR	0.0538	0.0714	-0.3343	-0.1314	1.0000	
TANG	0.0561	0.2399	-0.3380	-0.3307	0.0937	1.0000

10.2.4 Assumption 4: Zero Conditional Mean

The assumption of zero conditional mean states the error term u must have an expected value of zero independent of the values of the explanatory variables (Wooldridge, 2019). It further states that unobserved or omitted variables correlated to at least one independent variable may be harmful to causal inference. The likelihood of not-accounted-for variables being correlated with the explanatory variables included in our model is reasonably high. Whether it is due to a lack of measurability, data availability or nescience, the potential violation of the zero conditional mean assumption should not be disregarded.

10.2.5 Assumption 5: Homoscedasticity

The assumption of homoscedasticity implies that the error term u must hold a constant variance across all independent variables, regardless of the variables' values (Wooldridge, 2019). We tested this by using a Breusch-Pagan Lagrange Multiplier Test and a White's test. From the Bp test we fail to reject the null hypothesis of homoscedasticity. This suggests that there is no evidence of heteroskedasticity in the model's residuals. However, from the White's test we reject the null hypothesis of homoscedasticity. This suggests there is evidence of heteroskedasticity in the model's residuals. Overall, we conclude that there is evidence of heteroskedasticity.

Table A4: *Breusch-Pagan Lagrange Multiplier Test*

Test	bp	df	p-value
Breusch-Pagan Test	38.481	29	0.112

Table A5: *White's Test*

Test	bp	df	p-value
Breusch-Pagan Test	193.031	29	0

10.2.6 Assumption 6: Normality

The assumption of normality states that the population of error term *u* must, independently from explanatory variables *x1, x2, ... , xk,* be normally distributed with a mean-variance, σ^2, of zero (Wooldridge, 2019). Normality is tested by using the following tests: a Shapiro-Wilk normality test, a Kernel Density distribution and a quantile of normal distribution. The Shapiro-Wilk test indicates that the residuals are not normally distributed. From the other tests, in Figure 2 and 3, we see minor infractions of normality.

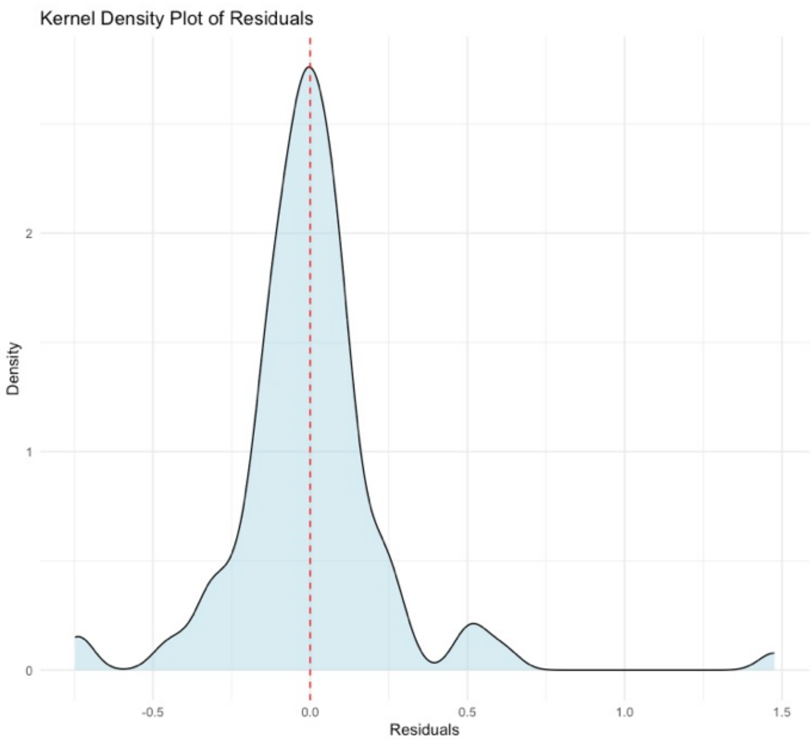

Figure 2: *Plot of Kernel Density Distribution.*

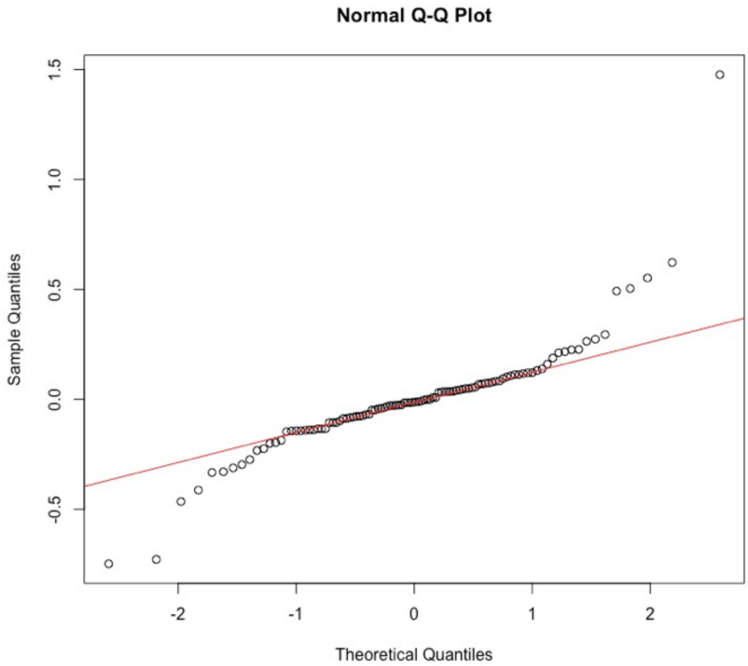

Figure 3: Q-Q-Plot for Normal Distribution.

10.2.7 Assumption 7: No Autocorrelation

The assumption of no autocorrelation requires the error terms of time period *s* and *t,* u_s and u_t, to be uncorrelated independently of the value of the explanatory variables (Wooldridge, 2019). If the error terms of multiple time periods are correlated, the errors will suffer from serial correlation or autocorrelation. To test for autocorrelation, the standard Wooldridge test has been utilized. From the test we reject the null hypothesis of no autocorrelation, breaking the assumption.

Table A6: *Breusch-Godfrey/Wooldridge Test For Serial Correlation in Panel Models*

chisq	df	p-value
7.4536	2	0.02407

Alternative hypothesis: serial correlation in idiosyncratic errors

10.3 Norwegian Bankruptcy Statistics

As mentioned, the motivation for writing this thesis and further investigate bankrutcies in Norway initially stemmed from the increase in bankruptcy filings in recent years. Taking a look at published articles from Statistics Norway, we saw constant publications of increases in bankruptcies. An overview of all currently available articles in Statistics Norway, where increased bankruptcies is the subject, is presented in Table A7.

Table A7: *Published Articles Regarding Increase in Norwegian Bankruptcies from Statistics Norway*

Published Date	Title of Article
21.04.17	More Bankruptcies
21.02.18	4557 Bankruptcies in 2017
02.05.18	Increase in Number of Bankruptcies
16.08.18	More Bankruptcies
07.11.18	More Bankruptcies
05.02.19	More Bankruptcies in 2018
06.05.19	Small Increase in Number of Bankruptcies
04.11.19	Increase in Number of Bankruptcies
04.05.22	The Number of Bankruptcies Increases
27.10.22	Big Increase in Number of Bankruptcies
25.01.23	More Bankruptcies in 2022
25.04.23	40 Percent Increase in Number of Bankruptcies
14.08.23	More Bankruptcies
25.10.23	Increase in Number of Bankruptcies
26.01.24	4517 Bankruptcies in 2023
14.08.24	The Number of Bankruptcies Increases

Retrieved from Statistics Norway (2024)

Consequently, we were intrigued to further investigate this phenomena. To further determine the increase in bankruptcies, we retrieved the statistics from Statistics Norway. We created four plots showing the amount of observed bankruptcies for each year with a trend line showing if there is an increasing or decreasing trend in observations over time. The first plot shows the period 1980 to 2023, the second shows 1990 to 2023, the third shows 2000 to 2023 and the fourth shows the period we retrieved our sample from; 2000 to 2020. This is presented in Figure 4.

From the plots we see that the observations are scattered, making it difficult to determine if the bankruptcies have increased during recent years. However, the trend-line shows the actual gradual increase in bankruptcies over the different periods, being most pronounced in the first and last plot.

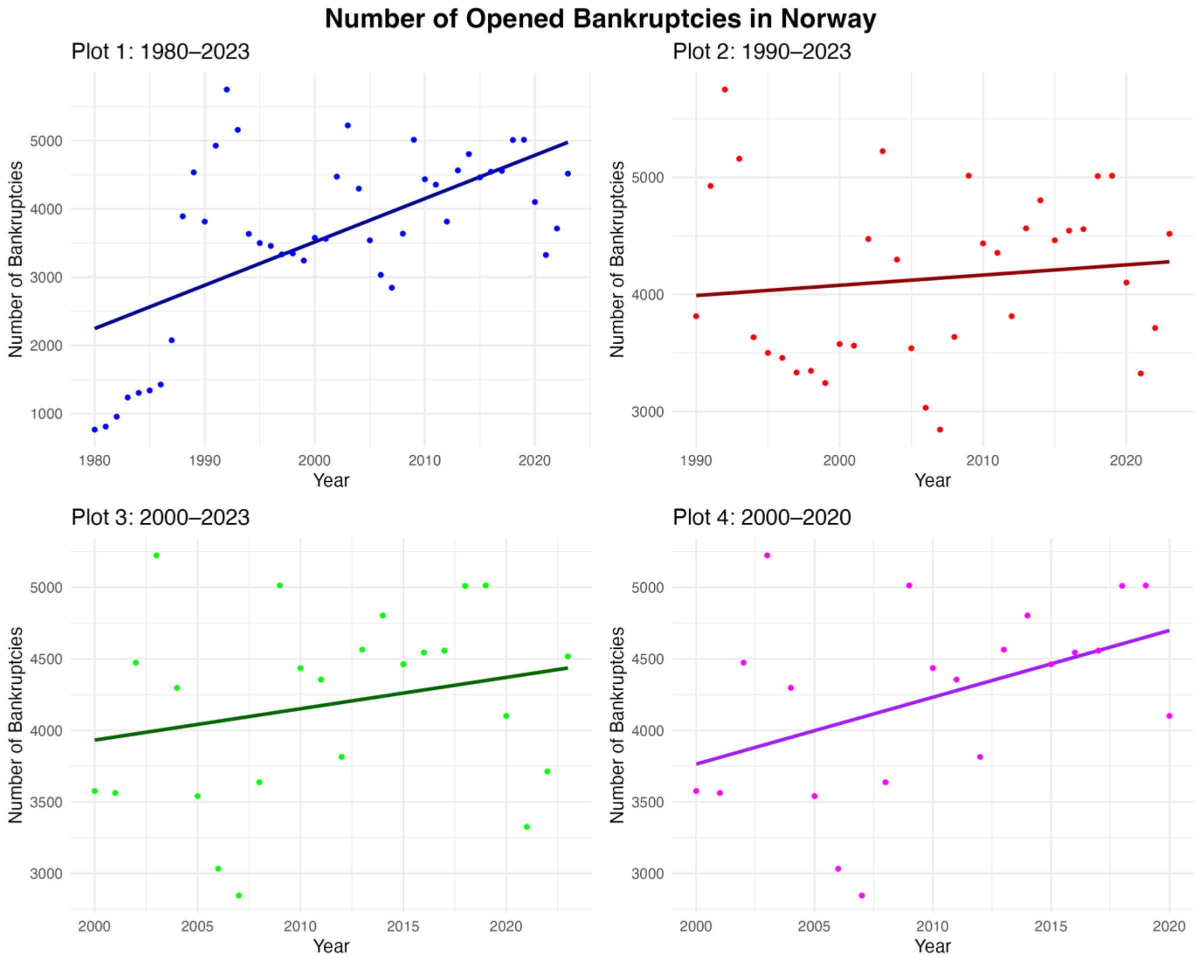

Figure 4: *Historically Observed Norwegian Bankruptcies*

10.4 Robustness of sample selection

The decision to disregard further filtration of the selected sample led to a few considerations. Firstly, the mean asset size of these firms in year *t* is NOK 1.21 billion, with a range of between NOK 0.97 million and NOK 12.91 billion, in the last year of available information. Secondly, the sample represents firms from 13 different industries, as seen in Table A8. The largest industry present (74) has 10 bankrupt firms and the smallest industries present (24, 30, 51, 52, 55, 71) are six industries with only one bankrupt firm each. Consequently, every industry included represents an average of two to three bankrupt firms. However, when categorizing by sector the sample is distributed over eight sectors. The largest sector is offshore/shipping with eight firms and the smallest is construction with two, averaging four bankrupt firms per sector. Thirdly, the lifespans of the firms vary. Initially we filtered the data to only include firms with a lifespan of over 10 years. However, this resulted in a sample size of 24 firms. Consequently, we disregarded this filtering to keep the sample size larger. Fourthly, six firms from our sample were delisted prior to the firms' four last years of financial information. These were included since they were previously listed and appeared to have minimal changes in metrics from being listed to being delisted. Moreover, two firms were listed but had unavailable share price information over the four years, while three additional firms had one to two years of unavailable share price information.

Recognizing that this group is not completely homogeneous, due to the variety of firms, our selection may incur difficulties for our analysis. However, through careful analysis the sample variety could be beneficial for our study and provide a more comprehensive analysis. Moreover, it may result in an outcome that is more generalizable to other sectors, countries and firms than studies with selection bias, only targeting specific industries and firm-sizes.

Furthermore, a thorough review of previous literature was conducted to determine whether or not our sample size was adequate, where we found empirical evidence in favor of the selected number of firms.

Table A8: *Sample Distribution by Sector and Industry*

Sector	Number of Firms	Industry	Number of Firms
Offshore/Shipping	8	11	5
Manufacturing	2	21	2
Telecom/IT/Tech	7	24	1
Construction	2	30	1
Wholesale/Retail	3	51	1
Holding	5	52	1
Consulting	3	55	1
Research	3	61	2
Total: 8	**Total: 33**	70	2
		71	1
		72	4
		73	2
		74	10
		Total: 13	**Total: 33**
Firms per sector: 4.13		***Firms per industry: 2.54***	

To further justify the sufficiency of our sample, we conducted a brief sensitivity analysis of the thesis' results through changes in sample selection, as seen in Table A9. Overall, we see that further filtration of the sample, to improve its homogeneity, produces negligible changes to our results. Averages and ranges of indirect cost ratios and asset values experience minor changes. The same goes for the output of the leverage regressions although the fit (R-Squared) slightly improves for all the filtrations. Moreover, we see all filtrations receive p-values that are slightly higher than our sample, and some obtain less significant relationships of BCI or PROB. Overall, we conclude that our findings strengthen the credibility of our current sample and its results, and arguably improves the generalizability of our findings since we can use a larger and more diverse sample.

Table A9: *Sensitivity Analysis of Sample Selection*

	Selected sample	Excl. industries with one firm	Excl. firms with age < 10 years
BCI/EV (%)			
Mean	22.71	23.05	24.15
Range	17.74 – 25.38	19.46 – 26.13	17.33 – 29.37
Asset Value (BNOK)			
Mean	1.21	1.02	0.76
Range	0.001 – 12.91	0.001 – 12.91	0.001 – 12.91
Regression			
Signif. of BCI	***	**	***
Signif. of PROB	***	***	***
R-Squared	0.806	0.811	0.903
p-value	$2.56e^{-11}$	$1.38e^{-07}$	$1.24e^{-09}$

	Excl. firms with 0.1 > asset value > 4.5	Excl. firms delisted in last four periods
BCI/EV (%)		
Mean	23.68	20.74
Range	16.96 – 26.83	17.65 – 23.38
Asset Value (BNOK)		
Mean	1.10	1.51
Range	0.11 – 4.28	0.001 – 12.91
Regression		
Signif. of BCI	***	**
Signif. of PROB	**	***
R-squared	0.862	0.856
p-value	$7.60e^{-09}$	$6.29e^{-08}$

10.5 Robustness of Enterprise Value

As mentioned previously, for 11 firms from our sample of 33 we were unable to obtain the firm value for all four periods prior to bankruptcy, due to them being delisted or having unavailable share prices. To determine the firm values for this selection, we utilized a comparable company analysis (CCA). CCA is a commonly used process of comparing companies based on similar metrics to determine enterprise value. When conducting such an analysis, widely used ratios are value-to-ebitda (EV/EBITDA), value-to-revenue (EV/Revenue), price-to-earnings (P/E) and price-to-book (P/B).

For the 11 firms we used an altered version of CCA. To find our ratios we could conduct tedious research on endless of comparable firms to find an average multiple for valuing our firms. However, as all 11 firms were listed, or previously listed, on OSE, we decided to use the latest available information from their years as listed firms as comparable years, for ease of computation. Hence, the data from “comparable firms” gave us average multiples from their years as public firms. These multiples were multiplied by the respective variables from their recent performance as private firms, to end up with an estimation of their firm value prior to bankruptcy.

To justify this decision, we argue that although different periods could involve different external shocks, there is no greater comparable firm than the firm itself. Moreover, for the majority of the ratios the necessary metrics from their years as public firms were comparable to the respective metrics of the private firms. Furthermore, as public firms exit the market to keep operations going as private firms, they are arguably in a state of distress. Likewise, the six previously listed firms in our sample are in a state of distress approaching bankruptcy. To use metrics from their years as public firms in distress to estimate an average multiple to use for estimating their firm value as currently private firms in distress, appears reasonable.

Furthermore, we use an estimated average multiple from a period of four years from when the firm was listed, and apply the same multiple to estimate firm value for each year from *t-3* to *t*. This was done to account for the fact that we only use one comparable firm and to minimize the effect of few observations of excessively poor or good performance from the public firm. Moreover, as this selection varies majorly in financial statistics, certain ratios may fit certain firms better than others. Consequently, we estimated multiples using all four methods.

Firstly, for the value-to-ebitda ratio the multiple is found by dividing the comparable firm's value by its ebitda. The ratio is then multiplied by the private firm's ebitda to end up with the enterprise value of the private firm.

$$\frac{EV_{1,i,t}}{EBITDA_{i,t}} = \frac{\overline{EV}_{j,T}}{\overline{EBITDA}_{j,T}} \quad \leftrightarrow \quad EV_{1,i,t} = \frac{\overline{EV}_{j,T}}{\overline{EBITDA}_{j,T}} \cdot EBITDA_{i,t}, \quad t = -3, -2, -1, 0,$$

where $EV_{1,i,t}$ denotes market value for firm i in year t using the value-to-ebitda multiple and $EBITDA_{i,t}$ shows earnings before interest, tax, depreciation and amortization for firm i in year t. $\frac{\overline{EV}_{j,T}}{\overline{EBITDA}_{j,T}}$ denotes the average value-to-ebitda ratio from comparable firm j in period T, where $\overline{EV}_{j,T}$ is the average firm value of comparable firm j in period T and $\overline{EBITDA}_{j,T}$ is the average earnings before interest, tax, depreciation and amortization for comparable firm j in period T.

Secondly, for the value-to-revenue ratio the multiple is found by dividing the comparable firm's value by its revenue. The ratio is then multiplied by the private firm's revenue to end up with the enterprise value of the private firm.

$$\frac{EV_{2,i,t}}{Revenue_{i,t}} = \frac{\overline{EV}_{j,T}}{\overline{Revenue}_{j,T}} \quad \leftrightarrow \quad EV_{1,i,t} = \frac{\overline{EV}_{j,T}}{\overline{Revenue}_{j,T}} \cdot Revenue_{i,t}, \quad t = -3, -2, -1, 0,$$

where $EV_{2,i,t}$ denotes market value for firm i in year t using the value-to-revenue multiple and $Revenue_{i,t}$ shows annual revenue for firm i in year t. $\frac{\overline{EV}_{j,T}}{\overline{Revenue}_{j,T}}$ denotes the average value-to-revenue ratio from comparable firm j in period T, where $\overline{EV}_{j,T}$ is the average firm value of comparable firm j in period T and $\overline{Revenue}_{j,T}$ is the average annual revenue for comparable firm j in period T.

Thirdly, for the price-to-book ratio the multiple is found by dividing the comparable firm's market value of equity by book value of equity. The ratio is then multiplied by the private firm's book value of equity to estimate the private firm's market value of equity. To find the enterprise value, the estimated market value of equity adds book value of total debt less total cash.

$$\frac{P_{i,t}}{B_{i,t}} = \frac{\bar{P}_{j,T}}{\bar{B}_{j,T}} \quad \leftrightarrow \quad P_{i,t} = \frac{\bar{P}_{j,T}}{\bar{B}_{j,T}} \cdot B_{i,t}$$

$$\rightarrow \quad EV_{3,i,t} = P_{i,t} + D_{i,t} - C_{i,t} = \frac{\bar{P}_{j,T}}{\bar{B}_{j,T}} \cdot B_{i,t} + D_{i,t} - C_{i,t}, \qquad t = -3, -2, -1, 0,$$

where $EV_{3,i,t}$ denotes market value for firm i in year t using the price-to-book multiple, $P_{i,t}$ shows market value of equity for firm i in year t, $B_{i,t}$ shows book value of equity for firm i in year t, $D_{i,t}$ denotes book value of total debt for firm i in year t and $C_{i,t}$ is total cash for firm i in year t. $\frac{\bar{P}_{j,T}}{\bar{B}_{j,T}}$ denotes the average price-to-book ratio from comparable firm j in period T, where $\bar{P}_{j,T}$ is average market value of equity for comparable firm j in period T, and $\bar{B}_{j,T}$ is average book value of equity for comparable firm j in period T.

Fourthly, for the price-to-earnings ratio the multiple is found by dividing the comparable firm's market value of equity by total net earnings. The ratio is then multiplied by the private firm's total net earnings to estimate the private firm's market value of equity. To find the enterprise value, the estimated market value of equity adds book value of total debt less total cash.

$$\frac{P_{i,t}}{E_{i,t}} = \frac{\bar{P}_{j,T}}{\bar{E}_{j,T}} \quad \leftrightarrow \quad P_{i,t} = \frac{\bar{P}_{j,T}}{\bar{E}_{j,T}} \cdot E_{i,t}$$

$$\rightarrow \quad EV_{3,i,t} = P_{i,t} + D_{i,t} - C_{i,t} = \frac{\bar{P}_{j,T}}{\bar{E}_{j,T}} \cdot E_{i,t} + D_{i,t} - C_{i,t}, \qquad t = -3, -2, -1, 0,$$

where $EV_{3,i,t}$ denotes market value for firm i in year t using the price-to-earnings multiple, $P_{i,t}$ shows market value of equity for firm i in year t, $E_{i,t}$ shows total net earnings for firm i in year t, $D_{i,t}$ denotes book value of total debt for firm i in year t and $C_{i,t}$ is total cash for firm i in year t. $\frac{\bar{P}_{j,T}}{\bar{E}_{j,T}}$ denotes the average price-to-earnings ratio from comparable firm j in period T, where $\bar{P}_{j,T}$ is average market value of equity for comparable firm j in period T, and $\bar{E}_{j,T}$ is average total net earnings for comparable firm j in period T.

The results of the estimated firm values are presented in Table A10 and can be seen to vary. Due to firms being economically and financially distressed, many variables we are looking at are small or negative. This may distort the valuation by resulting in unreasonably low or negative market values of equity or enterprise values. Moreover, comparable companies with barely positive denominators in the given ratios will result in unreasonably high multiples.

Hence, ratios under these conditions will be unable to properly value the firms. Consequently, we provide an average firm value estimate from all values received using the different ratios with a condition that all negative and excessively positive estimates will be excluded from the average. This was further done to ensure that the value estimates would not be chosen on a subjective basis to avoid selection bias.

Table A10: *Comparable Companies Analysis – Firm Value Estimates*

Company	Year	EV/EBITDA	EV/Sales	P/B	P/E	Average
Fesil AS	*t - 3*	-	54.08	818.36	3613.38	**1495.27**
	t - 2	-	17.11	835.73	445.63	**432.82**
	t - 1	384.88	10.40	566.16	2182.11	**785.89**
	t	-	0.06	559.96	302.34	**287.45**
Hjellegjerde AS	*t - 3*	-	54.79	10.63	67.49	**44.30**
	t - 2	-	2031.69	24.32	94.93	**716.98**
	t - 1	-	1332.32	36.20	138.49	**502.34**
	t	-	985.97	7.81	134.86	**376.21**
Linde-Goup ASA	*t - 3*	-	-	-	-	**-**
	t - 2	30.82	18.84	92.21	42.26	**46.03**
	t - 1	1.67	38.11	95.69	26.64	**40.53**
	t	173.00	13.36	47.28	227.35	**115.25**
Conseptor AS	*t - 3*	208.23	126.14	118.16	7496.87	**1987.35**
	t - 2	107.86	122.20	231.90	2144.63	**651.65**
	t - 1	60.99	125.03	196.44	-	**127.49**
	t	122.80	130.59	233.15	-	**162.18**
Frontier Drilling AS	*t - 3*	-	-	-	-	**-**
	t - 2	-	7687.08	5649.66	688.19	**4674.98**
	t - 1	-	-	-	-	**-**
	t	62.99	1120.28	2215.55	286.33	**921.29**
Choice Hotels Scandinavia AS	*t - 3*	-	3059.88	10013.61	5850.19	**6307.90**
	t - 2	1143.62	3043.35	16690.20	-	**6959.06**
	t - 1	-	4094.64	1147.96	-	**2621.30**
	t	-	120.90	588.71	-	**354.81**
Inforstream AS	*t - 3*	198.49	0.85	-	2667.71	**955.69**
	t - 2	283.00	3.98	-	263.70	**183.56**
	t - 1	94.87	2.98	-	290.61	**129.49**
	t	1812.69	2.98	-	2683.42	**1499.70**
Invivosense ASA	*t - 3*	35.33	9.93	23.22	43.90	**28.09**
	t - 2	43.09	10.33	25.28	51.87	**32.64**
	t - 1	29.85	27.75	41.97	29.76	**32.33**
	t	45.16	28.55	48.75	49.87	**43.08**
Scan Geophysical AS	*t - 3*	-	-	0.41	-	**0.41**
	t - 2	-	247.68	313.66	-	**280.67**
Customax	*t - 3*	105.05	48.17	357.40	970.79	**370.35**
	t - 2	176.24	187.46	825.64	252.31	**360.41**
Enitel ASA	*t - 3*	123.68	0.24	35.26	6.19	**41.34**

\- *Observations excluded due to the firm being reportedly inactive or value being negative or zero.*

Table A11: *Enterprise Value in MNOK*

Company	*t - 3*	*t - 2*	*t - 1*	*t*
Ability Drilling ASA	-	-	249.78	75.77
Alvern ASA	149.49	95.85	153.38	119.66
Cecon ASA	504.79	447.14	485.17	245.36
Cellcura ASA	290.46	604.62	38.13	51.82
Choice Hotels Scandinavia ASA *	6307.90	6959.06	2621.30	354.81
Conseptor ASA *	1987.35	651.65	127.49	162.18
Customax ASA	370.35 *	360.41 *	337.27	164.87
Dolphin Drilling ASA	16211.75	13561.97	10612.96	10603.96
Dolphin Group ASA	4402.03	13195.36	12696.41	10258.71
Enitel ASA	41.34 *	35.33	4309.14	4085.70
Evercom Network ASA	127.72	95.88	175.95	38.71
Exense ASA	59.22	66.86	-	75.84
Faktor Eiendom ASA	49330.65	5053.37	16728.51	18907.00
Fesil ASA *	1495.27	432.82	785.89	287.45
Frontier Drilling ASA *	-	4674.98	-	921.29
Hjellegjerde ASA *	44.30	716.98	502.34	376.21
IMSK SE	1853.58	1317.39	987.71	1154.70
Infostream ASA *	955.69	183.56	129.49	1499.70
Intellinet ASA	-	166.04	190.42	225.28
Invivosense ASA *	28.09	32.64	32.33	43.08
Linde-Group ASA *	-	46.03	40.53	115.25
Noral ASA	93.00	68.50	156.53	167.15
Nordic Water Supply ASA	160.74	220.81	469.55	258.41
Norse Energy Corp. ASA	41030.48	30987.08	6997.91	281.71
Norske Skogindustrier ASA	16892.22	14439.00	8404.15	3311.35
Petrojack ASA	7902.08	8041.62	9575.04	3572.37
Petromena ASA	8732.17	32139.56	17038.71	4820.82
Reservoir Expl. Tech. ASA	124033.05	414344.36	2091.04	1132.81
Scan Geophysical ASA	0.41 *	280.67 *	1715.63	2437.34
Tandberg Data ASA	23963.46	26854.23	16553.14	8651.60
Tandberg Storage ASA	150.83	402.75	366.15	305.18
Telecast ASA	1677.63	877.74	2033.37	1127.81
Tordenskjold ASA	2690.19	1642.49	1260.60	1550.47

- *Observations excluded due to the firm being reportedly inactive.*

* *CCA value estimate.*

Hence, ratios under these conditions will be unable to properly value the firms. Consequently, we provide an average firm value estimate from all values received using the different ratios with a condition that all negative and excessively positive estimates will be excluded from the average. This was further done to ensure that the value estimates would not be chosen on a subjective basis to avoid selection bias.

$$EV_{i,t} = \frac{EV_{1,i,t} + EV_{2,i,t} + EV_{3,i,t} + EV_{4,i,t}}{n_{i,t}}, \qquad t = -3, -2, -1, 0,$$

where $EV_{i,t}$ denotes the average firm value from the CCA estimates for firm i in year t, $EV_{1,i,t}$ shows the estimated firm value for firm i in year t using the value-to-ebitda ratio, $EV_{2,i,t}$ shows the estimated firm value for firm i in year t using the value-to-revenue ratio, $EV_{3,i,t}$ shows the estimated firm value for firm i in year t using the price-to-book ratio, $EV_{4,i,t}$ shows the estimated firm value for firm i in year t using the price-to-earnings ratio and $n_{i,t}$ is the number of observed CCA estimates for firm i in year t.

All enterprise values for the whole sample are reported in Table A11.

10.6 Robustness of indirect bankruptcy cost estimation

Absolute indirect costs were found for 91% of our sample, i.e. 30 of 33 firms. However, for each year individually only 56% of firms were observed having indirect costs on average. This implies that these firms are experiencing major fluctuations in performance and outcome, indeed being distressed. Additionally, it implies that on average 44% of the firms exceed their expected performance rather than losing opportunities for the four periods prior to bankruptcy. This can be seen in Table A12.

Altman's (1984) method for estimating indirect costs seemingly excludes unexpected profits, i.e. when firms' actual profits exceed expected profit obtaining negative indirect costs. Although this is not directly stated in his paper, it appears plausible as 16% of his sample has no indirect costs. This seems unlikely if negative costs were included, since it implies that for all four periods prior to bankruptcy these firms exactly matched actual profits to expected profits. However, Andrade and Kaplan (1998), Davydenko et al. (2012) and Reindl et al. (2017) show that negative bankruptcy costs are consistent with evidence from actual bankruptcies. For this reason, we are interested in seeing how the addition of negative bankruptcy costs will affect our results. Arguably this should be addressed, as this will reduce the costs and provide more realistic results as this allows for the firms to compensate the losses from other years.

Table A12: *Yearly Indirect Bankruptcy Costs excl. Negative Values*

Company	**Indirect Costs (NOK 1000)**			
	t-3	*t-2*	*t-1*	*t*
Ability Drilling ASA	0.00	0.00	0.00	2569.00
Alvern ASA	0.00	0.00	10417.26	0.00
Cecon ASA	200575.60	50473.12	219353.60	7804.37
Cellcura ASA	21652.84	7556.38	0.00	172785.30
Choice Hotels Scandinavia ASA	0.00	202588.60	329961.60	196247.70
Conseptor ASA	49935.78	1083.50	0.00	0.00
Customax ASA	0.00	5827.93	15226.87	226915.00
Dolphin Drilling ASA	0.00	0.00	289844.60	0.00
Dolphin Group ASA	0.00	0.00	333576.80	18585.27
Enitel ASA	0.00	3353.00	62650.54	1055189.00
Evercom Network ASA	0.00	0.00	10610.87	1338.20
Exense ASA	0.00	0.00	0.00	0.00
Faktor Eiendom ASA	53194.47	344854.60	290721.10	540961.20
Fesil ASA	0.00	434315.30	50239.80	0.00
Frontier Drilling ASA	0.00	0.00	0.00	0.00
Hjellegjerde ASA	24600.36	17013.56	0.00	0.00
IMSK SE	0.00	0.00	61610.67	1069231.00
Infostream ASA	32725.66	3999.37	10962.06	41487.51
Intellinet ASA	0.00	0.00	23843.00	0.00
Invivosense ASA	0.00	0.00	0.00	0.00
Linde-Group ASA	4022.74	11252.76	24647.39	64935.06
Noral ASA	45581.77	2428.06	5305.54	43574.44
Nordic Water Supply ASA	6069.31	54246.28	0.00	5119.35
Norse Energy Corp. ASA	76331.47	64093.77	265861.30	118113.00
Norske Skogindustrier ASA	1043386.00	0.00	0.00	0.00
Petrojack ASA	3701.00	0.00	315825.90	0.00
Petromena ASA	0.00	99670.00	294114.00	2361720.00
Reservoir Expl. Tech. ASA	0.00	611021.60	0.00	0.00
Scan Geophysical ASA	1315.00	19618.00	16555.31	0.00
Tandberg Data ASA	22471.80	0.00	102416.20	186099.70
Tandberg Storage ASA	28761.00	0.00	0.00	5262080.00
Telecast ASA	0.00	38081.93	14173.98	38282.71
Tordenskjold ASA	0.00	0.00	0.00	71094.06

Table A13: *Yearly Indirect Bankruptcy Costs incl. Negative Values*

Company	**Indirect Costs (NOK 1000)**			
	t-3	*t-2*	*t-1*	*t*
Ability Drilling ASA	0.00	0.00	0.00	2569.00
Alvern ASA	-62212.69	-24561.44	10417.26	-48502.81
Cecon ASA	200575.60	50473.12	219353.60	7804.37
Cellcura ASA	21652.84	7556.38	-47448.94	172785.30
Choice Hotels Scandinavia ASA	-103856.50	202588.60	329961.60	196247.70
Conseptor ASA	49935.78	1083.50	-19025.97	-19471.73
Customax ASA	-2007.00	5827.93	15226.87	226915.00
Dolphin Drilling ASA	-794364.20	-72048.85	289844.60	-1077363.00
Dolphin Group ASA	-49038.99	-183439.50	333576.80	18585.27
Enitel ASA	0.00	3353.00	62650.54	1055189.00
Evercom Network ASA	-2913.93	-19195.37	10610.87	1338.20
Exense ASA	-92942.34	-108141.40	-2269.94	-9717.57
Faktor Eiendom ASA	53194.47	344854.60	290721.10	540961.20
Fesil ASA	-183174.00	434315.30	50239.80	-637718.40
Frontier Drilling ASA	-380392.40	-609049.90	-517297.50	-22820.12
Hjellegjerde ASA	24600.36	17013.56	-124498.00	-148599.00
IMSK SE	-99310.50	-140307.50	61610.67	1069231.00
Infostream ASA	32725.66	3999.37	10962.06	41487.51
Intellinet ASA	0.00	0.00	23843.00	-300106.80
Invivosense ASA	-7708.93	-6870.31	-11110.12	-18103.79
Linde-Group ASA	4022.74	11252.76	24647.39	64935.06
Noral ASA	45581.77	2428.06	5305.54	43574.44
Nordic Water Supply ASA	6069.31	54246.28	-15903.08	5119.35
Norse Energy Corp. ASA	76331.47	64093.77	265861.30	118113.00
Norske Skogindustrier ASA	1043386.00	-1594072.00	-6820123.00	-9719432.00
Petrojack ASA	3701.00	-501732.00	315825.90	-2418248.00
Petromena ASA	0.00	99670.00	294114.00	2361720.00
Reservoir Expl. Tech. ASA	-17270.57	611021.60	-349335.40	-263584.00
Scan Geophysical ASA	1315.00	19618.00	16555.31	-48691.89
Tandberg Data ASA	22471.80	-28271.07	102416.20	186099.70
Tandberg Storage ASA	28761.00	-219264.20	-2967698.00	5262080.00
Telecast ASA	-5853.00	38081.93	14173.98	38282.71
Tordenskjold ASA	-8607.00	-8206.00	-30409.00	71094.06

However, Altman's (1984) reasoning to exclude the negative values could be to exclusively address costs, disregarding any profits that could minimize overall loss of the firm. The overview of positive and negative indirect bankruptcy costs for the four periods is reported in

Table A13. They arefurther presented in a relative sense with different conditions in the sensitivity analysis in Table A14.

Furthermore, our thesis has observations where costs exceed firm value. This could be attributed to the use of aggregated BCI over multiple periods, as proposed by Altman (1984). This inherently results in inflated ratios for some firms with rapidly declining values, particularly in the final stages of distress. While this methodological approach captures the cumulative impact of indirect costs, it may overstate their relative magnitude in extreme cases. Although this is an inherent limitation of the method, it should not diminish the significance of the findings. To check this, we look at how the results would change if we instead compared yearly costs to yearly value, which is presented in Method 7 and 8 in Table A14.

To check the robustness of our indirect bankruptcy costs, following Altman's (1984) method, we will conduct a sensitivity analysis. We will include different measures of bankruptcy costs and results from previous literature, to compare with our results to address if they appear reasonable. The different methods for calculating indirect costs are as follows:

Method 1: This measure will follow the notations of the trade-off theory stating that a levered firm's value is the result of the sum of unlevered firm value, tax shield and distress costs. This was done for the four periods prior to bankruptcy.

$$V_L = V_U + PVTS + PVBC \quad \leftrightarrow \quad PVBC = V_L - V_U - PVTS,$$

where V_L denotes levered firm value, V_U denotes unlevered firm value, $PVTS$ is present value of interest tax shield and $PVBC$ is present value of bankruptcy costs.

Method 2: This measure will back out distress costs from market value changes similar to Davydenko et al. (2012). This implies that if a firm experiences increased or decreased firm value from one year to the next, this change will represent the negative or positive bankruptcy costs, respectively. For this measure we allow for both negative and positive bankruptcy costs, but choose to exclude extreme values of over 100% and under -100%. This is done for all four periods. Since we only have the liquidation value for eight firms, derived from their bankruptcy reports, we used the average liquidation values compared to the respective firms' value in the last operating year to estimate an overall bankruptcy cost for the sample for year *t.*

$$BC_{i,t} = \Delta EV_i = EV_{i,t} - EV_{i,t+1},$$

where $BC_{i,t}$ denotes bankruptcy costs for firm i in year t, ΔEV_i is the change in firm value of firm i from one year $EV_{i,t}$ to the next $EV_{i,t+1}$. If value decreases we will obtain positive bankruptcy costs and if value increases we will obtain negative bankruptcy costs.

Method 3, method 4 and method 5: These measures include both positive and negative indirect bankruptcy costs for the four periods prior to bankruptcy. The costs are aggregated to obtain an absolute value of indirect costs for each firm. For method 3, we allow for all values. For method 4 we exclude EV/BCI ratios that either are negative or exceed 100%. For method 5 we exclude extreme EV/BCI ratios, i.e. ratios must be in the range of ±100%.

We acknowledge that for method 1 and 2, the results will represent the overall bankruptcy costs, not just indirect. Consequently, we calculate an average empirical direct bankruptcy cost estimate, using estimates from Warner (1977), Altman (1984) and Weiss (1990). This provided us with a direct cost of 4% which is deducted from the average bankruptcy cost estimates, to isolate indirect costs. Furthermore, bankruptcy costs found in methods 1 through 5 are further divided by the firm value to find relative indirect bankruptcy costs.

Method 6: This measure will compare the aggregated absolute indirect costs with the aggregated yearly firm values. Hence, the costs are aggregated to obtain an absolute value of indirect costs for each firm for the four periods, which is further aggregated to find an absolute value of indirect costs for the whole sample. Furthermore, firm values are aggregated to obtain an absolute enterprise value for the whole sample for each year, i.e. one absolute firm value for *t-3,* one for *t-2,* one for *t-1* and one for *t.* The aggregated absolute indirect costs are then divided by the aggregated yearly firm values. This is similar to our thesis' current method but using aggregated values instead of calculating ratios for each firm. For this measure we only include positive indirect costs.

Method 7 and Method 8: This measure will compare the yearly indirect costs with the yearly firm values for each firm instead of using the absolute value of indirect costs. Hence, BCI for year *t-3* is divided by EV for *t-3,* and so on. Like our thesis' current method, we will exclude values that are either negative or exceed 100% for method 7, while only negative values are excluded from method 8.

Furthermore, we include the results from a set of previous literature to further justify our thesis' current method. Firstly, we include three of the estimates provided by Altman (1984). Altman's first method is the one we use in our thesis, while his second and third method is security analyst estimates where the latter compares BCI to EV using summation of all firms instead of finding average ratios for each firm. Secondly, we include two of the estimates from Andrade and Kaplan (1998). Their first method defines bankruptcy costs as changes in operating performance, while the second method defines bankruptcy costs as change in firm value. Lastly, we include results from Korteweg (2010), Glover (2016), Davydenko et al. (2012) and Reindl et al. (2017)

Table A14: *Sensitivity Analysis of Indirect Bankruptcy Cost Estimate*

Method	**BCI/EV**				**Mean**
	t-3	*t-2*	*t-1*	*t*	
Method 1	17%	21%	25%	35%	**20%**
Method 2	23%	18%	26%	98%	**37%**
Method 3	16%	103%	31%	14%	**41%**
Method 4	22%	19%	30%	24%	**24%**
Method 5	10%	4%	11%	9%	**9%**
Method 6	6%	3%	15%	23%	**12%**
Method 7	14%	6%	9%	22%	**13%**
Method 8	13%	30%	13%	46%	**26%**
Mean	***15%***	***26%***	***20%***	***34%***	***24%***
Altman #1	8%	7%	7%	11%	**8%**
Altman #2		22%	18%	18%	**19%**
Altman #3		30%	22%	21%	**24%**
Andrade & Kaplan #1			10%	20%	**15%**
Andrade & Kaplan #2			19%	23%	**21%**
Korteweg			15%	30%	**23%**
Glover				25%	**25%**
Davydenko et al.				22%	**22%**
Reindl et al.				20%	**20%**
Mean					***20%***
Total mean					***22%***
Thesis	***25%***	***18%***	***23%***	***25%***	***23%***

Results are presented in Table A14. For the seven methods, results are presented for each of the four periods (column 1-4) along with an average of all periods for each method (column 5), an average of all methods for each period (column 1-4, row 11) and an average of all methods and periods (column 5, row 11). For the results of previous literature, we were unable to obtain full ranges for all literature, hence averages were calculated based on the results obtained. For these, ranges are presented (column 1-4) along with an average of the ranges for each method (column 5) and an average of all methods and ranges (column 5, row 21). Lastly, we present an average combining the average of all methods and ranges from our seven methods and all methods from previous findings. This is compared to the findings from our thesis.

Our thesis' overall average is 23% which is similar to the overall average from the eight methods, strengthening our results while indicating minor sensitivity to change in parameters. However, we see some differences among the averages for each method although they have ranges that are comparable to ours. Furthermore, our overall average is slightly higher than that of previous literature but similar in range. This could potentially be altered if we would be able to obtain full ranges for all literature. Ultimately, our indirect bankruptcy cost estimates appear robust and show low sensitivity to changes in method, strengthening the credibility of our results.

Furthermore, we stated that we excluded BCI/EV values that exceeded 100% from our table in the main body of our thesis. There are several reasons for this. Firstly, these few extreme observations could distort the overall trends being analyzed and likely reflect unique circumstances or measurement anomalies that could obscure broader patterns in the dataset. This can be argued to have the same justification as for the widely used winsorization, to reduce the effect of extreme outliers. Secondly, we wanted to present our findings similar to Altman and other papers for comparability reasons. Altman's method uses aggregated indirect costs divided by yearly firm values. By doing this, the results may appear disproportionately high, which is an inherent weakness of the method. In Table A15, we see that including all observations distorts the overall results, providing average costs exceeding 100% for the entire sample for each year. The reason for this is a few observations exceeding 500% which further showcases the weakness of the estimation method. However, by including negative bankruptcy costs, unlike Altman, we see from method 3 in Table A14 that the averages are more comparable to those in the main body. Thirdly, some firms rapidly decrease firm value nearing bankruptcy. When costs are calculated based on historical performance and then aggregated, they will intuitively be disproportionately higher than the rapidly decreasing firm values.

However, when including the indirect costs in the leverage regression they are presented as yearly indirect costs divided by yearly firm value for each firm. As seen for method 8 in Table A7, this results in more reasonable averages, much more comparable to our results presented in the main body.

Table A15: *Relative Indirect Bankruptcy Costs Including Extreme Values*

Method	BCI/EV			
	t-3	*t-2*	*t-1*	*t*
Incl. Extreme Values	405.22%	177.17%	188.89%	117.87%

10.7 Robustness of logit estimation

All statistics, tables and results presented in this section are excerpts from one year prior to bankruptcy.

For our full sample of bankrupt and non-bankrupt firms, we stated that we chose the specific set of variables as a result of previous literature, potential importance for our sample and no multicollinearity. We present the descriptive statistics for all variables for the bankrupt and non-bankrupt sample in Table A16. We see that almost 70% of the variables for the non-bankrupt sample have positive means, while 70% of the variables for the bankrupt sample are negative. There seems to be differences in means between the two samples, but to conclude if this is the case we want to conduct a t-test.

Table A16: *Descriptive Statistics for Bankrupt and Non-Bankrupt Firms*

Variable	Non-Bankrupt Firms		Bankrupt Firms	
	Mean	*St.Dev*	*Mean*	*St.Dev*
WCTA	0.13	0.44	-4.76	27.55
RETA	-0.26	2.53	-9.41	50.85
EBITTA	-0.51	4.72	-0.73	3.25
EBITDATA	-0.48	4.72	-0.68	3.22
EBITDATL	-15.95	154.93	-0.31	0.64
TDTE	0.44	3.51	-0.29	16.59
TETD	28.88	113.07	1.65	3.00
TETA	0.61	0.53	-4.67	27.57
TRTA	0.25	0.50	0.24	0.38
CACL	14.21	53.00	16.32	67.72
CACLTA	0.13	0.44	-4.76	27.55
TATL	29.88	113.07	2.65	3.00
TLTA	0.39	0.53	5.67	27.57
ROA	-0.14	0.62	-15.23	85.11
ROE	0.17	1.92	-1.32	15.38
N	*132*		*33*	

Table A17 reports t-statistics testing the null hypothesis that there is no difference in the means between the non-bankrupt and bankrupt firms. We see that eight of the fifteen variables are significant at a 5% or 10% level, indicating the statistically significant difference between the means for the bankrupt and non-bankrupt sample. Hence, showing the variables' importance for distinguishing healthy firms from risky firms, i.e. their strong ability to predict bankruptcy.

Table A17: *T-Statistics Testing for Differences Between Means of Bankrupt vs Non-Bankrupt Sample*

WCTA	RETA	EBITTA	EBITDATA	EBITDATL	TDTE	TETD
-2.06**	-2.08**	-0.26	-0.22	0.58	-0.47	-1.38*

TETA	TSTA	CACL	CACLTA	TATL	TLTA	ROA	ROE
-2.22**	-0.18	0.19	-2.057**	-1.38*	2.22**	-2.06**	-1.0868

*Significance Codes: 1% *** 5% ** 10% **

Furthermore, in Table A18 and A19 we present the results from the VIF-tests, checking for multicollinearity. VIF-values lower than 5 indicates moderate to no correlation between independent variables, i.e. no multicollinearity. This was the case for the optimal mix of four variables.

Table A18: *VIF-Test of Significant Variables*

WCTA	RETA	TETD	TETA	TATL	TLTA	ROA
1.64	1.18	995895600000.00	174809000000.00	995873500000.00	174809000000.00	1.27

Table A19: *VIF-Test of Optimal Variable Selection*

WCTA	RETA	TLTA	ROA
1.640011	1.174996	1.366484	1.271002

Moreover, we want to strengthen the results of our bankruptcy probability estimates from the logit model by comparing the output of the regression with the output from an OLS model. This is reported in Table A20.

Table A20: *Comparison of Results from Logit and OLS model*

Variable	Logit	OLS
	Estimate	*Estimate*
WCTA	0.677	0.109
RETA	0.088	0.009
TLTA	1.231	0.197
ROA	-0.281	0.021

We see that the size of the coefficients has major differences between the two models. However, both models seem to agree on the positive relationship between the probability of bankruptcy and the variables. Both models estimate that WCTA, RETA and TLTA have positive relationships with the probability of bankruptcy. However, the models disagree on the relationship of ROA, where the logit model estimates it to be negative and the OLS model estimates it to be positive. Overall, we interpret these results as favorable for the robustness of our model.

To further determine the robustness of our model we will present the results of several measures of evaluating the model's performance and compare our results with empirical findings. First, we will present the AUC-score (Area Under the Curve) and pseudo R^2 results, comparing the results from our model to the five multi-period logit models from Charalambakis and Garret (2018). The AUC-score provides a single scalar value summarizing the model's ability to distinguish between positive and negative classes at various threshold levels, where values over 0.5 indicate good performance, while lower values indicate random guessing and worse. Furthermore, pseudo R^2 indicates how much improvement a model provides compared to a null model, indicating the proportion of variation in the dependent variable explained by the model, where a higher value indicates better fit.

Table A21: *Model Performance Evaluation*

Measure	**Thesis**			**Charalambakis & Garret**		
	Logit	*BPM1*	*BPM2*	*BPM3*	*BPM4*	*BPM5*
AUC	0.7858	0.7984	0.8061	0.8042	0.8115	0.8191
Pseudo R^2	0.1663	0.1136	0.1157	0.1175	0.1259	0.1342

As seen in Table A21 our results of model performance are comparable to Charalambakis and Garret's (2018) five models, indicating good performance. We see that the AUC-scores indicate that our model performs slightly worse than their models, while the pseudo R^2 results indicate that our model performs slightly better.

To further evaluate the performance, we will utilize classification threshold optimization, looking at the type II errors in our model estimates. Ohlson (1980) states that type II errors for bankrupt firms occur when the probability of bankruptcy is lower than a given cutoff point. We compare our estimates to Ohlson's in Table A22.

Table A22: *Type II Error Analysis*

Cutoff Point	Thesis		Ohlson	
	t	*t-1*	*t*	*t-1*
0	0%	0%	0%	0%
0.02	0%	6%	8%	0%
0.04	0%	6%	14%	1%
0.06	6%	6%	20%	5%
0.08	6%	9%	26%	9%
0.1	6%	12%	27%	12%
0.2	21%	36%	45%	31%
0.3	48%	55%	49%	44%
0.4	82%	76%	57%	51%
0.42	85%	82%	61%	51%
0.5	88%	88%	68%	57%
0.54	88%	88%	69%	61%
0.6	88%	88%	71%	63%
0.7	94%	91%	76%	71%
0.8	94%	94%	82%	74%
0.9	94%	94%	89%	83%
1	100%	100%	100%	100%

From Table A22 we see that we obtain less type II errors for the lower cutoff points and more errors for the higher cutoff points one year prior to bankruptcy. This can be attributed to our smaller sample of 33 firms compared to Ohlson's 105 bankrupt firms. However, our average bankruptcy probabilities were comparable, where our method averaged 34% and Ohlson's averaged 39%. Two years prior to bankruptcy we see that we receive slightly more errors overall. However, we receive higher average probability for our sample with 31% compared to Ohlson's 20%. Thus, our errors must be attributed to a few firms with high probabilities of bankruptcy and the majority with low probabilities. Additionally, the errors could again be due to differences in samples. Overall, evaluating our model's performance – using AUC, pseudo R^2 and classification threshold optimization – indicate good performance that is comparable to empirical findings, hence strengthening the robustness of our model.

10.8 Cost-Benefit Input

In Table A23, we present the yearly present values of bankruptcy costs and interest tax shields over the four periods, to show the input used for the PVBC/PVTS ratios presented in the thesis.

Table A23: *Yearly PVBC and PVTS in NOK 1000*

Company	PVBC				PVTS			
	t-3	*t-2*	*t-1*	*t*	*t-3*	*t-2*	*t-1*	*t*
Ability Drilling ASA	0	0	0	2569	0	0	0	0
Alvern ASA	0	0	10838	0	0	0	932	330
Cecon ASA	250877	81631	279330	13452	6435	15404	7608	14459
Cellcura ASA	25760	11021	0	197050	249	943	190	940
Choice Hotels Scandinavia ASA	0	202589	329962	196248	0	0	0	1
Conseptor ASA	50561	1083	0	0	279	0	0	0
Customax ASA	0	13730	16979	226915	0	334	725	0
Dolphin Drilling ASA	0	0	309253	0	74947	167835	110458	99065
Dolphin Group ASA	0	0	361145	18585	841	1117	13289	0
Enitel ASA	0	3353	62651	1055189	0	0	0	0
Evercom Network ASA	0	0	10611	1338	1864	20	0	0
Exense ASA	0	0	0	0	0	188	0	794
Faktor Eiendom ASA	874435	418485	323848	595040	68429	11458	10005	4853
Fesil ASA	0	434315	50240	0	0	0	0	0
Frontier Drilling ASA	0	0	0	0	113731	126553	19405	2131
Hjellegjerde ASA	24600	19748	0	0	0	2542	1231	1189
IMSK SE	0	0	85733	1169931	20189	35778	33745	19899
Infostream ASA	32744	4000	10980	43527	7	1	42	3684
Intellinet ASA	0	0	25093	0	0	0	166	953
Invivosense ASA	0	0	0	0	0	0	17	0
Linde-Group ASA	5184	12089	24647	64935	3241	967	0	0
Noral ASA	54834	2993	5618	43574	1477	1306	1143	0
Nordic Water Supply ASA	6069	54246	0	5277	0	0	380	301
Norse Energy Corp. ASA	113391	64094	1085424	130238	33059	6852	34418	6110
Norske Skogindustrier ASA	1214750	0	0	0	198526	184726	113810	67637
Petrojack ASA	3701	0	365963	0	0	33689	70343	98860
Petromena ASA	0	113615	320617	3303851	0	38650	66257	189110
Reservoir Expl. Tech. ASA	0	611022	0	0	0	0	0	0
Scan Geophysical ASA	1315	19618	16555	0	0	0	0	6461
Tandberg Data ASA	22472	0	399448	226269	25	18	14334	13616
Tandberg Storage ASA	35614	0	0	5262080	72	0	718	1320
Telecast ASA	0	38082	14174	38283	0	0	0	0
Tordenskjold ASA	0	0	0	77787	159	929	1137	2591

Table A24: *Yearly Interest Bearing Debt & Interest Expenses in NOK 1000*

Company	Interest Expenses				Interest Bearing Debt			
	t-3	*t-2*	*t-1*	*t*	*t-3*	*t-2*	*t-1*	*t*
Ability Drilling ASA	0	0	0	0	0	0	0	435469
Alvern ASA	0	0	3199	1167	0	60027	115077	99984
Cecon ASA	18373	34016	21337	31069	229911	140908	119590	31341
Cellcura ASA	746	2309	660	3053	12103	12400	14489	15870
Choice Hotels Scandinavia ASA	0	0	0	3	0	0	0	0
Conseptor ASA	1022	0	0	0	239320	298420	264781	303145
Customax ASA	0	506	2323	0	0	1102	29891	56349
Dolphin Drilling ASA	259526	557165	414103	399632	11172341	10946146	9428964	9237047
Dolphin Group ASA	2096	3906	45460	0	16019	394649	819373	1406844
Enitel ASA	0	0	0	0	0	0	0	2403637
Evercom Network ASA	868	70	0	0	941	0	0	0
Exense ASA	0	586	0	2535	16218	9038	0	15329
Faktor Eiendom ASA	14867	33722	32077	15758	10561	364387	416602	113494
Fesil ASA	0	0	0	0	265807	80697	122046	0
Frontier Drilling ASA	347383	368408	62330	7255	6273668	3761396	824116	106499
Hjellegjerde ASA	0	7821	4190	4302	113432	110566	124613	133525
IMSK SE	54000	86000	97002	75776	465000	405000	405000	611489
Infostream ASA	26	4	151	12541	135725	129806	134984	183694
Intellinet ASA	0	0	565	3192	8920	8920	15724	34476
Invivosense ASA	0	0	55	0	1000	1000	800	600
Linde-Group ASA	8983	3214	0	0	98839	95679	45225	42130
Noral ASA	4385	3783	3856	0	66771	37717	95766	64937
Nordic Water Supply ASA	0	0	1269	1044	14363	14363	26679	24484
Norse Energy Corp. ASA	79480	24473	30108	19791	550254	0	21241	138804
Norske Skogindustrier ASA	609000	581000	389000	247000	11316000	9667000	6933000	1943000
Petrojack ASA	0	105603	216806	300016	0	1710786	2041797	1221532
Petromena ASA	0	121092	217071	482798	0	1954049	3545260	871395
Reservoir Expl. Tech. ASA	0	0	0	0	413355	878114	17858	459295
Scan Geophysical ASA	0	0	0	21810	0	0	229672	270731
Tandberg Data ASA	90	64	13126	39995	0	10850	9694	133412
Tandberg Storage ASA	209	0	2352	4713	2742	0	38079	0
Telecast ASA	0	0	0	0	0	1078	5411	22439
Tordenskjold ASA	550	2871	3864	8458	52075	41769	111502	64690

Furthermore, Table A24 presents the yearly interest bearing debt and interest expenses over the four periods, to show the input used to calculate the tax shield. Furthermore, the corporate tax rates were ranging from 24% to 28% for the two decades we were looking at in our thesis. From Table A24 we see the missing values for interest bearing debt and interest expenses. As mentioned previously this could be due to the firms being insolvent and unable to fulfill their obligations, or avoid reporting the exact amounts. Furthermore, these missing values could be due to risk aversion. Companies that are risk-averse or have low tolerance for financial risk may avoid interest-bearing debt as it introduces interest payment obligations, which could lead to distress during downturns. Furthermore, if a company is not profitable or has limited tax liability, the benefit of tax shields might not outweigh the costs of debt, resulting in a company avoiding interest-bearing debt.