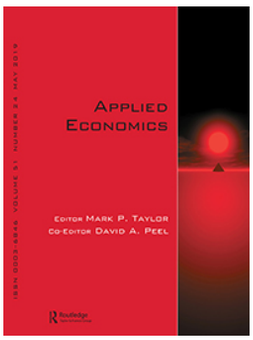

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Corporate governance and default prediction: a reality test

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ABSTRACT

Default prediction has commanded the attention of researchers for at least 50 years. This paper addresses several testable hypotheses regarding the relations between corporate governance and default prediction. We employ the conventional logistic regression to provide empirical evidence from U.S. default data over the period of 2000 to 2015. Empirical results are consistent with the following notions: First, default firms are associated with high ownership concentration, low shareholder rights, low financial transparency and disclosures, and less board effectiveness. Second, in-sample and out-of-sample tests support the incremental contribution of corporate governance information on default prediction, when compared with the models involving just financial information.

KEYWORDS

Corporate governance; default prediction; accounting information; market information

JEL CLASSIFICATION

C01; G21; C34; G34; C87

I. Introduction

Managing and measuring credit risk is a core activity for banks. The key parameter to quantify credit risk is default probability.[1] However, default probability is difficult to estimate because defaults occur relatively infrequently. The difficulty in predicting corporate failure has posed a long-standing problem in credit risk research. The importance of financial information for estimating default probability has been well documented in the literature. Recent studies pay attention to non-financial information, such as corporate governance, and point out non-financial information may improve accuracy of default probability estimation.

Financial information for estimating default probability could be grouped into two categories: accounting information suggested by Altman's (1968) model: and market information involved in Merton's (1974) model. The former seeks to estimate default probability of corporate borrowers based on their accounting-based information (e.g. Beaver 1966; Altman, 1968; Ohlson 1980). The latter predicts corporate failure based on the information of their equity prices (e.g. Vassalou and Xing 2004; Hillegeist et al. 2004; Du and Suo 2007; Bharath and Shumway 2008; Campbell, Hilscher, and Szilagyi 2008). Each type of financial information has limitations. The past performance reported in a firm's accounting reports may not be informative for predicting the future. Moreover, accounting manipulation behaviours by managers may damage financial reporting quality (Agarwal and Taffler 2008). Market information may show up-to-date information about the company which are not yet reflected in the accounting ratios, but only if markets are efficient. Accordingly, recent studies stress the importance of corporate governance and consider it as an alternative non-financial information source for bankruptcy prediction.

Extensive studies document that corporate governance is a key factor for corporate management decisions and thus influences corporate performance. Goktan, Kieschnick, and Moussawi (2006) argue if corporate governance affects company performance, the attributes of corporate governance also ensure the survival of the company. Although some studies have tested the effect of corporate governance on bankruptcy prediction (e.g. Daily and Dalton 1994a, 1994b; Gales and Kesner 1994; Simpon and Gleason, 1999, 1998; Elloumi and

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[1]Under the Basel requirements, banks need to link the capital requirements of the bank to the individual level of credit risk.

Gueylé, 2001; Parker, Peters, and Turetsky 2002), they are restricted to a limited set of governance variables, such as board characteristics and ownership concentration.

Ashbaugh-Skaife, Collins, and LaFond (2006) adopt the framework[2] developed by Standard & Poor's (2002) to systematically assess firms' corporate governance and to test the effect of corporate governance on credit ratings. While the study of Ashbaugh-Skaife, Collins, and LaFond (2006) may relate to credit losses due to downgrades (i.e. from high to low ratings), it is unable to measure credit losses due to defaults. To fill the gap, we follow the framework of Ashbaugh-Skaife, Collins, and LaFond (2006) to adopt several testable corporate governance proxies for four major dimensions of governance: ownership structure and influence; shareholder rights and relations; financial transparency and disclosures; and board structure and effectiveness. Additionally, we test how the integration of governance information with financial information enhance the bankruptcy predictions using the historical default data.

In this paper, we introduce several research hypotheses to test the relation between corporate governance and default prediction for firms. Specifically, we argue that default firms are associated with high ownership concentration, low shareholder rights, low audit committee quality, poor auditor opinions, small board size, CEO duality, and low numbers of independent and outside directors on the board. We extend the framework of Ashbaugh-Skaife, Collins, and LaFond (2006) by proposing several additional testable hypotheses regarding the impact of corporate governance on corporate bankruptcy.[3] Further, we examine how the combination of corporate governance information with financial information could enhance the default probability using historical realized default data.

The rest of the paper is organized as follows. Section 2 reviews the literature and develops research hypotheses. Section 3 presents the research methodology. Section 4 discusses the empirical results. The conclusion and the future research directions are presented in Section 5.

II. Literature review and research hypotheses

Studies on financial information for bankruptcy prediction

Research has extensively tested accounting and market information for default prediction. The initial default prediction studies are mainly based on accounting information e.g. Beaver (1966), Altman (1968), and Ohlson (1980). Altman (1968) developed the Z-Score model based on five accounting ratios. The model is a significant landmark in the field of credit risk modelling. Many other researchers also apply accounting information as the sole predictor in credit risk modelling e.g. Deakin (1972); Altman, Haldeman, and Narayanan (1977), Casey and Bartczak (1985). Later, researchers used cash flow based ratios deviating from accrual-based accounting, e.g. Beaver (1966), Ohlson (1980), Aziz and Lawson (1989), Westgaard and Wijest (2001). However, accounting information-based models forecast the financial condition of a firm on the basis of going concern whereas bankruptcy violates this key concept of accounting (Hillegeist et al. 2004). Emel et al. (2003) also criticise the use of accounting ratios on the basis that significant ratios differ from industry to industry, and macroeconomic factors affect balance sheet items.

Agarwal and Taffler (2008) point out the importance of market-based information in default prediction. Market information is backed by sound theoretical underpinnings and is free from accounting accrual adjustments. However, the market-based information is valid only in an efficient market. For example, insider dealings could invalidate a market-based model. Therefore, researchers have combined accounting and market information into their default prediction models (See, e.g. Atiya 2001; Shumway 2001; Campbell, Hilscher, and Szilagyi 2008, Li and Miu 2010).

[2]We consider this as the compressive analysis of corporate governance information pertaining to the corporate governance literature. The framework includes four dimensions assumed to be necessary to reduce management opportunistic behaviour and information asymmetry.

[3]In this paper the terms financial distress, failure, bankruptcy and liquidation are used interchangeably as each represents the situation where a firm is placed in default and investors suffer credit loss.

Studies on corporate governance for bankruptcy prediction

Chaganti, Mahajan, and Sharma (1985) pioneer examining differences in corporate governance between failed and non-failed firms, by considering three board characteristics. Daily and Dalton (1994a, 1994b) test the effect of board structure, ownership concentration, and board quality on bankruptcy. Gales and Kesner (1994) investigate board size and composition of failed firms. They find a decline in outside directors when the company is close to bankruptcy. Simpson and Gleason (1998) adopt two ownership structure variables and three board structure variables to predict financial distress of financial firms in the banking industry. Their results indicate that only CEO duality is significant for bankruptcy prediction.

Parker, Peters, and Turetsky (2002) investigate the effect of corporate governance on corporate failures based on three governance indicators: insider turnover, creditor involvement and ownership structure. The insider turnover in their study covers the board structure, whereas ownership structure includes block-holder and insider ownership. However, they establish creditor involvement measures are not significant in predicting failure. Patt and Platt (2012) examine the relationship between corporate board attributes and bankruptcy, focusing on board attributes. They suggest five board composition and nine board characteristics as proxies.

Some researchers examine the impact of corporate governance on bankruptcy using non-U.S. data. The main variable of interest of Elloumi and Gueyie's study in 2001 are outside directors and CEO duality. However, they have use audit committee composition and block holdings as control variables to predict financial distress of Canadian firms. They find board composition information, in addition to the financial information, contributes to predicting financial distress. Lee and Yeh (2004) examine the effect of ownership structure and board structure on financial distress prediction. They ascertain board structure has significant effect on explaining financial distress of the Taiwanese companies.

Lakshan and Wijekoon (2012) use the data in Sri Lanka to test the effect of corporate governance on failure prediction by using board characteristics under the governance information. Ciampi (2015) uses data of small and medium-sized enterprises in Italy to examine the impact of corporate governance on bankruptcy prediction, including board size, CEO duality, ownership concentration, and board independence. Wang and Deng (2006) predict financial distress of Chinese companies based on three corporate governance dimensions; Ownership structure, board composition and structure, and managerial agency costs. Liang et al. (2016) examine the effect of board structure, ownership structure, cash flow rights and key person retention, on company failure using the data from Taiwanese companies.

Table 1 summarizes the empirical results in the related literature over the past three decades. As seen in Table 1, we find that most of the studies are limited to a set of corporate governance variables, and focus on board structure composition and ownership structure. Ashbaugh-Skaife, Collins, and LaFond (2006) use Standard and Poor's governance framework (2002) to test a comprehensive set of corporate governance information in which four dimensions of corporate governance are considered: (i) ownership structure and influences, (ii) shareholder rights and relations, (iii) financial transparency and disclosures, and (iv) board structure and process. Although their study may capture the credit loss due to downgrade, as credit rating moves up and down frequently, it is not that short-term risk investors should focus on. We argue that the more relevant risk is the chance that we are going to lose our money – that there is going to be a permanent loss. The risk is default risk or bankruptcy risk. Accordingly, we extend Ashbaugh-Skaife et al.'s (2006) study via examining the effect of corporate governance on corporate defaults.

Methods for default prediction

Bankruptcy prediction studies have mainly utilized three methods: Multiple discriminant analysis (MDA), binary response models (logit or probit) and neural network (NN) (Bellovary, Giacomino, and Akers 2007). The MDA was pioneered by Altman (1968). He develops the Z-score model by using MDA and derives a combination of weighted ratios which provides a single Z score

Table 1. Overview of previous studies on corporate governance and default prediction.

Study	Research design	Corporate governance variables	Findings
Panel A: Corporate governance and default prediction			
Chaganti Mahajan and Sharma (1985)	USA, 1970–1976, Pair-wise analysis, 21 failed and 31 non-failed firms in the retailing industry.	Board size, outsiders on the board, multiple offices (CEO duality).	Non failed companies tend to have a larger board. Outside directors and multiple offices held by CEO are not significant among the failed and non-failed firms.
Daily and Danton (1994a)	USA, in 1990, logistic regression, 50 bankrupt and 50 non-bankrupt companies.	CEO Duality, proportion of independent directors, absolute number of independent directors.	Three governance variables improved the default probability.
Daily and Danton (1994b)	USA, 1972–1982, Logistic regression-on, 57 bankrupt companies and 57 non-bankrupt companies.	Board composition, CEO-board chairperson structure, composition -structure interaction, Control variables; ownership structure indicators and board quality indicators.	Prediction improved due to governance variables. Duality, the structure composition interaction term are significant. Bankrupt firms have affiliated directors.
Gales and Kesner (1994)	USA, 1978–1985, 127 bankrupt firms, match paired t-Test and logistic regression.	Board size preceding bankruptcy, board size after declaration of bankruptcy, board size after two years after filing for bankruptcy, smaller board at the time of bankruptcy, outside directors, change in board membership.	Firms leading to bankruptcy show a declining of outside directors and the board size. Bankrupt firms have different board structure compared to non-bankrupt counterparty.
Simpson and Gleason (1998)	USA, 1989, 300 Banking firms, ordered logistic regression.	Management and board member equity ownership, board size, insiders on the board, CEO duality, CEO equity ownership.	CEO duality, management and board member equity ownership negatively related with financial distress.
Elloumi and Gueyie (2001)	Canada, Logistic regression, 46 distress firms and 46 distress firms.	Board composition, board size, ratio of outsiders to total members of the board, CEO-based chair duality, blockholdership, and audit committee composition.	Outside directors' ownership and directorship affect the probability of financial distress.
Parker, Peters, and Turetsky (2002)	USA, 1988–1996, Cox-Proportional Hazards Regression, 176 distress firms and 176 non-distress firms.	1. CG-insider turnover; insider replacement CEO, outsider replacement CEO, board outsiders, board size, board turnover. 2. Creditor involvement; creditor ownership, total debt restructuring. 3. Ownership structure; blockholder ownership, insider ownership.	Corporate governance impact on the likelihood of survival.
Lee and Yeh (2004)	Taiwan, 1996–1999, logistic regression, 88 distress firms and 88 non-distress firms.	Control rights and cash flow rights, stock pledge ratio, adjusted control rights, shareholding of the second largest shareholder and institutional shareholders, the ratio of board seats held by the largest shareholders, the ratio of board seats held by non-large shareholders, management participation, founder participation.	Control rights and cash flow rights, stock pledge ratio and percentage of directors occupied by the controlling shareholder are positively related to financial distress.
Wang and Deng (2006)	China, 2002–2003, Logistic regression, 96 distress firms and 96 non-distress firms.	Largest shareholders' percentage, managerial ownership, top five shareholders' ownership, degree of ownership balance, board size, CEO duality, independent directors, administrative expenses ratio.	Ownership concentration are negatively and significantly associated financial distress whereas managerial agency costs has positive effect. CEO duality have no effect on financial distress.
Lakshan and Wijekoon (2012)	Sri Lanka, 2002–2008, Logistic Regression, 70 distress and 70 non-distress companies listed in CES.	Outside directors, CEO duality, outsider ownership, audit opinion, remuneration of directors, presence of an audit committee, board size.	Outside director ratio, CEO duality, remuneration of board of directors and company audit committee are the only significant variables in predicting financial distress.
Ciampi (2015)	Italy, Logistic regression. 1605 defaulting and 1605 non-defaulting Italian small enterprises.	CEO Duality, board independence: outside directors, board size, ownership concentration.	Combination of economic-financial and governance variables improves SE default accuracy rates of SE.
Platt and Platt (2012)	USA, 1998–2007, Mean comparison, 695 companies.	Inside directors, Outside directors, Independent directors, gray directors, Board size, Percentage interlocking directors, Firm CEO age, Average age of directors, Number on Board who are CEOs from outside, Number of boards held by firm CEO, Average% stock owned by independent directors. Average% stock owned by outside directors, Percentage with classified boards, Audit committee, Nomination committee, compensation committee composition.	Non-bankrupt firms have large, older board, more independent directors, more sitting CEOs, and less directorship than bankrupt companies.
Liang, Lu, Tsai and Shin (2016)	Taiwan, 1999–2009, 239 bankrupt and 239 non-bankrupt	Corporate governance covering the areas of board structure, ownership structure, cash flow rights and key personal retention and accounting ratios covering solvency, capital structure, profitability, turnover, cash flows and growth.	Board structure and ownership structure are the most important corporate governance indicators in predicting bankruptcy. Solvency and profitability are the key indicators under accounting information.

(*Continued*)

Table 1. (Continued).

Study	Research design	Corporate governance variables	Findings
Panel B: Corporate governance and credit ratings			
Ashbaugh-Skaife, Collins, and LaFond (2006)	USA, 2002, logistic regression, 894 firms.	Blockholders, % institutional shareownership, % of shares held by directors and officers, G_Score, working capital accruals, timeliness, audit fee, % audit committee independence, financial expertise, % board independents, CEO power, % of independent directors that hold seats on other firms, governance policy, % of directors that own stocks in the firm.	Blockholders, G-Score, working capital accruals, timeliness, % board independents, CEO power, % of independent directors that hold seats on other firms and % of directors that own stocks in the firm are significant in the integrated model.

component. In the main, his model comprises the five most essential accounting-based ratios: Working capital to total assets, retained earnings to total assets, earnings before interest and taxes to total assets, market value of equity to book value of total debt and sales to total assets. The primary quality that the data should possess is the normal distribution of the variables. Altman argues that the advantage of MDA lies in its ability to create a standard profile with interrelated firm characteristics. The original Z-Score model was revised in 1983 and again in 1993. In the first revision, the ratio of market value of equity to book value of total debt is replaced by the book value of equity to book value of total debt when applied to private companies, and the ratio of sales to total asset was dropped in the second version when applied to manufacturing companies.

However, there are limitations with MDA. According to Altman and Sabato (2007), MDA is restricted in default prediction since it violates the two critical assumptions behind MDA. The assumptions are (i) independent variables are multivariate and normally distributed, and (ii) the dispersion of both categories of the sample are equal. However, these assumptions could be different for default and non-default firms. Further, the coefficients obtained from the model cannot be interpreted as in regression analysis.

In the 1970s the application of logit and probit regression have received more attention. However, the popularity of these models began in the 1980s. Ohlson (1980) applies logit regression in default prediction for the first time. The advantage of the application of binary response models arises as it is easy to examine the underlying structure of the prediction (i.e. what are the essential predictors), whereas the emphasis with MDA is on grouping the results. The main difference between logit and probit regression is based on the distribution assumption of the function; the logit model requires logistic distribution whereas the probit model requires standard normal distribution. Further, the logit model does not demand multivariate normality as in MDA.

In 1990's studies began to apply NN. This method uses inputs to search a pattern and develop models for decision-making (Bellovary, Giacomino, and Akers 2007). Many studies use financial ratios as the inputs to generate the predictions (see Lee, Han, and Kwon 1996) under NN. The research hypothesis corresponding to each corporate governance category is discussed in the next section.

Development of research hypotheses

This section develops research hypotheses based on the corporate governance framework proposed by Ashbaugh-Skaife, Collins, and LaFond (2006). Higher ownership concentration can have a positive impact to the organisation (Jensen and Meckling 1976). Since block-holders and institutional investors have financial interest and independent views, they are expected to influence governing practices, depending on the share percentage held. Therefore, it is necessary to analyse the ownership concentration to identify the influence on governing practices. Generally, shareholders expect that the governing body of the organisation will act in the interest of the shareholders. While Shleifer and Vishny (1997), Bhojaraj and Sengupta (2003) and Ashbaugh-Skaife, Collins, and LaFond (2006) discover a higher ownership concentration can be detrimental to the minority shareholders since the block-holders or institutional shareholders can

exercise undue influence on management decisions. Zeitun and Tian (2007) establish higher ownership concentration increases the probability of defaults. Jensen (1993) shows Allocating a considerable number of shares to outside directors enhances the effective monitoring of the firm's management and helps to weaken the likelihood of financial fraud (Beaver 1966). Accordingly, we hypothesize:

H1: Defaults firms are associated with higher ownership concentration.

Shareholder rights and relations help to identify the power balance between shareholders and managers (Ashbaugh-Skaife, Collins, and LaFond 2006). To eventually protect their interest and avoid any detrimental decisions made by managers, shareholders should possess a certain degree of power in decision-making. Shleifer and Vishny (1997) find that relaxing shareholder rights increases their power to monitor management's actions and reduces a bias in financial reporting. Shareholder rights are also necessary to reduce the agency cost. Even though this category is an important part of corporate governance, application of this variable in the literature is very limited. Therefore, we measure the shareholder rights and relations by using two dummy variables viz., whether shareholders approve the remuneration of the board of directors and officers, and whether shareholders appoint the external auditor.

We assume that remuneration[4] of the board of directors should be approved by the shareholders because shareholders should decide whether the board of directors and officers get fair remuneration as the agents of the company. Further, the power on appointing external auditor[5] may influences on company internal control process, auditing process and audit committee functions. Therefore, we assume ratification or endorsement of these two decisions by the shareholders enhance the transparency of the functions of the remuneration and audit committee as part of corporate governance. Thus, two variables indicate the level of shareholder control over management opportunism. Consequently, we hypothesize:

H2: Defaults firms are associated with lower shareholder rights and relations.

Transparency and disclosures are important to reduce information asymmetry and to ensure that managers are accountable to the shareholders (Ashbaugh-Skaife, Collins, and LaFond 2006). Therefore, timely and adequate information helps shareholders, investors and debtholders to make appropriate financing decisions. The audit committee which is an important subcommittee of the board has the responsibility of reporting financial progress to the board members (Klein 2002).

The financial reporting quality is affected by the quality of the audit committee (Rainsbury, Bradbury, and Cahan 2009). The quality of the audit committee reduces fraudulent financial reporting, accounting irregularities (Dechow, Sloan, and Sweeney 1996), and overstatement of earnings (Klein 2002). According to DeAngelo (1981), audit committee independence is necessary to create distance between the audit firm and client firm. Additionally, the auditor's opinion is an important variable for measuring the transparency and disclosures of the accounting information. Studies show firms that receive a qualified audit opinion tend to have higher accruals (e.g. Francis and Krishnan 1999; Bradshaw, Richardson, and Sloan 2001). Proponents of efficient earnings management claim that managers use discretionary accruals to improve the quality of reported earnings by communicating proprietary information to market participants (e.g. Dechow 1994; Subramanyam 1996). Accordingly, accruals are positively priced by markets (e.g. Beaver et al. 1989; Wahlen 1994). In this study, we employ auditor opinion as a variable for bankruptcy prediction, and hypothesize that firms receiving qualified auditor opinion are associated with less likelihood to default.[6]

[4]Even though there are provisions on executive remuneration we have considered the shareholder rights to approve remuneration because the act has implemented in 2010 (say-on-pay provision under Dodd-Frank Wall Street Reform and Consumption act 2010), however, our sample period convers 2000 to 2015.

[5]There are no such legislative requirements for the appointment of external auditor in US context.

[6]Altman and McGough (1974) ascertain companies had received a going-concern modified opinion before bankruptcy occurred. Lensberg, Eilifsen, and McKee (2006) find the most significant variable in their final model of bankruptcy prediction was the auditor's opinion. Unmodified opinion (qualified and unqualified with explanatory language) shows a negative effect on bankruptcy prediction in Lensberg and others' study (2006).

H3: Defaults firms are associated with lower financial transparency and disclosure.

The board structure is important since the Board provides an independent view on management performance and are responsible for effective governance of the company (Simpson and Gleason 1999). Under agency theory, Chaganti, Mahajan, and Sharma (1985) argue a larger board creates issues for coordination and increases managers' freedom in decision-making. By contrast, resources dependency theory states a larger board has the advantage of diversified skills and wider linkages to the external environment (Pearce and Zahra 1992). Simpson and Gleason (1999) propose having one person in the position of CEO and board chair could reduce the risk of the company by better monitoring the board and management through proper and up-to-date knowledge. Generally, board of directors could be categorized as inside, outside and independent directors. Inside directors are employees of the company. Outside directors are not employed by the company, but are not independent because of prior employment by the company or by providing consultancy services to the company. Independent directors do not have any material relationships with the company. We use these definitions for independent and outside directors in our study.

In the US, the Sarbanes-Oxley Act (2002) requires companies to increase the number of independent directors as the lack of independence of the board was a major issue behind many corporate scandals (Platt and Platt 2012). Bhojraj and Sengupta (2003) state that a higher proportion of outside directors has a significant positive effect on effective monitoring of management, whereas Elloumi et al. (2001), Wang and Deng (2006) and Platt and Platt (2012) establish independent directors are significant in bankruptcy prediction. We hypothesise:

H4: Defaults firms are associated with less effective board structure and effectiveness.

As stated in 2.1, due to the limitations of using accounting and market information for bankruptcy prediction, researchers support testing nonfinancial information for bankruptcy prediction (e.g. Grunert, Norden, and Weber 2005,; Bhimani, Gulamhussen, and Lopes 2013, Parnes 2010). Many studies consider corporate governance as the key to predict bankruptcy (e.g. Elloumi and Gueyie 2001, Lee and Yeh 2004, Ciampi 2015) as non-financial information, because it ensures the confidence, transparency, and fairness of firm information. Due to the limitations of financial information and the importance of the corporate governance, we combine both variables to find if non-financial governance information enhances default prediction. We hypothesise:

H5: In addition to financial information, non-financial corporate governance information strengths bankruptcy prediction.

III. Research methodology

Binary logistic regression

This study employs the conventional binary logistic regression to conduct empirical tests. The binary logistic model is presented as follows:

$$y^{*}_{it+1} = cont. + \beta x_{it} + e_{it+1}, \quad e_{it+1} \sim (0, \sigma), \tag{1}$$

where the explained variable, y^{*}_{it+1}, $i = 1, 2, \ldots, N$ and $t = 1, 2, \ldots, T$, represents the credit quality of firms, where the subscript i denotes the ith firm and $t + 1$ denotes the $t + 1$th period. The x_{it} variables are the explanatory variables for firm's credit quality and e_{it} denotes the error term. Notably, y^{*}_{it+1} is an unobservable latent variable. What we observe is a dummy variable y_{it+1}, defined as $y_{it+1} = 1$ if $y_{it+1}^{*} > 0$ (i.e. company i defaults at time $t + 1$); otherwise, $y_{it+1} = 0$ (i.e. company i does not default at time $t + 1$). Subsequently, if the cumulative distribution of e_{it} is logistic, we have what is known as a logistic model and the default probability becomes

$$\begin{aligned} P_{it+1} &= prob(y_{it+1} = 1 | x_{i,t}) \\ &= \frac{1}{1 + e^{-(cont. + \beta \times x_{it})}}. \end{aligned} \tag{2}$$

Empirical models

We consider the three types of information to establish the default prediction approach. Specifically, the credit quality of the firm is developed as follows:

$$y^{*}_{it+1} = cont. + \beta_1 ACC_{it} + \beta_2 MKT_{it} + \beta_3 GOV_{it} + e_{it+1}, \quad e_{it+1} \sim (0, \sigma). \tag{3}$$

ACC denotes accounting information, *MKT* denotes market information, and *GOV* denotes corporate governance information. To test *H5* we develop five empirical models using various types of information:

- Model 1 is an accounting-based approach in which only accounting information is incorporated (i.e. $\beta_2 = \beta_3 = 0$).
- Model 2 is a market-based approach using the restriction of $\beta_1 = \beta_3 = 0$.
- Model 3 is a corporate governance-based approach in which only *GOV* variables are adopted (i.e. $\beta_1 = \beta_2 = 0$).
- Model 4 captures both accounting and market variables. (i.e. $\beta_3 = 0$).
- Model 5 integrates all three types of information.

Measurements of variables

To establish the accounting-based bankruptcy prediction approach, we employ five accounting ratio-based variables used in Altman's Z-score function: working capital to total assets (WCTA), sales to total assets (STA), retained earnings to total assets (RETA), earnings before interest and tax to total assets (EBITTA), and market value of equity to book value of total debt (MVEBTD). Moreover, we adopt cash to market value of total assets (CASHMTA) as an additional accounting variables.[7]

To measure market information, we use equity price to develop four market-based variables. We use natural log values of equity prices (*SHARE PRICE*), standard deviation of quarterly equality prices (STOCK_*VOL*), the ratio of company market capitalization to market capitalization of S&P 500 (*RELATIVE SIZE*), and excess stock return (*EXCESS RETURN*). Panel A of Table 2 presents detailed definitions of accounting and market variables.

We follow the Standard & Poor's (2002) corporate governance framework as used by Ashbaugh-Skaife, Collins, and LaFond (2006) to test corporate governance effect on credit rating. We select four proxies for ownership structure and influence: percentage of the company's shares held by institutions (*INST%*), percentage of shares held by directors and officers (*DIRECTOR%*), number of owners who hold at least 5% of the shares (*NUM_SHARE*) and a dummy variable to recognize share ownership of more than 20% by a single shareholder (*BLOCK*). For the shareholder rights and relation dimension, we develop two dummy variables to represent shareholders appointment of the external auditor (*EXT_AUD*) and approval of the remuneration of the management (*REM_MAG*). We measure financial transparency via audit committee quality (*AUDCOM_QUA*) and auditor opinion (*AUD_OP*). Two dummy variables represent whether the audit committee is chaired by an independent director, and whether the firm has a qualified auditor opinion.[8] We adopt four proxies to measure the effect of board structure and process: number of board members in the board (*BOARD SIZE*), a dummy variable to measure CEO duality (*CEO DUALITY*), number of independent directors (*IND_DIRE*), and number of outside directors (*OUT_DIRE*).[9] Panel B of Table 2 presents detailed definitions of the corporate governance variables. We also tested principal component analysis (PCA) to check the consistency of the governance variable categorization.[10]

IV. Empirical results

Data

Firms encountering bankruptcy or liquidation events, as defined by the Compustat database over the period 2000–2015, are selected as default firms

[7]The ratio working capital to total assets and cash to market value of total assets are measures for liquidity. Profitability is measured by using three variables; sales to total assets, retained earnings to total assets, earnings before interest and tax to total assets. Market value of equity to book value of total debt is a proxy for the leverage.

[8]Qualified includes qualified (scope limitation and different from GAAP) and unqualified opinion with explanatory language.

[9]We define outside directors those who are not employed by the company. But they are not independent because outside directors might be prior employees of the company or may provide consultancy services to the company and independent directors as those who have no any material relationships with the company.

[10]PCA provides five components; two components for ownership concentration with other three dimensions (board effectiveness, shareholder rights and financial transparency). However, we limit to four dimensions based on the S&P (2002) identification.

Table 2. Variable definitions.

Variable	Definition
Panel A: Definition of financial variables	
Accounting information	
WCTA	Working capital to total assets
CASHMTA	Cash/market value of total assets
MVEBTD	Market value of equity to book value of total debt
STA	Sales to total assets
RETA	Retained earnings to total assets
EBITTA	Earnings before interest and taxes to total assets
Market information	
SHARE PRICE	Log price
STOCK_VOL	Stock's volatility for the present quarter; is computed as the sample standard deviation using the last three quarter market prices
RELATIVE SIZE	Logarithm of each firm's equity value divided by the total market equity value of S&P 500
EXCESS RETURN	quarterly return on the firm minus the market return based on S&P 500 (EXCESS $RETURN_{it} = \log(1 + R_{it}) - \log(1 + RS\&P500_{it})$)
Panel B: Definition of corporate governance variables	
Ownership structure and influence	
INST (%)	Percentage of share ownership by institutions
DIRECTOR (%)	Percentage of share ownership of directors and officers
NUM_SHARE	Number of shareholders hold more than 5% shares
BLOCK	1 = if at least one shareholder has more than 20% shares, 0 = otherwise
Shareholder rights and relations	
EXT_AUD	1 = if shareholders appoint the external auditor, 0 = otherwise
REM_MAG	1 = if shareholders approve the remuneration of management, 0 = otherwise
Financial transparency and disclosures	
AUDCOM_QUA	1 = if the audit committee chair is an independent director, 0 = otherwise
AUD_OP	1 = if the opinion is qualified, 0 = otherwise`
Board structure and effectiveness	
BOARD SIZE	Number of board members in the board
CEO DUALITY	1 = if CEO and Chair are same person, 0 = otherwise
IND_DIRE	Number of independent directors
OUT_DIRE	Number of outside directors

in this study. Next, we use the match sample design to select non-default firms.[11] For each default firm, we select a firm of similar size (defined by the value of total assets) in the same industry-defined by the four-digit Standard Industrial Classification (SIC) code-as the non-default firm sample. The selection of comparable non-default firm effectively mitigates imbalance problems (see Liang et al. 2016).[12] Most bankruptcy prediction studies use matched samples (see Altman 1968, Daily and Danton, 1994a, Gales and Kesner 1994, Elloumi and Gueyie 2001, Parker, Peters, and Turetsky 2002, Lee and Yeh 2004). For purpose of prediction, the explanatory variables for credit quality of firms are collected as panel data over five-year on a quarterly basis.[13] Panel data mitigates the time-varying risk of the variables (Tinoco and Wilson 2013; Altman, Sabato, and Wilson 2010; Shunway, 2001).

We obtain accounting variables from the Compustat database. The information of equity prices for market variables is obtained from the Center for Research in Security Prices (CRSP) database. Corporate governance variables are collected through company proxy statements. To avoid biased results due to outliers, we winsorize accounting and market variables.[14] Accordingly, we collect 3280 firm-quarter observations for default and non-default firms.

Descriptive statistics

Table 3 shows the descriptive statistics of the predictor variables for firm credit quality. First, we

[11]Matched pairs design has been used by more than 70% of the studies in this area (Zmijewski 1984).
[12]The bankruptcy prediction results generally used to find the effect of selected variables on default likelihood of the companies which may go bankrupt, but not to generalize to the entire population (Ciampi 2015).
[13]We assume five-year observations are necessary to find the signal of default risk among default and non-default companies and banks generally conduct 3 to 5 year analysis of their borrowers. Li and Miu (2010) used 10 year quarterly data for their analysis based on the USA.
[14]As a solution to the outliers founded after applying the median absolute deviation (MAD). After detecting outliers, we use trimming (Taffler 1983; Barnes 1987) to avoid false positive results. For trimming, we apply winsorizing, which means changing an outlier's value into the value of the closest non-outlier (Barnes 1987).

Table 3. Descriptive analysis and t-Test.

Category	Variables	Default Firms		Non-default firms		t-Statistics
		Mean	Std. Dev	Mean	Std. Dev	
	Ownership structure and influence					
Corporate governance information	*INST (%)*	32.174	20.839	26.430	19.130	8.269***
	DIRECTOR (%)	19.924	21.185	20.771	19.407	−1.200
	NUM_SHARE	3.974	2.208	3.524	1.956	5.884***
	BLOCK	.335	.472	.305	.460	1.777*
	Shareholder rights and relations					
	EXT_AUD	.624	.484	.841	.365	−14.171***
	REM_MAG	.905	.293	.990	.098	−11.063***
	Financial transparency and disclosures					
	AUDCOM_QUA	.971	.169	.973	.162	−.417
	AUD_OP	.009	.0920	.012	.110	−2.271**
	Board structure and effectiveness					
	BOARD SIZE	6.946	1.954	7.254	2.141	−4.196***
	CEO DUALITY	.539	.499	.520	.500	1.149
	IND_DIRE	4.980	1.926	5.412	2.214	−5.942***
	OUT_DIRE	4.951	2.172	5.551	2.333	−7.509***
Accounting information	*WCTA*	.176	.371	.483	.385	−24.007***
	MVEBTD	3.980	7.569	5.499	8.202	−6.088***
	STA	.293	.261	.347	.261	−7.581***
	RETA	−2.518	4.901	−.788	3.302	−13.854***
	EBITTA	−.194	.380	.024	.257	−21.393***
	CASHMTA	−.053	.221	.137	.164	−26.552***
Market information	*SHARE PRICE*	.254	.812	.878	.648	−26.548***
	STOCK_VOL	.436	.373	.243	.210	18.808***
	RELATIVE SIZE	.242	.127	.304	.148	−14.615***
	EXCESS RETURN	−.069	.250	−.002	.138	−10.072***

This table presents the descriptive statistics for the predictor information for matched pair sample. Followed matched sample design, the sample represents 3280 firm-quarter observations. The descriptive statistics are given for mean standard deviation and the results of the paired sample t-Test. *Denotes significance at 10% level; **Denotes significance at 5% level; ***Denotes significance at 1% level.

examine ownership structure and influence, the first category of corporate governance. Institutional ownership (*INST%*) in default firms is higher than that in the non-default counterpart (i.e. 32.17% *versus* 26.43%).[15] The average number of shareholders who hold more than 5% of shares (*NUM_SHARE*) for default firms is higher than that for non-default firms (i.e. 3.974 *versus* 3.524). Moreover, block-holdings (*BLOCK*) for default firms is higher than that for non-default firms (0.335 *versus* 0.305). Overall, these results indicate that the higher the ownership concentration, the higher the risk of company being default. However, the percentage of share ownership of directors and officers (*DIRECTOR%*) for default firms is lower than that for the non-default firms (i.e. 19.924 *versus* 20.771) but the difference is insignificant (t-Statistic = −1.200).[16]

Next, we investigate shareholder rights and relations, the second category of corporate governance. First, the value of the *EXT_AUD* and *REM_MAG* variables for default firms is significantly lower than non-default firms (0.624 *versus* 0.841 and 0.905 *versus* 0.990, respectively). These results indicate shareholders in default firms have less rights to appoint external auditor and approve remuneration of the management than default firms.[17] For the third category of corporate governance, financial transparency and disclosures, the value of *AUDCOM_QUA* for default firms is lower than non-default firms (0.971 *versus* 0.973). The result indicates that the audit committee quality in default firms is lower than that in non-default firms.[18] Next, the value of *AUD_OP* for default firms is 0.009, which is lower than that for non-default firms (0.012).

The fourth category of corporate governance, board structure and effectiveness, shows the board size of the default firms is lower than non-default firms (6.946 *versus* 7.254). Moreover, default firms have a higher portion of CEO duality than non-default firms (0.539 *versus* 0.520).

[15]Shleifer and Vishny (1997), argued, the ownership concentration is an incentive for owners to monitor management, however, if the ownership exceed a certain threshold, the owners motivate to pursue their private benefits.
[16]The result is in agreement with Jensen's study (1993).
[17]As per Ashbaugh-Skaife, Collins, and LaFond (2006), the higher shareholder rights and power enhance the power balance between management and stakeholders.
[18]Audit committee quality represent the independency of the audit committee chair.

Further, the number of independent directors and outside directors in default firms is lower than that in non-default firms (4.980 *versus* 5.412 and 4.951 *versus* 5.551, respectively).

Table 3 also reports the descriptive statistics of accounting and market variables. All the mean values of the accounting variables of default firms is significantly lower than that of non-default firms, which is consistent with the literature. Moreover, the results of market variables are also in line with the literature. Specifically, default firms have a lower average value of equity price, firm size, and excess stock return, but a higher value of equity volatility than non-default firms.

Estimation results of alternative bankruptcy prediction specifications

Table 4 lists the estimation results of various model specifications in which different types of information are utilised. First, the results of Model 1, the accounting-based approach, show that the effects of the accounting variables on a firm's bankruptcy probability are significant.[19] Second, the results of Model 2 show that *SHARE PRICE* and *EXCESS RETURN* are significantly negative, and *RELATIVE SIZE*, and *STOCK_VOL* is significantly positive. This result is consistent with the notion that default firms are associated with a lower equity value, and excess stock return,[20] but higher equity volatility and higher relative size.[21]

Third, Model 3 represents the setting with corporate governance variables. Most of corporate governance variables are significant and have sign as hypothesized in Section 2.3, except the variables *BLOCK, AUDCOM_QUA* and *CEO DUALITY*. *INST* is significant and positive (*coeff.* = 0.010 and *t-Statistic* = 4.08). Institutions ownership concentration is an incentive for institutions owners to monitor management. However, Shleifer and Vishny (1997) indicate that if the ownership exceeds a threshold, the owners are motivated to pursue their private benefits, which increases default probability of firm. The *DIRECTOR* variable is negative and significant (*coeff.* = −0.013 and *t-Statistic* = −5.08), consistent with the notion that the allocation of equity shares increases management interest in supporting organizational goals above self-interest. The result also indicates that the allocation of considerable number of shares to outside directors enhances effective monitoring of firm management (see Jensen 1993). *NUM_SHARE* is positive and significant (*coeff.* = 0.087 and *t-Statistic* = 3.98), implying the number of shareholders holding more than 5% shares is positively related to default.

The second category of corporate governance examines the effect of shareholder rights and relations on default probability. The *EXT_AUD* and *REM_MAG* variable is significant and negative, as hypothesized. Our results show that shareholders right and relations may decrease default probability of firm, which is consistent the argument of Ashbaugh-Skaife, Collins, and LaFond (2006) that shareholder rights and relations enhance the power balance between management and stakeholders.

For the third corporate governance category, financial transparency and disclosures, the *AUDCOM_QUA* is negative and insignificant (*t-Statistic* = −1.03). One possible explanation is that audit committee quality has no significant effect on the quality of financial reporting, as indicated by Rainsbury, Bradbury, and Cahan (2009). Moreover, Zhang, Zhou, and Zhou (2007), using the data of U.S. firms after enactment of Sarbanes–Oxley Act (2002), find auditor independence generates the problem of internal control weaknesses. AUD_OP is significant and shows a negative effect (*coeff.* = −1.584 and *t-Statistic* = −2.98) as hypothesized in section 2.3. Suggesting, a company with a qualified opinion is less likely to default as a result of the potential incentives of efficient earnings management.

The fourth category of corporate governance examines board structure and process. First, the

[19]A study based on the USA by Deakin (1972), also found WCTA as the best predictor of potential distress re-classification. MVEBTD also found to be significant in Aziz and Lawson's study in 1989. STA ratio was the least significant variable in Altman's study (1968). However, the highest prediction has provided by EBITTA in his study. Campbell, Hilscher, and Szilagyi (2008) found CASHMTA variable as the most significant in their study.

[20]Excess return shows a negative coefficient, representing companies with higher excess return have less exposure to default risk (Shumway 2001).

[21]Size of the company measured based on the relative market capitalization indicates a positive sign even though we expect a negative sign. However, this is in line with the results of Campbell, Hilscher, and Szilagyi (2008). One possible explanation would be larger companies have complex business processes and they are more exposed to the default risk due to this complexity.

Table 4. Logistic regression results of the alternative models.

Governance Variables	Variable	*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Ownership structure and influence	***Intercept***	1.362 (12.19)***	−0.687 (−5.49)***	3.389 (8.67)***	1.264 (6.28)***	3.787 (5.89)***
	INST (%)			0.010 (4.08)***		0.006 (1.87)*
	DIRECTOR (%)			−0.013 (−5.08)***		−0.015 (−3.96)***
	NUM_SHARE			0.087 (3.98)***		0.186 (6.83)***
	BLOCK			0.000 (0.00)		0.380 (2.40)***
Shareholder rights and relations	*EXT_AUD*			−1.176 (−12.72)***		−1.248 (−9.71)***
	REM_MAG			−2.388 (−8.30)***		−3.288 (−9.71)***
Financial transparency and disclosures	*AUDCOM_QUA*			−0.232 (−1.03)		1.206 (−9.70)***
	AUD_OP			−1.584 (−2.98)***		−3.248 (−7.29)***
Board structure and effectiveness	*BOARD SIZE*			0.189 (5.02)***		0.146 (2.63)***
	CEO DUALITY			0.089 (1.15)		0.057 (0.54)
	IND_DIRE			−0.103 (−2.58)**		−0.150 (−2.90)***
	OUT_DIRE			−0.224 (−6.90)***		−0.173 (−3.98)***
Financial variables	*WCTA*	−0.541 (−4.38)***			−0.530 (−4.32)***	−0.489 (−2.61)***
	MVEBTD	−0.152 (−7.01)***			−0.099 (−4.35)***	−0.126 (−4.46)***
	STA	−1.365 (−6.49)***			−1.634 (−7.22)***	−1.737 (−6.48)***
	RETA	−0.354 (−4.80)***			0.075 (0.86)	−0.135 (−1.30)
	EBITTA	−2.795 (−7.59)***			−1.620 (−4.19)***	−1.728 (−3.67)***
	CASHMTA	−11.569 (−19.67)***			−12.449 (−19.66)***	−13.510 (−19.98)***
	SHARE PRICE		−1.601 (−16.060)***		−0.721 (−5.54)***	−0.769 (−4.74)***
	STOCK_VOL		2.439 (11.410)***		2.234 (8.76)***	2.224 (8.01)***
	RELATIVE SIZE		3.486 (7.350)***		0.139 (0.24)	1.905 (2.58)**
	EXCESS RETURN		−0.825 (−2.800)***		−0.960 (−6.90)**	−0.692 (−1.74)*
Pseudo R^2		0.34	0.172	0.111	0.379	0.466
Likelihood ratio		1545.19***	782.87***	503.02***	1722.59***	2146.34***
Wald $\chi 2$						294.63***

This table presents the results of the logistic regression for five alternative models. Three thousand two hundred and eighty firm-quarter observations. 1 = if the company is default and 0 otherwise. The goodness of fit of the models is measured by using Pseudo $R^{2,}$ Likelihood ratio χ^2 and Wald $^{X2.}$ Wald $\chi 2$ measures whether the corporate governance information explains the variation of the default probability compared to the accounting and market information-based model.

Notes:***Model 1:*** Default risk = *f* (Accounting),***Model 2:*** Default risk = *f* (Market),***Model3:*** Default risk = *f* (Corporate governance),***Model 4:*** Default risk = *f* (Accounting and Market),***Model 5:*** Default risk = *f* (Accounting, Market and Corporate governance) **Denotes significance at the 5% level; ***Denotes significance at the 1% level. Z values are presented in parenthesis.

BOARD SIZE variable is positive and significant (*coeff.* = 0.189 and *t-Statistic* = 5.02), suggesting a large board brings complexity in decision-making, and increases default probability of a firm. Moreover, Goodstein, Gautam, and Boeker (1994) find that a large and diverse board is less effective than a small board when directing strategic change in a financial distress environment. Second, *CEO DUALITY* is positive but insignificant (*coeff.* = 0.089 and *t-Statistic* = 1.15). The positive coefficient indicates CEO duality decreases board effectiveness, and thus increase default probability of firm (Daily and Dalton 1994b). The insignificant coefficient implies that the effect of CEO duality on bankruptcy prediction is marginal, as consistent with Chaganti, Mahajan, and Sharma (1985). Third, *IND_DIRE* and *OUT_DIRE* are negative and significant, indicating that companies with a higher proportion of independent and outside directors are less likely to go bankrupt than those with a lower proportion.

Model 4 incorporates both accounting and market information. In Model 5 all the three types of information, accounting, market and corporate governance, are integrated. Comparing results from the settings with a single source of information (i.e. Models 1, 2 and 3) and the settings with multiple sources of information (i.e. Models 4 and 5), we find that although the magnitude of estimated coefficients slightly change, sign and significance are robust for most of estimated coefficients. This result indicates a low degree of multicollinearity in different types of information and provides the justification for the hybrid bankruptcy model.

Model 5 is associated with higher values of Pseudo R^2 and log likelihood ratio in comparison with Models 1–4. This indicates that the hybrid model in which all three types of information are integrated performs better in explaining the in-sample variation of the dependent variable (i.e. bankruptcy or liquidation events). The final three rows of Table 4 show certain goodness statistics for model selection, including Pseudo R^2, log likelihood ratio and Wald χ^2.

Prediction performance: in-sample test

Validation is an integral part of the prediction models because it judges the quality of the prediction. In this study, we use ROC (Receiver Operating Characteristics) and CAP (Cumulative Accuracy Profile) curves for model validation. The ROC curve identifies the percentage of true positive predictions (percentage of defaults that are correctly classified as defaults) on *y*-axis against the false positive (percentage of non-defaults that are mistakenly classified as defaults) on *x*-axis. To plot CAP curve, we first rank firms by their default probability estimates, from highest to lowest. Next, we construct a graph with the percentage of all the companies on the *x*-axis and the percentage of all the defaults on the *y*-axis. Figure 1 presents the ROC curves for the five competing models proposed in the study; the CAP curves are shown in Figure 2. We use ROC and CAP curves to calculate the predictive accuracy of risk measure errors into one statistic. The accuracy ratio is a fraction between zero and one and models with higher accuracy ratios have more predictive power.[22]

The results of the accuracy ratio are summarized in Table 6. We find Model 1 is associated with a higher accuracy ratio in comparison with Models 2 and 3. However, the accuracy ratios of Models 4 and 5, the two hybrid models, are higher than those of Models 1, 2, and 3. Model 5 has the highest accuracy ratio. We establish hybrid models in which three types of information (accounting, market and corporate governance), are incorporated can enhance default prediction performance.

Implications and discussions

The findings of this research provide theoretical and practical implications for corporate bank lending. Thus, we extend the existing literature by testing hypotheses regarding the impact of corporate governance on corporate default prediction. The findings imply that the corporate default prediction models should address a comprehensive application of corporate governance variables, and further the integration of accounting, market and corporate governance information is needed to increase the prediction performances. A credit manager is concerned about the defaults of the individual borrower in order to reduce the credit risk. Therefore, it is necessary to recognize the sources behind the corporate default risk. The findings of this study open a new discussion on refining the current strategies to reduce default risk in terms of firms' corporate governance practices. First, the hypothesis regarding ownership concentration confirms that firms with higher ownership concentration reflect a higher default risk than low ownership concentration firms. Therefore, when defining risk strategies, banks should consider the ownership structure of the company and increase economic capital to absorb the additional credit risk loss involved in the high ownership concentration firm borrowers.

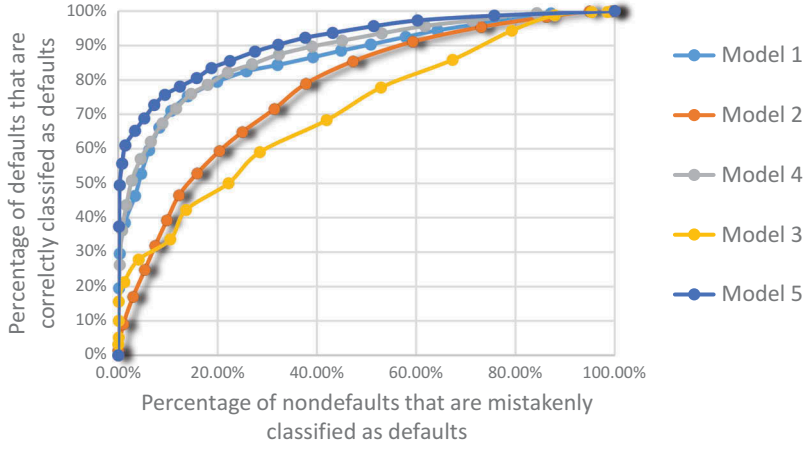

Figure 1. ROC curve for alternative models.

[22]The calculation of accuracy ratio is described in Li and Miu study in 2010.

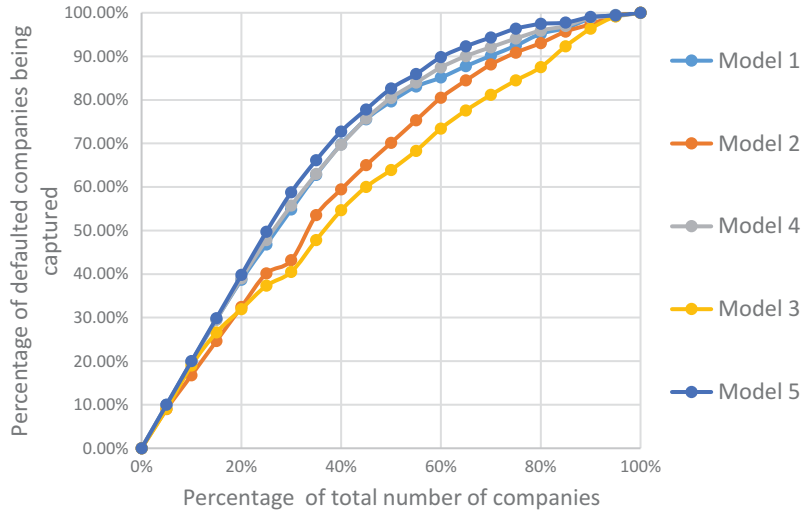

Figure 2. CAP curve for alternative models.

As per the results, we also confirm the other three hypotheses; that is the impact of board effectiveness, financial transparency and shareholder rights as governance dimensions are significant on default risk. Therefore, if the loan granted to corporate borrowers having a less effective board, low financial transparency, and high shareholder rights, the loans should be charged a higher interest rate, imposed to compensate for the high risk. Alternatively, loans could be extended to select firms with more effective governance practices.

Further, confirmation of our fifth hypothesis suggests that internal credit rating models should not ignore accounting and market information in predicting the default risk of their corporate borrowers. In order to enhance the default prediction ability of their models, they should integrate accounting, market and corporate governance information in a single model to protect banks from making loans to risky borrowers.

Robustness tests

We conduct two alternative tests to check the robustness of the primary results discussed above. First, we control the industry effect. In specific, we re-estimate our models by introducing nine industry dummies defined by the first two digits of the SIC codes. The results are reported in Table 5. In addition to the one-period-ahead prediction test, we conduct the three- and five-period-ahead tests. The empirical results indicate that our conclusions are robust, i.e. Model 5 is associated with the highest prediction accuracy.[23]

Prediction performance: out-of-sample test

To complete the validation process, we conduct an out-of-sample test. To do so, we randomly withhold 20% of default and non-default samples (i.e. 328 observations for default and non-default firms), which are defined as the test set. The residual samples are defined as the model set and are used for estimation of models. Table 7 presents the results of the out-of-sample accuracy ratios obtained with ROC and CAP curves of all the default prediction models. Our results are consistent with the following notions. First, in having higher values of accuracy ratio, the two hybrid models (i.e. Models 4 and 5) outperform Models 1 to 3. Second, by having higher accuracy ratio, the hybrid model using three types of information outperforms the hybrid model with two types of information and those models with a single type of information.

V. Conclusion and future research directions

In contrast to prior studies on default correlation and corporate governance, this study incorporates comprehensive corporate governance information

[23]Results are available upon the request.

Table 5. Logistic regression results with industry effect.

Governance Variables	Variable	*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Ownership structure and influence	***Intercept***	1.262 (7.13)***	−0.212 (−1.11)***	3.481 (8.09)***	1.358 (5.59)***	3.220 (4.97)***
	INST (%)			0.010 (4.11)***		0.006 (1.85)*
	DIRECTOR (%)			−0.015 (−5.45)***		−0.012 (−3.12)***
	NUM_SHARE			0.096 (4.30)***		0.181 (5.83)***
	BLOCK			0.037 (0.35)		0.425 (2.84)***
Shareholder rights and relations	*EXT_AUD*			−1.241 (−13.0)***		−1.221 (−9.21)***
	REM_MAG			−2.446 (−8.40)***		−3.101 (−8.25)***
Financial transparency and disclosures	*AUDCOM_QUA*			−0.167 (−0.72)		1.454 (4.38)***
	AUD_OP			−1.497 (−2.64)***		−3.286 (−5.91)***
Board structure and effectiveness	*BOARD SIZE*			0.193 (5.01)***		0.138 (2.48)***
	CEO DUALITY			0.103 (1.32)		0.093 (0.86)
	IND_DIRE			−0.108 (−2.59)**		−0.115 (−1.88)***
	OUT_DIRE			−0.220 (−6.63)***		−0.206 (−4.28)***
Financial variables	*WCTA*	−0.704 (−5.25)***			−0.674 (−5.04)***	−0.625 (−4.36)***
	MVEBTD	−0.151 (−6.84)***			−0.097 (−4.12)***	−0.120 (−4.34)***
	STA	−1.726 (−6.83)***			−2.150 (−7.79)***	−2.291 (−7.29)***
	RETA	−0.362 (−4.67)***			0.052 (0.58)	−0.167 (−168)
	EBITTA	−2.793 (−7.44)***			−1.554 (−3.91)***	−1.491 (−3.37)***
	CASHMTA	−11.805 (−19.46)***			−12.767 (−19.45)***	−13.515 (−18.61)***
	SHARE PRICE		−1.694 (−16.54)***		−0.715 (−5.34)***	−0.820 (−1.52)***
	STOCK_VOL		2.434 (11.26)***		2.271 (8.74)***	2.179 (7.64)***
	RELATIVE SIZE		3.460 (7.20)***		−0.277 (−0.47)	1.963 (2.59)**
	EXCESS RETURN		−0.785 (−2.64)***		−0.913 (−2.57)**	−0.586 (−1.52)*
	Industry_dummy2	1.014 (3.35)**	−0.088 (−0.31)	−0.816 (−2.72)	1.190 (3.73)***	0.732 (1.99)**
	Industry_dummy3	0.514 (2.79)	−0.432 (−2.60)***	−0.170 (−1.13)	0.433 (2.19)**	0.415 (1.89)*
	Industry_dummy4	−0.50 (−0.24)	−0.229 (−1.18)	−0.276 (−1.46)	−0.005 (−0.02)	0.032 (0.13)
	Industry_dummy5	0.045 (0.15)	−0.105 (−0.41)	0.019 (0.08)	0.091 (0.29)	0.380 (1.12)
	Industry_dummy6	0.670 (2.87)	−0.226 (−1.18)	0.017 (0.09)	0.700 (2.79)***	1.032 (3.70)***
	Industry_dummy7	−0.098 (−0.49)	−0.604 (−3.39)***	0.075 (0.46)	−0.215 (−1.02)	0.017 (0.07)
	Industry_dummy8	0.014 (0.05)	−0.987 (−4.37)***	0.042 (0.21)	−0.227 (−0.85)	0.283 (0.97)
Pseudo R^2		0.350	0.179	0.114	0.390	0.472
Likelihood ratio		1592.22***	814.53***	519.74***	1774.6***	2146.34***
Wald $\chi 2$						371.73***

This table presents the results of the logistic regression for five alternative models with industry effect. ***Notes: Model 1:*** Default risk = *f* (Accounting),***Model 2:*** Default risk = *f* (Market),***Model3:*** Default risk = *f* (Corporate governance),***Model 4:*** Default risk = *f* (Accounting and Market), ***Model 5:*** Default risk = *f* (Accounting, Market and Corporate governance)**Denotes significance at the 5% level; ***Denotes significance at the 1% level. Z values are presented in parenthesis. Intercept = Mining, Industry_dummy2 = Construction, Industry_dummy3 = Manufacturing, Industry_dummy4 = Transportation, Industry_dummy5 = Wholesale, Industry_dummy6 = Retail, Industry_dummy7 = Services, Industry_dummy8 = Public administration.

Table 6. In-sample accuracy ratio comparison.

Model Specifications	Accuracy ratio by ROC curve	Accuracy ratio by CAP curve
Model 1	72.97%	73.12%
Model 2	54.63%	53.77%
Model 3	41.87%	40.18%
Model 4	76.13%	75.82%
Model 5	**82.05%**	**81.96%**

This table summarizes the results of accuracy ratio as performance measure of bankruptcy prediction. The value in bold denotes the maximum in the column.

Table 7. Out-of-sample accuracy ratio comparison.

Model specifications	Accuracy ratio by ROC curve	Accuracy ratio by CAP curve
Model 1	77.07%	76.89%
Model 2	58.59%	59.70%
Model 3	42.15%	41.04%
Model 4	79.75%	79.51%
Model 5	**84.49%**	**85.00%**

This table presents the out-of-sample accuracy ratio of the five competing models. To conduct the out-of-sample test, we randomly select 3,280 firm-quarter observations from each group randomly. Named as test set, and the rest of the observations are defined as 'model set'. See section 4.5 for detailed discussion of the out of sample test.

for corporate default prediction, in addition to accounting and market information. We apply Ashbaugh-Skaife, Collins, and LaFond (2006) four governance dimensions to hypothesize the relations between corporate governance and default prediction. Accordingly, we speculate that default firms associate with higher ownership concentration, lower shareholder rights, lower financial transparency, and less effective board structure. Further, we postulate that combining corporate governance information with financial information could improve default prediction. Our empirical study is based on non-financial U.S. firms over the period from 2000 to 2015. Firms that experienced bankruptcy or liquidation events as recorded in the Compustat database are defined as default firms. The firms with similar size from the same industry are collected as the non-default firm samples.

Overall, our findings suggest that the default risk rises with poor corporate governance in terms of higher ownership concentration; lower shareholder rights and relations; lower financial transparency and disclosures; and less effective board structure. Importantly, our findings provide implications for banks and regulatory authorities. We stress the importance of considering the comprehensive application of corporate governance information in corporate credit decisions. Further, we suggest that banks should incorporate corporate governance information in addition to the financial information in their default prediction models for better performance. Selecting different sample criteria for non-default firm selection, particularly firms with higher credit quality, would be an interesting study for the future. Also developing a modified Altman model by including financial and corporate governance information also could become a valuable addition to the existing literature.

Disclosure statement

No potential conflict of interest was reported by the authors.

Data Availability

Data analysed in the study are collected from public sources

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