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Do IFRS Promote Transparency? Evidence from the Bankruptcy Prediction of Privately Held Swedish and Norwegian Companies

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Abstract: The purpose of our paper is to investigate whether any differences between International Financial Reporting Standards (IFRS) and local Generally Accepted Accounting Principles (GAAP) impact the transparency of financial reporting of non-listed companies through bankruptcy prediction. This contributes to extant research that has focused on the effects of IFRS adoption in the context of listed companies. For our investigation, we used logistic regression, well-established accounting-based predictors, and a sample of financial statements from privately held Swedish companies using IFRS, and Norwegian companies using Norwegian GAAP. The results indicate that financial statements made under IFRS may be better suited for bankruptcy prediction than those made under Norwegian GAAP. Our findings suggest that the use of IFRS could aid in increasing the informativeness of financial reports by promoting transparency and prevent managers of firms facing insolvency from engaging in creative accounting practices. Our results should, however, be applied with caution, as they may be due to the differences in characteristics across firms that are not captured by our research design. We leave this issue open to future research.

Keywords: IFRS; accounting standards and principles; bankruptcy prediction; transparency; privately held companies; Norwegian GAAP; logistic regression; accounting-based predictors



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1. Introduction

Predicting company bankruptcy is at the core of credit risk management and thus important for academics, regulators and practitioners (Bărbuță-Misu and Madaleno 2020). Since the input variables of models used for bankruptcy predicting often are derived from financial statements, it is important that these are transparent. International Financial Reporting Standards (IFRS) are widely used for financial reporting and promote cross-country comparability and more transparency than local Generally Accepted Accounting Principles (GAAP) through the use of fair values and more disclosure requirements (Diamond and Verrecchia 1991; Levitt 1998; Botosan and Plumlee 2002; International Standards Accounting Board 2002; Lambert et al. 2007; George et al. 2016; Fossung et al. 2020). Thus, the use of IFRS can prevent managers from engaging in creative accounting practices in order to mask the credit risk of their companies (Bhat et al. 2014; Bodle et al. 2016). All of this should make financial statements based on IFRS more relevant to stakeholders than those based on local GAAP. In this paper, we evaluate this by investigating whether the use of IFRS relative to local GAAP improves the transparency of financial reporting through bankruptcy prediction.

A financial report presents the financial position and performance of a company. When preparing a financial report, the choice of accounting regulations is of great importance, since different regulations yield different accounting figures, resulting in varied perceptions of a company. For example, the 110 companies listed on the Oslo Stock Exchange in 2005 experienced a 17% increase in net income on average, after restating their 2004 financial

statements from the Norwegian GAAP (NGAAP) to IFRS, which [Gjerde et al. \(2008\)](#) argue is mainly due to differences in accounting for goodwill and intangible assets under the two sets of regulations. First, development expenditures are recognized as intangible assets under IFRS, while NGAAP provide a widely used option to expense them immediately. Second, goodwill is subject to amortization under NGAAP, while IFRS require that it be tested annually for impairment. Third, expenditure on brands is recognized as an intangible asset under NGAAP but not under IFRS ([Norwegian Accounting Standards Board 2012](#); [Picker et al. 2016](#); [Bodle et al. 2016](#); [IFRS Foundation 2021](#)). Given these differences, we expect that the use of IFRS will lead to a change in transparency and thus the assessment of bankruptcy prediction, especially when using accounting-based variables.

We used a comprehensive sample of 2,290,551 annual financial statements from privately held Swedish and Norwegian companies based on IFRS and NGAAP, respectively, spanning the time period of 2006–2018. Furthermore, we predicted company bankruptcy using logistic regression (LR) and the input variables from [Altman \(1968\)](#) and the SEBRA model developed by the central bank of Norway. Our findings suggest that financial statements based on IFRS yield better bankruptcy prediction models, compared to those based on NGAAP, both in terms of in-sample fit and out-of-sample performance.

We contribute to the literature in the following ways. First, our study focuses on the role of accounting standards in bankruptcy prediction—an area which to the best of our knowledge has not been researched extensively. Second, our study is among the few that focus on the benefits of IFRS for creditors while the majority of the existing literature has investigated the effects of IFRS adoption on equity markets, cost of capital, cross country comparability and corporate investment efficiency ([George et al. 2016](#)). Third, to the best of our knowledge, we are the first to investigate whether the alleged benefits of IFRS also apply to bankruptcy prediction in the Scandinavian market. Our choice of market thus differs from most studies on bankruptcy prediction, which have used data from the United States of America ([Appiah et al. 2015](#); [Bodle et al. 2016](#)). A study related to ours is that of [Bodle et al. \(2016\)](#), which found that financial reporting under IFRS yields better capabilities in terms of bankruptcy prediction models, compared to financial reporting under Australian GAAP. However, the authors used only listed companies, which is, indeed, the convention in the bankruptcy prediction literature ([Appiah et al. 2015](#)). By contrast, our analysis of medium- and large-sized privately held Swedish companies is particularly relevant, as such companies can choose to prepare their consolidated financial statements under IFRS. Consequently, IFRS have considerable legitimacy in Sweden ([IFRS Foundation 2016](#); [Marton 2017](#)).

The rest of this paper is structured as follows. Section 2 reviews the literature on IFRS and their impact on value relevance, forecasting accuracy, credit ratings, and bankruptcy prediction. Section 3 describes the data and sampling choices, and Section 4 describes the research method. The results are presented and discussed in Section 5. Finally, the conclusions are given in Section 6.

2. Literature Review

We review the literature on the impact of IFRS on (i) value relevance, (ii) forecasting accuracy, and (iii) credit ratings and bankruptcy prediction. All of these areas can be regarded as providing evidence on the transparency of financial reporting ([Singleton-Green 2015](#)).

2.1. IFRS and Value Relevance

Financial reports are value relevant if their accounting numbers are correlated with stock market prices. Thus, if the economic reality is reflected in market prices, then value relevant financial reports are transparent, as their accounting numbers will reflect the economic reality. This also results in other benefits, such as an increased comparability of financial reports and improved efficiency of capital markets ([George et al. 2016](#)).

Studies have reported that using IFRS rather than local GAAP leads to an increased value relevance of financial reports ([Bartov et al. 2005](#); [Singleton-Green 2015](#)). For instance,

Barth et al. (2008) found that adopting International Accounting Standards (IAS) yields more value relevant financial reports in a sample of 327 adopters and non-adopters across 21 countries in the time period of 1992–2009.¹ Moreover, Horten and Serafeim (2010) suggested that financial reports under IFRS promote more value relevance through the credible communication of bad news, compared to financial reports under UK GAAP.

On the contrary, several studies found a weak relationship or no relationship between IFRS and value relevance. For instance, Hung and Subramanyam (2007) studied a sample of 80 German companies that adopted IAS during the time period of 1998–2002 and found that accounting standards did not have a major impact on value relevance. They found only weak evidence of a higher timeliness of IAS income, compared to local GAAP income, and that IAS adjustments were value relevant for the book value of equity, but not for net income. Furthermore, Oliveira et al. (2010) studied 32 Portuguese companies over the time period of 1998–2008 and found that using IFRS, instead of local GAAP, yields a lower value relevance of earnings, no change in the value relevance of the book value of equity and intangibles, and a higher value relevance of goodwill. In a similar vein, Christiansen et al. (2015) and Günther et al. (2009) found no change in value relevance when using IFRS, instead of German GAAP. Moreover, Ates (2021) used a sample of listed companies from 11 European Union countries and found that the use of IFRS led to increased value relevance of earnings per share and no significant impact on the value relevance of book value per share.

Some studies have found that the value relevance of intangibles is lower when using IFRS. For instance, a study by Cordazzo and Rossi (2020) based on a sample of non-financial listed Italian firms from 2000 to 2015 found that intangibles as a whole were not value relevant under IFRS, except for goodwill and research and development expenditures. However, when they divided the sample into intangible-intensive or non-intangible-intensive firms, the value relevance of research and development expenditures fell after the IFRS adoption. In a similar vein, a study by Paolone et al. (2020) based on a sample of Italian listed firms in the period 2010–2018 found that intangibles such as goodwill and research and development expenditures were positively related to stock prices. By contrast, Güleç (2021) claimed no change in the value relevance of research and development expenditures under IFRS.

In summary, there is a lack of consensus on whether using IFRS, instead of local GAAP, affects the value relevance of financial reports. Moreover, the different findings in the above-mentioned studies reflect the differences in the markets and time periods covered. The differences in findings could also be due to any changes in the accounting standards and principles over time.

2.2. IFRS and Forecasting Accuracy

Tan et al. (2011) and Choi et al. (2013) found that financial analysts' earnings forecasts were more accurate when based on financial reports under IFRS, compared to financial reports under UK GAAP for mandatory UK IFRS adopters in the period of 2003–2007. Furthermore, Wang et al. (2008) examined the effects of mandatory IFRS adoption in 2005 for a sample of 1438 firms in 17 European countries during the period of 2005–2006. They found significantly more accurate financial analysts' earnings forecasts for the post-IFRS adoption period than for the pre-IFRS adoption period. However, this finding was not so obvious when the authors divided the countries into legal origin groups. In particular, they found more accurate financial analysts' earnings forecasts for the French legal origin group but no significant change in accuracy for the German legal origin group. Byard et al. (2010) found that financial analysts' earnings forecasts were more accurate and less dispersed when using accounting numbers based on IFRS for 1168 mandatory adopters in 20 European countries for the time period of 2005–2006. However, this applied

¹ IAS are related to IFRS to a high degree. The IAS were published by the International Accounting Standards Committee (IASC) between 1973 and 2000. In 2000, IASC restructured itself into the International Accounting Standards Board (IASB), adopted all the IAS standards, and named the future standards IFRS (IFRS Foundation 2020).

only to IFRS adopters domiciled in countries with both strong enforcement regimes and significantly different reporting practices under local GAAP, compared to IFRS. Further, [Kwon et al. \(2019\)](#) found that the use of IFRS led to more accurate earnings forecasts for a sample of firms listed on the Korean Stock Exchange. In a similar vein, [Masoud \(2017\)](#) investigated 66 companies listed on the Amman Stock Exchange and found that earnings forecasts were more accurate under IFRS. Hence, it appears that using IFRS results in better earnings forecast accuracy.

2.3. IFRS, Credit Ratings, and Bankruptcy Prediction

[Bodile et al. \(2016\)](#) used a sample of 46 listed Australian companies that went bankrupt in the period of 1991–2004 and found that the accounting numbers based on IFRS predicted bankruptcy better than those based on Australian GAAP due to the increased transparency and conservative accounting rules for intangibles under IFRS. This is consistent with [Florou and Kosi \(2015\)](#), who found lower bond yield spreads for companies using IFRS, and [Florou et al. \(2017\)](#), who found that the accounting numbers of listed companies explained credit ratings better after the introduction of mandatory IFRS reporting in 2005. Furthermore, [Charitou et al. \(2015\)](#) found that IFRS were beneficial to the market, as companies with a higher default risk exhibited deteriorating characteristics after they started using IFRS. In addition, [Wu and Zhang \(2014\)](#) documented a significant increase in the sensitivity of credit ratings with the adoption of IFRS. On the other hand, [Kraft and Landsman \(2020\)](#) found no clear evidence of the credit relevance of accounting numbers after mandatorily switching to IFRS. Similarly, [Bhat et al. \(2014\)](#) found that adopting IFRS yields no change in the ability of earnings, the book value of equity, and the leverage to explain credit risk prices.

3. Data

It is difficult to obtain enough financial reports for model estimation and evaluation from the same companies and same accounting years based on IFRS and local GAAP separately as most companies make financial statements for an accounting year under a single set of accounting standards. Consequently, we consider two similar Scandinavian countries by including annual financial statements of (i) Swedish companies made under IFRS, retrieved through the Orbis database, and (ii) Norwegian companies made under NGAAP, provided by the Norwegian governmental agency, Brønnøysund Register Centre.² By using accounting data from the two countries, we obtain enough financial statements to compare the results of using local GAAP and IFRS, within the same accounting years. Thus, we eliminate any time period effects. However, as national cultures can impact accounting measurements and financial reporting practices, our results could potentially be affected by cross-country differences ([Kanagaretnam et al. 2014](#)). [Guermazi and Halioui \(2020\)](#) found that individualism and uncertainty avoidance are two important dimensions of national culture that influence behavior in terms of the implementation of accounting standards. Norway scores 69 and 50, whereas Sweden scores 71 and 29 for these dimensions, respectively. The scores for individualism are almost similar, meaning that both nations are characterized by an individualistic culture. The scores differ, however, in terms of uncertainty avoidance. The score of 50 for Norway does not indicate any preference for avoiding uncertainty, while the score of 29 for Sweden indicates a very low preference ([Hofstede Insights 2020](#)). Overall, it appears that both countries are similar in terms of cultural dimensions that could impact the accounting practice. Hence, we assume that any effects due to cross-country differences in our data can be deemed negligible. Moreover, the local GAAP of Norway and Sweden are also very similar to each other in practice ([Kristoffersen 2020](#)).

We include financial statements of privately held limited liability companies, spanning over the time period of 2006–2018. Furthermore, we include only financial statements of

² Restrictions apply to the availability of these data. The web pages for the data providers are www.orbis.bvdinfo.com and www.brreg.no, respectively.

medium- or large-sized companies, which we define in accordance with the Orbis database as those with a turnover above EUR 1 million or total assets above EUR 2 million.³ Following the common convention in the literature, we exclude all financial statements operating in the banking, real estate, and public utility sectors (Mansi et al. 2012). Further, we exclude financial statements that have missing values for any of the accounting indicators used for deriving our input variables.⁴ In accordance with the central bank of Norway, we categorize financial statements as bankrupt if they are the last of their company to which they belong, and the company has filed for bankruptcy (Bernhardsen and Larsen 2007). All other financial statements are categorized as non-bankrupt. Our final data sample consists of 1,892,294 financial statements using NGAAP, of which 1.8% are categorized as bankrupt, and 347,159 financial statements using IFRS, of which 1.5% are categorized as bankrupt.

In keeping with the recent bankruptcy prediction literature (e.g., Tian et al. 2015), we chose to use the real population of observations and to refrain from performing any matching in order to achieve a balanced dataset with an equal number of bankrupt and non-bankrupt financial statements. This is in line with Zmijewski (1984), who argued that the capability of a bankruptcy prediction model is distorted if it is estimated using a constructed dataset with a ratio of bankrupt to non-bankrupt observations that deviates from the real population.

The Input Variables

Since we are studying the effects of accounting standards, we use accounting-based input variables. Our initial set of variables is taken from the bankruptcy prediction model of Altman (1968) and the SEBRA model for bankruptcy prediction developed by the central bank of Norway. The former has been proven to perform well across different country settings (Altman et al. 2017) and is widely used by practitioners and academics (Begley et al. 1996; Grice and Ingram 2001; Mansi et al. 2012; Appiah et al. 2015; Tian et al. 2015; Bodle et al. 2016; Tian and Yu 2017). The latter is developed for Norwegian companies and is used by the Financial Supervisory Authority of Norway (Bernhardsen and Larsen 2007). Paraschiv et al. (2021) proved empirically that the variables of the SEBRA model yield good predictions when used with recent financial statements from privately held companies. Our initial set of variables is shown in Table 1 and measures liquidity, profitability, leverage, solvency, and company size. We do not consider the variable measuring activity which is present in the model of Altman (1968) as it has been found to be insignificant and industry sensitive (Altman 1968, 1993). Furthermore, this is also consistent with Vo et al. (2019) and Ntounis et al. (2020) who also predicted bankruptcy with the accounting-based variables of Altman (1968) but without the variable measuring activity.

Altman (1968) used the market value of equity in the numerator of the variable, BVEQ/TL. Instead, we follow the revised model of Altman (1993), using the book value of equity. This is in accordance with the claim that book–debt ratios are better than market–debt ratios, as debt issued against the latter can distort future investment decisions, which is due to the fact that market values incorporate present values of future growth opportunities (Moyer 1977; Shyam-Sunder and Myers 1999). Further, as the book value of equity is not directly available in the Orbis database, we calculate it by subtracting total liabilities from total assets. Moreover, as retained earnings are not commonly reported by privately held companies in the Orbis database, we use “Other shareholder funds” as a proxy. This item also includes profits for the fiscal year, treasury reserves, voluntary provisions, and other minority interests (Orbis 2007). However, this is deemed acceptable, as all of these items reflect the company’s savings (Fan and Kalemli-Ozcan 2015).

³ The Orbis database also uses the number of employees for defining size. We, however, do not rely on this, as it is not available for all our data.

⁴ This constitutes 0.5% of the financial statements in our remaining data set.

Table 1. The initial set of input variables used in this paper. The first four are taken from Altman (1968) with the book value of equity in the variable BVEQ/TL, as suggested by Altman (1993). The remaining are taken from the SEBRA model developed by the central bank of Norway (Bernhardsen and Larsen 2007).

Variable	Category	Description
WC/TA	Liquidity	Working capital to total assets
RE/TA	Leverage	Retained earnings to total assets
EBIT/TA	Profitability	Earnings before interest and taxes to total assets
BVEQ/TL	Solvency	Book value of equity to total liabilities
BVEQ/TA	Leverage	Book value of equity to total assets
dEQ	Solvency	Dummy: one if book value of equity is less than paid in capital
LIQ/REV	Liquidity	Cash and cash equivalents less current liabilities to operating revenue
logTA	Size	The natural logarithm of total assets in EUR
PA/TA	Liquidity	Trade payables to total assets

Following the existing literature,⁵ we restrict the values of the non-dummy input variables between the 5th and 95th percentiles across the financial statements based on IFRS and NGAAP, respectively, for each accounting year. If the denominator of a ratio variable is zero and its numerator is positive (negative) then the variable value is set to the maximum (minimum), i.e., the 95th (5th) percentile. If both the numerator and denominator are zero, the variable value is set to zero.

To avoid multicollinearity, we exclude several input variables from our initial set in Table 1. The exclusions are based on the Pearson correlation coefficient between the pairs of input variables and the variance inflation factor for each input variable i calculated as:

$$VIF_i = \frac{1}{1 - R_{OLS}^2} \quad (1)$$

where R_{OLS}^2 is the coefficient of determination of an ordinary least squares (OLS) model with variable i as the regressand and the remaining variables as regressors. VIF_i can take any value above one, where the lower the VIF_i the lower the multicollinearity (Gareth et al. 2017). We recalculate the VIF_i values each time a variable is excluded from our variable set.

We find that the input variables RE/TA, BVEQ/TL, BVEQ/TA and LIQ/REV are highly correlated with each other, especially for the financial statements based on IFRS, resulting in very high VIF_i values of above 100. To ensure that leverage is measured by the final variable set, we select only BVEQ/TA from these four variables. Next, we exclude logTA as it has a high VIF_i value even though it is not highly correlated with any other single variable. In the remaining variable set, we have two variables measuring liquidity. Among these, we exclude WC/TA as it has the highest VIF_i value and is highly correlated with BVEQ/TA while the other liquidity variable, PA/TA, is only weakly correlated with any other variable.

Tables 2 and 3 show the VIF_i values for each variable in the final variable set when using the financial statements based on IFRS and NGAAP, respectively, as well as the correlations between the pairs of variables. We observe no evidence of unacceptable multicollinearity for the final variable set.

⁵ e.g., Campbell et al. (2008) and Gupta et al. (2018).

Table 2. The variance inflation factor (VIF_i) values for each variable in the final set and the correlations between the pairs of variables when using the financial statements based on International Financial Reporting Standards (IFRS). The description of the variables is provided in Table 1.

Variable	VIF_i	EBIT/TA	BVEQ/TA	dEQ
EBIT/TA	1.66			
BVEQ/TA	1.77	0.23		
dEQ	1.07	−0.18	−0.25	
PA/TA	1.44	−0.05	−0.39	0.13

Table 3. The variance inflation factor (VIF_i) values for each variable in the final set and the correlations between any pairs of variables when using the financial statements based on Norwegian Generally Accepted Accounting Principles (NGAAP). The description of the variables is provided in Table 1.

Variable	VIF_i	EBIT/TA	BVEQ/TA	dEQ
EBIT/TA	1.27			
BVEQ/TA	1.22	0.32		
dEQ	1.37	−0.45	−0.57	
PA/TA	1.32	−0.20	−0.41	0.23

4. Methodology

Earlier bankruptcy prediction studies used a linear discriminant analysis to derive their models.⁶ However, there are several issues with using this method in economics and finance, including its assumption of a multivariate normal distribution of the input variables and equal variance–covariance matrices across the groups of classes (Joy and Tollefson 1975; Deakin 1976; Eisenbeis 1977). Consequently, LR was introduced for bankruptcy prediction by Ohlson (1980). The benefits of using LR are that it requires less restrictive assumptions and gives more intuitive outputs.⁷

Let the vector $\hat{y} = \{\hat{y}_n\}_{n=1 \dots N} \in [0, 1]^N$ determine the predicted probabilities of bankruptcy given by:

$$\hat{y} = \iota \odot (\iota + \exp(-X\beta - \iota\beta_0)) \quad (2)$$

where $X = \{x_{(n,i)}\}_{n=1 \dots N, i=1 \dots I}$ is a matrix of values for the input variables and i , derived from the financial statements, n , $\beta = \{\beta_i\}_{i=1 \dots I}$ and β_0 are the model coefficients, \odot denotes the Hadamard (elementwise) division, and ι is an $N \times 1$ vector of ones.

The coefficients are estimated by maximizing the likelihood function given by:

$$\prod_{n=1}^N (\hat{y}_n)^{y_n} (1 - \hat{y}_n)^{1-y_n} \quad (3)$$

where $y = \{y_n\}_{n=1 \dots N} \in \{0, 1\}^N$ is the vector of actual classifications of bankrupt (1) or non-bankrupt (0) for the financial statements n . In practice, instead of maximizing the likelihood function, we minimize the negative of the log likelihood function given by:

$$\ell(\beta, \beta_0) = \sum_{n=1}^N [y \odot (X\beta + \iota\beta_0) - \log(\iota + \exp(X\beta + \iota\beta_0))] \quad (4)$$

⁶ e.g., Altman (1968); Meyer and Pifer (1970); Deakin (1972); Wilcox (1973); Blum (1974); Libby (1975); Altman and Loris (1976); Ketz (1978); and Pettway and Sinkey (1980).

⁷ When predicting bankruptcy using LR, where bankruptcy is labeled 1, the frequency of bankruptcies in the training data, i.e., the data used for estimating the coefficients, will always correspond to the average of the outputs from the trained LR model across all observations in the training data. Consequently, the output of the LR bankruptcy prediction model for any specific observation can be interpreted as the probability of bankruptcy.

where \odot denotes the Hadamard (element-wise) product. The minimization is conducted by following an iterative optimization algorithm.⁸

We predict bankruptcy in a one-year horizon, which corresponds with the practice of most practitioners and academics (Hillegeist et al. 2004; Tian et al. 2015; Tian and Yu 2017). Indeed, Appiah et al. (2015) found that one-year data were most often considered among all the bankruptcy prediction studies they reviewed and that such studies achieved remarkable results. Further, several studies on bankruptcy prediction have shown that the best prediction was made when the forecasting horizon was one year or shorter.⁹ By using a one-year time horizon, we comply with the Basel III regulatory framework, which states that the probability of default for bank and corporate exposures is the prediction of a one-year-ahead probability of default (Bank of International Settlements 2017).

We use an eight-fold cross-validation procedure with forward validation and a rolling window to divide the sample into eight subsamples, as illustrated in Table 4 (Kaastra and Boyd 1996; Keles et al. 2016).¹⁰ For each of the eight subsamples, we evaluate the out-of-sample performance using test data consisting of all financial statements from one of the accounting years during the period of 2011–2018. We name the subsamples in accordance with the year used for measuring out-of-sample performance. Furthermore, we train the model, i.e., estimate the coefficients β and β_0 , and evaluate the in-sample fit separately for each subsample using training data consisting of all financial statements from the five previous years. The procedure is carried out separately for all financial statements based on IFRS and local GAAP.

Table 4. For each of the eight subsamples, we separately train the model and evaluate the in-sample fit using training data consisting of all financial statements from five subsequent accounting years, which are given in green. We further evaluate the out-of-sample performance using test data consisting of all financial statements from the following accounting year, which are given in blue.

Subsample	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2011													
2012													
2013													
2014													
2015													
2016													
2017													
2018													

Table 5 shows the number of financial statements based on IFRS and local GAAP within the training and test data for each of the eight subsamples. It also shows the fractions of financial statements categorized as bankrupt. We restrict the values of the input variables between the 5th and 95th percentiles as explained in Section 3 across financial statements based on IFRS and NGAAP, respectively, for each accounting year.

We evaluate the model performance using the area under the receiver operating characteristic curve (AUC), which is a widely used metric for evaluating bankruptcy prediction models.¹¹ The receiver operating characteristic curve is a plot of the false positive rate against the true positive rate at different thresholds for defining the predicted class that an observation belongs to (Fawcett 2006; Hosmer et al. 2013). The AUC can, in practice, have any value between 0.5 and 1, where a higher value indicates a higher

⁸ For minimization, we use the L-BFGS-B algorithm (Byrd et al. 1995; Zhu et al. 1997). Further, we use zero as the initial value for all coefficients β and β_0 for the algorithm.

⁹ e.g., Altman (1968); Blum (1974); Altman et al. (1977); Moyer (1977); Ohlson (1980); Aziz et al. (1988); Altman et al. (1994, 1995); Dimitras et al. (1999); Tian et al. (2015); and Tian and Yu (2017).

¹⁰ Our results are robust to using an expanding window for enabling the utilization of all previous data when training models. Results are available upon request.

¹¹ e.g., Duffie et al. (2007); Altman et al. (2010); Tian et al. (2015); Tian and Yu (2017); and Gupta et al. (2018).

explanatory power.¹² As a rule of thumb, an AUC between 0.7 and 0.8 is considered acceptable, while a value above 0.8 is considered excellent (Hosmer et al. 2013). When comparing different prediction models, the AUC has been found to be superior to other statistics, as it takes into account both error costs and class skewness within the data (Huang and Ling 2005).

Table 5. Number of financial statements within the training and test data for each subsample, based on International Financial Reporting Standards (IFRS) and Norwegian Generally Accepted Accounting Principles (NGAAP), respectively. The fractions of financial statements categorized as bankrupt are shown below each number.

Subsample	2011	2012	2013	2014	2015	2016	2017	2018
IFRS								
Training data	35,772	69,046	104,801	141,986	180,936	200,151	215,406	231,768
Bankrupt	3.3%	2.7%	2.4%	2.0%	1.6%	1.4%	1.2%	1.1%
Test data	34,803	37,727	39,564	41,932	46,125	50,058	54,089	58,187
Bankrupt	1.9%	1.8%	1.4%	0.9%	1.0%	1.1%	1.1%	1.1%
GAAP								
Training data	620,395	634,431	650,756	672,262	702,234	738,792	778,695	818,318
Bankrupt	2.0%	2.0%	1.8%	1.8%	1.7%	1.7%	1.7%	1.7%
Test data	128,715	136,584	145,556	153,781	161,706	167,824	175,798	181,244
Bankrupt	1.7%	1.8%	1.8%	1.7%	1.6%	1.8%	1.6%	1.3%

We also measure in-sample fit using the pseudo-R squared (R^2) of McFadden (1974), which is given as:

$$R^2 = 1 - \frac{\ell(\beta, \beta_0)}{\ell(\beta_0)} \in [0, 1] \quad (5)$$

where $\ell(\beta_0)$ is the log likelihood of the null model, which does not contain any independent variables, but only the intercept coefficient β_0 .

To determine the significance of the estimated coefficients, we use Wald statistics to assess the z-score of any coefficient of any input variable.¹³ This is given for input variable i by:

$$z_i = \frac{\beta_i}{s_{\beta_i}} \quad (6)$$

where the denominator is the standard deviation of the numerator, which is given as $s_{\beta_i} = \sqrt{C_{i,i}}$, where $C = \{C_{j,k}\}_{j=1,\dots,N,k=1,\dots,N}$ is the variance covariance matrix, given as $(X'DX)^{-1}$, and $D = \{d_{j,k}\}_{j=1,\dots,N,k=1,\dots,N}$ is a diagonal matrix with $d_{i,i} = \hat{y}_i(1 - \hat{y}_i)$.

5. Results and Discussions

Tables 6 and 7 show the estimated coefficient values and model evaluations across the eight subsamples for the accounting years of 2011–2018, when considering the financial statements based on IFRS and NGAAP, respectively. The values in parentheses are the z-scores. The in-sample fit is evaluated by R^2 and AUC, while the out-of-sample performance is evaluated using AUC.

¹² In theory, AUC can have a value below 0.5 which represents an unrealistic model.

¹³ The reader is referred to page 330 in Ryan (2018) and page 40 in Hosmer et al. (2013) for details on Wald statistics.

Table 6. Results across the eight subsamples for the accounting years of 2011–2018, when considering the financial statements based on International Financial Reporting Standards (IFRS). We show the estimated coefficient values of the logistic regression (LR) model, with the z-scores in parentheses. The input variables are detailed in Table 1. We report the in-sample fit using R^2 and area under the receiver operating characteristic curve (AUC) and the out-of-sample performance using AUC.

Variable/Metric	2011	2012	2013	2014	2015	2016	2017	2018
constant	−2.75 (−89.98)	−2.89 (−117.53)	−3.05 (−144.18)	−3.18 (−161.81)	−3.51 (−179.37)	−3.63 (−183.18)	−3.72 (−184.4)	−3.81 (−186.99)
EBIT/TA	−2.56 (−11.51)	−2.75 (−14.46)	−2.67 (−15.87)	−2.58 (−15.83)	−2.73 (−15.92)	−2.52 (−14.71)	−2.35 (−13.77)	−2.17 (−12.96)
BVEQ/TA	−3.84 (−27.29)	−4.17 (−37.02)	−4.32 (−44.30)	−4.78 (−50.18)	−4.54 (−49.01)	−4.60 (−49.13)	−4.51 (−48.38)	−4.32 (−47.48)
dEQ	0.53 (8.58)	0.74 (14.94)	0.87 (20.62)	0.97 (25.22)	1.05 (27.39)	1.11 (29.00)	1.12 (27.95)	1.12 (26.96)
PA/TA	1.39 (13.40)	1.80 (20.70)	2.29 (30.32)	2.60 (36.87)	2.94 (41.77)	3.00 (41.79)	2.91 (39.01)	2.78 (36.25)
R^2	0.19	0.22	0.23	0.24	0.22	0.22	0.22	0.20
In-sample AUC	0.80	0.82	0.83	0.84	0.84	0.84	0.83	0.82
Out-of-sample AUC	0.84	0.84	0.85	0.83	0.83	0.81	0.80	0.82

Table 7. Results across the eight subsamples for the accounting years of 2011–2018, when considering the financial statements based on Norwegian Generally Accepted Accounting Principles (NGAAP). We show the estimated coefficient values of the logistic regression (LR) model, with the z-scores in parentheses. The input variables are detailed in Table 1. We report the in-sample fit using R^2 and area under the receiver operating characteristic curve (AUC) and the out-of-sample performance using AUC.

Variable/Metric	2011	2012	2013	2014	2015	2016	2017	2018
Constant	−4.89 (−522.56)	−4.93 (−528.47)	−4.98 (−522.25)	−4.95 (−518.98)	−4.91 (−531.88)	−4.93 (−543.10)	−4.88 (−552.90)	−4.84 (−559.44)
EBIT/TA	−1.21 (−40.20)	−1.16 (−38.68)	−1.11 (−36.64)	−1.07 (−34.21)	−1.03 (−34.08)	−0.88 (−30.33)	−0.86 (−31.68)	−0.80 (−30.80)
BVEQ/TA	−0.89 (−38.44)	−0.85 (−37.41)	−0.89 (−39.53)	−0.94 (−42.57)	−0.92 (−44.17)	−0.83 (−41.86)	−0.81 (−44.24)	−0.84 (−49.19)
dEQ	1.11 (102.57)	1.12 (103.42)	1.07 (96.73)	0.98 (87.60)	0.93 (85.33)	0.93 (86.65)	0.87 (82.60)	0.81 (77.60)
PA/TA	2.61 (93.90)	2.76 (98.63)	2.79 (97.55)	2.83 (99.07)	2.95 (107.14)	3.00 (109.81)	2.95 (110.33)	2.86 (108.58)
R^2	0.22	0.23	0.22	0.21	0.20	0.19	0.18	0.17
In-sample AUC	0.83	0.83	0.83	0.82	0.81	0.81	0.80	0.80
Out-of-sample AUC	0.83	0.82	0.81	0.78	0.79	0.80	0.80	0.82

We observe that the values of R^2 , in-sample AUC, and out-of-sample AUC are mostly higher for the financial statements based on IFRS, compared to those based on NGAAP.¹⁴ This could be attributed to the increased transparency under IFRS, which prevents managers from using creative accounting practices to manipulate accounting reports in order to hide their true situation. Our findings also seem consistent with the literature, claiming improvements in financial reporting quality through IFRS adoption. Moreover, the AUC is close to or above 0.8 in all cases, which indicates that the accounting-based input variables in our study can accurately predict bankruptcy. Further, we observe stable coefficient estimates across the years, with high z-scores, indicating that all are significant.

The coefficient estimates for EBIT/TA have negative signs in all cases. This is expected, as higher values of these variables translate to relatively higher earnings and savings and thus a lower probability of going bankrupt. Furthermore, the magnitudes of these coefficients are greater under IFRS than NGAAP. The reason for this may be that NGAAP allow for the amortization of goodwill, while IFRS demand an impairment test, which yields more transparency. Furthermore, IFRS require the classification of development expenditures as intangible assets, whereas NGAAP allow them to be recognized as expenses. This

¹⁴ In this regard it should be noted that models resulting in only slight improvement in AUC scores have been shown to be superior at predicting bankruptcies resulting in potentially huge profit gains for creditors who use such models for credit decisions (Agarwal and Taffler 2008; Paraschiv et al. 2021).

can lead to an understatement of net income under NGAAP, which indicates that IFRS could be better suited to predicting company bankruptcy (Franzen et al. 2007).

The coefficient estimates for BVEQ/TA are negative under both IFRS and NGAAP. This is also in accordance with our expectations as it suggests that a higher rate of equity compared to debt lowers the probability of going bankrupt. However, the magnitudes of the coefficients are greater under IFRS than NGAAP. This may be due to IFRS being more conservative when it comes to accounting for intangibles. For instance, brands cannot be recognized as intangible assets under IFRS (IFRS Foundation 2021) while under NGAAP, they can. Another reason may be that IFRS require the recognition of more liabilities, such as long- and short-term employee benefits, termination benefits, and pension obligations, all of which increase liabilities and salary expenses. This lowers the value of BVEQ as higher expenses decrease retained earnings.

The coefficient estimates for dEQ are positive in all cases, which is logical as it suggests an increase in the probability of going bankrupt if the book value of equity falls below the paid-in equity. The coefficient values are higher under NGAAP than IFRS. This may be due to the lower retained earnings under IFRS as discussed above, which results in companies being worse off when dEQ is equal to one under NGAAP rather than IFRS.

The magnitudes of the coefficients for PA/TA are relatively similar under both NGAAP and IFRS. In all cases the signs are positive, which is as expected since it means that more trade payables increase the probability of going bankrupt.

Limitations and Suggestions for Future Research

Our study has some limitations. First, while we argue that cross country differences can be deemed negligible in our study, our research design does not capture any differences in firm characteristics. Second, it is difficult to obtain enough financial reports for model estimation and evaluation from the same companies and same accounting years reported based on both IFRS and local GAAP, respectively, as most companies make financial statements for any accounting year under a single set of accounting standards. Moreover, very few privately held companies report under IFRS in Norway.

While we analyze the role of IFRS through bankruptcy prediction only with Swedish and Norwegian data, we recommend future research to explore this issue in other markets with local GAAP of other countries. Furthermore, if possible, we recommend investigating the differences between IFRS and local GAAP by considering the same financial reports based on both IFRS and local GAAP separately.

6. Conclusions and Implications

This paper examined the impact of using IFRS on the transparency of financial reporting through bankruptcy prediction models using accounting-based input variables. We started with a set of variables taken from Altman (1968) and the SEBRA model developed by the central bank of Norway. We then excluded variables such that our final variable set showed no evidence of unacceptable multicollinearity. By using logistic regression and a comprehensive sample of privately held Norwegian and Swedish companies, our results indicate that financial reports using IFRS may yield better bankruptcy prediction models compared to financial reports using NGAAP. While our results show that the use of IFRS can help in providing a better picture of a company's financial health, our research design does not capture all differences in firm characteristics. This is due to the difficulties in obtaining the same financial statements of any particular company, derived under both IFRS and local GAAP separately, as most companies, especially private ones, make financial statements for any given accounting year under a single set of accounting standards. Hence, we urge caution while interpreting our results.

Our findings have implications for several stakeholders, as well as for the development and application of accounting. The increased performance of bankruptcy prediction models under IFRS could mean that the strict accounting regulations under IFRS improve transparency, which prevents managers of firms facing insolvency from hiding their com-

pany's true situation by engaging in creative accounting practices or window dressing of the accounts. For example, IAS 38 constrains managers from capitalizing on certain intangible assets such as brands (IFRS Foundation 2021), thereby limiting the opportunity for the overstatement of total assets. Overall, improved transparency under IFRS should aid in providing a clearer picture to investors and creditors who can then make a sound decision on investing or lending funds to companies. For standard setters, our results provide empirical evidence of the benefits of aligning accounting standards towards IFRS, and how abandoning strict accounting practices could impact bankruptcy prediction. While there are several benefits of using IFRS, it may, however, generate extra costs for companies' accounting departments.

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