Three essays on corporate default prediction: Special reference to corporate governance, default correlation and capital structure dynamics

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Abstract

This thesis consists of three essays that investigate corporate defaults connected to corporate governance, default correlations and capital structure adjustment. Granting a loan requires mutual trust between lenders and borrower and depends on the flow of information. The relevance and the accuracy of the information are necessary to ensure the best judgement about the creditworthiness of borrowers. However, information asymmetry between the borrower and the lender is the main hurdle for any judgement about the borrower. Although default prediction has commanded the attention of researchers over many years, there is still an important gap in the literature on the selection of the suitable default predictor information for improved borrower evaluation.

To broaden the understanding of the information content of default predictor variables, the first essay addresses and tests the impact of corporate governance on default prediction. It examines several testable hypotheses regarding the relations between corporate governance and default prediction, building on the Standard and Poor (2002) corporate governance framework proposed by Ashbaugh-Skaife et al. (2006). The research employs 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.

In addition to the analyses on the U.S. data, this thesis conducts a comparative study using the data of Sri Lanka, which serves as a representative emerging market. This study argues that emerging markets are important because they present several institutional differences that cannot be examined in the developed markets. The rapid evolvement of these markets provides excellent experimental grounds for studying many financial issues. The empirical results show that whilst an integrated model provides overall stronger predictive value; financial information is more

relevant for USA firms. Corporate governance appears more relevant in emerging markets than in mature markets, but the effectiveness of the individual corporate governance practices differs between countries.

The second essay discusses the impact of corporate governance on the correlation in corporate defaults. This essay investigates for the first time the effect of firm-specific corporate governance on default correlation as an extension to the contagion and cyclical effect proposed by Das et al. (2007) as the sources of default correlation. It hypothesizes that the degree of default correlations could increase disproportionally for firms with weak corporate governance in terms of high ownership concentration, low board effectiveness, low financial transparency, and higher shareholder rights. This study employs Lucas's (1995) method to provide empirical evidence based on the historical default data from the United States from 2000 to 2015. The empirical results imply that corporate governance is essential for credit risk management because poor corporate governance may increase not only individual default risk but also the domino effect of credit defaults. Moreover, the impact of corporate governance on the correlation in corporate defaults is more pronounced in the financial crisis.

The third essay examines the heterogeneity of the speed of capital structure adjustment in firms. In contrast to previously documented contemporaneous results, it tests the issue through distinguishing two types of the firms (default and non-default firms), and two measures of the speed of adjustment (cumulative versus marginal). The empirical results show that the speed of adjustment is non-uniform across firms and over time. In particular, default firms are associated with a higher speed of adjustment than non-default firms. The completion of leverage adjustment takes multiple periods. The marginal speed of adjustment accelerates from the beginning period to the end period, which is consistent with the anchoring and adjustment bias heuristic. The empirical results are robust using a book/market leverage and a two/one-step estimation approach. In addition to the tests on the speed of capital structure adjustment, this essay also examines the effect of leverage deviation on measuring firms' default risk. The in-sample and out-of-sample tests suggest that taking into account leverage deviation enhances the capacity of measuring corporate borrowers' default risk. Additionally, such benefit is persistent over various time horizons. Overall, the empirical findings provide important policy

implications for banks before granting loans to corporate customers. This work fills crucial gaps in the credit risk literature.

Keywords: Default prediction, corporate governance, accounting information, share market information, emerging and mature market, default correlation, credit risk, speed of adjustment, leverage deviation, Sri Lanka, USA.

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Thesis-related research outcomes

REFEREED PUBLICATIONS

1. Fernando, J.M.R., Li, L., & Hou, G. (2019). Corporate governance and default prediction: A reality test, *Applied Economics* 51, 2669-2686. [SSCI and ABDC ranking = A]

2. Fernando, J.M.R., Li, L., & Hou, G. (2019). Financial versus non-financial information for default prediction: Evidence from Sri Lanka and the USA, *Emerging Markets Finance and Trade*, in press, https://www.tandfonline.com/doi/abs/10.1080/1540496X.2018.1545644. [SSCI and ABDC ranking = B]

SUBMITTED AND COMPLETED PAPERS

1. Fernando, J.M.R., Li, L., & Hou, G. (2019). Corporate governance and default correlation. *Corporate Governance: An International Review*, revised and resubmitted. [SSCI and ABDC ranking = A]

2. Fernando, J.M.R., Li, L., & Hou, G. (2019). Heterogeneity in capital structure adjustment revisited: Default versus non-default firms and short versus long time horizon. *Journal of Banking and Finance*, submitted. [SSCI and ABDC ranking = A*]

3. Fernando, J.M.R., Li, L., & Hou, G. (2019). Do leverage dynamics strengthen bankruptcy prediction? A comprehensive test. *Applied Economic Letters*, submitted. [SSCI and ABDC ranking = B]

4. Fernando, J.M.R., Li, L., & Hou, G. (2019). Information selection in bankruptcy prediction: A survey research in banks of Sri Lanka. *Qualitative Research in Financial Markets*, submitted. [ABDC ranking = C]

CONFERENCE PAPERS

1. Fernando, J.M.R., Li, L., & Hou, G. (2018). Corporate governance and default prediction: A reality test. Paper presented at 2018 New Zealand Finance Colloquium PhD Symposium, Massey University, Palmerston North, New Zealand.

2. Fernando, J.M.R., Li, L., & Hou, G. (2018). Financial versus Non-Financial Information for Default Prediction: Evidence from Sri Lanka and the USA. Paper presented at 2018 AFAANZ Conference, Auckland, New Zealand.

3. Fernando, J.M.R., Li, L., & Hou, G. (2018). Corporate governance and default correlation. Paper presented at 31st Australasian Finance and Banking Conference, Sydney, Australia.

Table of Contents

List of Abbreviations

ACAP	Advisory Committee on the Auditing Profession
ACC	Accounting information
AGM	Annual General Meeting
CAP	Cumulative Accuracy Profile
CDS	Credit Default Swaps
CEO	Chief Executive Officer
CFO	Chief Finance Officer
CPA	Certified Public Accountant
CRSP	Center for Research in Security Prices
GAAP	Generally Accepted Accounting Principles
GDP	Gross Domestic Product
GMM	Generalized Method of Moment
GOV	Corporate governance information
MDA	Multiple Discriminant Analysis
MKT	Market information
NN	Neural Network
NPV	Net Present Value
R&D	Research and Development
ROC	Receiver Operating Characteristics
S&P	Standard and Poor
SIC	Standard Industrial Classification
SL	Sri Lanka
SOA	Speed of Adjustment
SOX	Sarbanes-Oxley Act of 2002
SSCI	Social Sciences Citation Index
US	United States of America
USA	United States of America
USA	United States of America

Chapter One

Introduction

1.1. Background of the thesis

This thesis investigates three crucial issues on corporate defaults. These are corporate governance and default prediction; corporate governance and default correlation; and, capital structure adjustment and default prediction.

The prediction of corporate default[1] has been of momentous interest among the practitioners and academics over the last four decades in credit risk research. Due to the dynamic nature of default firms and the changes of the regulatory environment, the practitioners and academics strive to develop improved credit risk prediction models. More importantly, following the financial crisis of 2007-2009, significant attention is given to credit risk assessment at the micro level i.e., measuring credit risk at an individual firm level. Credit risk calculated at the individual firm level from a default prediction model is called the 'Probability of Default'. Financial institutions need reliable default prediction models to make appropriate lending decisions and to reduce economic losses resulting from firm defaults. Financial institutions require timely and accurate information to build customized default prediction models depending on the appropriateness of the information relating to such as the economy, ownership, and the industry of the firms being evaluated.

The present thesis is structured into three essays and these three essays contribute to knowledge in several ways through empirically testing previously untested research hypotheses relating to corporate defaults. The novelty of this thesis is that, unlike the previous works, the default prediction model tested uses a combination of accounting, share market and corporate governance information in

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

a single predictor model. The effect of the comprehensive application of corporate governance information on corporate default prediction is also investigated. Moreover, this thesis compares the value relevance of the predictor information (accounting, share market and corporate governance) for predicting corporate defaults between emerging and mature markets.

Furthermore, this thesis examines the default risk at portfolio level by giving special consideration to corporate governance. It pioneers research into the effect of corporate governance on default correlation. From the results, the thesis provides direction for financial institutions and corporate managers to explore the behaviour of capital structure adjustments. The results from fault firms are compared to those from non-default firms over different time periods. Finally, the thesis examines the effect of leverage dynamics on default prediction models.

The following sections (1.2 to 1.4) provide an overview of the three essays comprising the body of this thesis.

1.2. Corporate governance and default prediction

The first essay focuses on corporate governance and corporate defaults, drawn from two research papers. The first paper tests the relative significance of the application of comprehensive corporate governance information in a corporate default prediction model. The second paper compares the effectiveness of different predictor information from mature markets with that from emerging markets.

Prior default prediction models give primary attention to testing different default predictor information with the aim of improving default probability predictions. Financial data based on accounting and share market information receives substantial attention. The importance of including corporate governance variables into credit risk modelling is also emphasised (Altman, 2006; Platt and Platt, 2012). Some researchers argue that if corporate governance affects company performance then the attributes of corporate governance also ensure the survival of a company (e.g., Goktan, Kieschnick, and Moussawi, 2006). Although some studies test the effect of corporate governance on bankruptcy prediction (e.g., Daily and Dalton, 1994a, 1994b; Gales and Kesner, 1994; Simpon and Gleason, 1998; Elloumi and Gueylé, 2001; Parker et al., 2002), these works are restricted to a few

governance variables, such as board characteristics and ownership concentration. This thesis tests and shows other variables are also important determinants of default prediction.

In this first essay, binary logistic regression is used for U.S. default data over the period of 2000 to 2015 to examine the effect of corporate governance on default prediction. Standard & Poor's (2002) governance framework is considered to be a comprehensive analysis of corporate governance information, pertaining to the corporate governance literature. Accordingly, the governance information is identified into four major dimensions: ownership structure and influence, shareholder rights and relations, financial transparency and disclosures and board structure and effectiveness.

For the first time, this research tests the incremental contribution of non-financial corporate governance information in addition to financial information, using a default prediction approach. This research emphasizes the importance of integrating these two forms of information as they are not mutually exclusive.

Research on default prediction starts by using accounting information (e.g., Beaver, 1966; Altman, 1968) and then shifts to using market-based information (e.g, Merton, 1974; Black and Scholes, 1973). However, researchers deem financial ratios as a backward-looking (e.g., Beaver, McNichols, and Rhie, 2005) and not highly relevant to making predictions about the future. To address the accounting information problems, researchers apply market information (e.g., Beaver, 1966; Beaver et al., 2005; Agarwal and Taffler, 2008). However, market-information-based models remain valid only in an efficient market. Furthermore, market-based-information is subject to manipulation through insider dealings, and this behaviour is a distinct challenge in the capital market. Subsequently, researchers criticise models based purely on financial information (i.e., accounting and market information).

Few studies use qualitative information and quantitative information together to improve default probability. An emergent question in the literature is about the effects of incorporating corporate governance into default prediction models. Few studies have tested the ability of corporate governance variables to predict corporate defaults and variables of the board characteristics and ownership concentration are mainly considered (e.g., Daily and Dalton, 1994a, 1994b; Gales

and Kesner, 1994; Simpon and Gleason, 1998; Elloumi and Gueylé, 2001; Parker et al., 2002). This essay tests the incremental contribution of the integrated accounting, share market and corporate governance information compared to models with single piece of financial and nonfinancial information. The prediction performances are evaluated by using the accuracy ratios under the Receiver Operating Characteristics and Cumulative Accuracy Profile curves.

The essay also identifies how the applicability of the integrated information models individually and collectively differs between an emerging and a mature market. The research on a mature market is based on companies in the US. For an emerging market, the study employs data of Sri Lanka. The rationale for such comparison between US and Sri Lanka follows.

The literature on corporate governance divides the governance system into two groups i.e., the Anglo-American and the Continental European/Japanese (Aguilera, Williams, Conley, & Rupp, 2006). The US belongs to the Anglo-American group, whereas Sri Lanka belongs to the European and Asian group. The practices of the European and Asian are categorised as the insider model, wherein ownership is highly concentrated, and both the transparency of market information and the standard of disclosures are low. The US is deemed to be market-oriented and tend to have diffused ownership- an outsider model. In the outsider model, there are well-governed regulations and laws, high standard disclosures, and high market transparency. Institutional investor ownership by entities such as banks, trust funds, insurance companies, investment advisory companies, pension funds, and investment companies is high in the US. There are, therefore, clear differences between the US and Sri Lanka in terms of their different market conditions and corporate governance practices. Consequently, it is reasonable to assume that default prediction information applies differently within the two countries.

1.3. Corporate governance and default correlation

The second essay examines the effect of corporate governance on default correlation. This study presents convincing reasons for using all four areas of corporate governance in default correlation.

Financial institutions use internal credit rating models to assess the default probability of individual borrowers. However, a credit portfolio manager is

concerned about not only the defaults of the individual borrowers but also the possible correlation among multiple default events in a credit portfolio. Default correlation implies the relationship between individual default probabilities and joint default probabilities among firms.

Researchers continuously explore the culprits behind the joint default probabilities of firms. Thus, the extant literature on default correlation shows there are three main reasons for joint default risk, namely, cyclical correlation, (Duffie, 1998; Keenan, Hamilton & Berthault, 2000; and Duffie, Saita & Wang, 2007), contagion effect (Aharony and Swary, 1983; Lang and Stulz, 1992; and Giesecke, 2004), and learning from defaults (Jarrow and Yu, 2001). Researchers test several proxies for the above main three reasons, for example, parent-subsidiary relationship under the contagion effect. More recently Li and Chen (2018) test the default correlation due to liquidity, systematic risk, and size as an extension to the three primary sources of default correlation proposed by Das, Duffie, Kapadia and Saita (2007).

However, the reasons behind the joint default probabilities among firms remain elusive and results of are inconclusive. This thesis extends the primary sources of default correlation suggested by Das et al. (2007) by considering firms' corporate governance practices. Thus, this thesis makes contributions by testing the impact of corporate governance on corporate default correlation for the first time.

Corporate governance is the mechanism to monitor managers and to reduce agency problem which arises due to the separation of ownership from management. There are two types of agency conflicts: the conflicts between managers and stakeholders (including shareholders and debtholders), and the conflicts between shareholders and debtholders. The role of corporate governance is highly valued in the US market where the ownership is widely dispersed. Thus, a strong corporate governance system could guarantee that there is no vacuum for managerial opportunism. The second conflict of interest arises between shareholders and debtholders, which creates the agency cost of debt. Generally, shareholders would like to pursue risky investments and the success of the projects yields the benefits to the shareholders; however, the failure of those investments affects firm's cash flows and causes reduction of the value of collateralization. Thus, the risk-shifting behaviour from shareholders to debtholders arises. Given such, these two kinds of

agency problems reduce the value of firms and increases default risk either via managerialism or by risk-shifting behaviours.

Thus, this essay focuses on examining the effect of the corporate governance mechanism on default correlation by linking the firm's specific governance attributes to the main sources of default correlation. The literature explicitly affirms that corporate governance affects default risk. Moreover, the literature establishes that default firms are associated with different levels of corporate governance practices in terms of board characteristics (e.g., Daily and Dalton, 1994a), and ownership characteristics (e.g., Elloumi and Gueyie, 2001). Bhojraj and Sengupta (2003). Ashbaugh-Skaife et al. (2006) find firms with a stronger governance mechanism enjoy higher credit ratings and lower default risk.

However, the literature on corporate governance suggests that the reaction of corporate governance practices is different due to the changes of macroeconomic conditions. Evidence of this is provided by, for example, Erkens, Mingyi, and Matos (2012)[2]. Further, Hutchinson and Gul (2004) argue that specific industries adopt similar corporate governance practices[3]. Thus, it is expected that firms with similar governance practices behave similarly due to industries and economic changes. The essay examines how the similar corporate governance practices of firms, in particular, weak corporate governance, affect default correlation due to cyclical and contagion effect. The essay considers four important attributes of governance mechanism, that is, ownership structure and influence, board effectiveness, financial transparency and shareholder rights. It is assumed that governance mechanism reduces the two kinds of agency conflicts and ensures an independent monitoring of the management to avoid managerial opportunism and the risk-shifting problem. Thus, the essay explores the effect of governance mechanism on default correlation due to the cyclical and contagion effect.

[2] They find that firms with higher institutional ownership take high risk prior to the crisis and create more losses to the large shareholders and firms with more independent boards raised more equity capital during the crisis.

3 They find that corporate governance practices affect the firm performances and the linkage of the organizational environment.

1.4. Capital structure adjustments and corporate defaults

The third essay focuses on the capital structure and corporate defaults. The essay examines (i) the heterogeneity of capital structure adjustment among default and non-default firms and over different time horizons, and (ii) the effect of leverage dynamics for default prediction.

The speed of capital structure adjustments varies mainly due to transaction cost and other reasons. For example, financial constraints[4] significantly affect the speed of capital structure adjustment (e.g., Korajczyk and Levy, 2003; Byoun, 2008; Dang et al., 2012). These studies consider the changes in the financial conditions in the short term by using the cash flow identity. However, in finance, there are two types of credit risk, default risk and risk of downgrading. Nevertheless, the risk investors should be focused on is that if they invest in a business, it might suffer financial distress and eventually go bankrupt, which will cause a permanent loss for the investors. Such risk is default risk. In other words, default is defined as the event that firms have gone through the bankruptcy or liquidation process. This essay fills a gap in the capital structure literature and finds heterogeneity of the adjustment speed among default and healthy firms.

Furthermore, this essay argues that the leverage adjustment behaviour of firms varies over time. Most of the extant literature on the issue of speed of capital structure adjustment focuses on the contemporaneous adjustment speed. It is posited that the studies based on the contemporaneous analysis are unable to capture the long-run financial behaviour of the firms (Leary and Roberts, 2005). It is also suggested that capital structure is formed as a result of the cumulative outcomes of the historical reactions to market changes (Baker and Wurgler, 2002). Further, Flannery and Rangan (2006) find that a firm accomplishes about one-third of its target leverage each year. Therefore, it is vital to examine the degrees of the speed of adjustments over multiple time horizons as the firms' histories influence the capital structure.

To fill this gap, this essay examines the heterogeneity of leverage adjustment speed over various time horizons and it addresses two types of speed of

[4] Different terms have been used in the literature for defining financial issues such as, financial deficit, and financial imbalances.

adjustments: cumulative and marginal. Very few studies addressed the issue on speed of adjustment over long-time horizons. An exception is Kayhan and Titman (2007) who examine the effect of the long-time horizon on the changes of capital structure decisions. The contribution from this essay is that it extends the literature by examining the SOA over various time horizons and using the two measurements of leverage adjustment speed (cumulative and marginal).

Finally, the essay focuses on the effect of capital structure dynamics on default prediction. Traditional capital structure theories hold that firms pursue target leverage by considering the trade-off between the cost and benefits of debt financing. Thus, it is posited that when the firms strive to focus only on the benefits of debt financing they will face the risk of financial distress or bankruptcy. However, dynamic capital structure models suggest that firms actively rebalance their leverage towards the target leverage with varying degrees. Löffler, and Maurer (2011) argue that if firms chase for the target leverage, the future leverage ratio is predictable. They show that leverage forecasts increase the discriminatory power of default prediction based on a hazard model.

Several studies have empirically incorporated capital structure dynamics into credit risk measurements. In particular, Collin-Dufresne and Goldstein (2001), Dangl and Zechner (2004), and Hui et al. (2007) use mean-reverting leverage ratio as a determinant of structural credit risk modelling to measure the default probabilities of corporate bonds.

Throughout this essay, comprehensive application of default predictor information is deemed necessary for correct classification between default and non-default firms. Even though previous studies have assessed default risk using capital structure dynamics, none were found to empirically examine the ability of leverage dynamics to predict default under a comprehensive default predictor environment. It appears that the combination of financial information (i.e., accounting and share market information), and non-financial information (i.e., corporate governance information), provides better credit risk assessments. This essay argues that the integration of leverage deviation with accounting, share market and governance information provides firm-specific risk information that is not subsumed by each other.

1.5. Structure of the thesis

The remainder of the thesis is organized in five chapters. A brief overview of each chapter is given below. The thesis covers five peer-reviewed papers being summarised into three essays, and these articles have been either published or submitted in academic journals at the time of thesis submission. Chapter one provides an overview of the thesis. Chapter two includes two research papers entitled, "Corporate governance and default prediction: a reality test" and "Financial versus non-financial information for default prediction: evidence from Sri Lanka and the USA". Chapter three presents the paper entitled, "Corporate governance and default prediction". Chapter four shares two research papers entitled, "Heterogeneity in capital structure adjustment revisited: default versus non-default firms and short versus long time horizon" and "Do leverage dynamics strengthen bankruptcy prediction? A comprehensive test". Chapter two to four are structured with an abstract, introduction, review of the literature, research methodology, conclusion, and references. Chapter five concludes with a summary of the thesis's findings together with research contributions, limitations and suggestions for future research directions.

Chapter Two

Corporate governance and default prediction

Chapter two consists of two research papers to address and test the impact of corporate governance on default prediction. The title of the first paper is "Corporate governance and default prediction: A reality test." This paper has been published in *Applied Economics* (SSCI and ABDC ranking = A) in 2019. This paper addresses several testable hypotheses concerning the relations between corporate governance and default prediction, building on the Standard and Poor's (2002) corporate governance framework. The conventional logistic regression is employed to provide empirical evidence from U.S. default data over the period of 2000 to 2015. It finds that default firms are associated with concentrated ownership, low shareholder rights, low financial transparency and low effectiveness of the board. It also finds that corporate governance information provides a positive contribution to financial information for default prediction models.

The title of the second paper is "Financial versus non-financial information for default prediction: Evidence from Sri Lanka and the USA." The paper has been published online by *Emerging Markets Finance and Trade* (SSCI and ABDC ranking = B) in 2019. This paper contains the results of a comparative study using the data of Sri Lanka, which serves a representative emerging market. It argues that emerging markets are important because they present several institutional differences that cannot be examined in the developed markets. The rapid evolvement of these markets provides excellent experimental grounds for studying many financial issues. The empirical results show that whilst an integrated model provides overall stronger predictive value, financial information is more relevant for USA firms than for Sri Lankan firms. Corporate governance appears more relevant in emerging markets than in mature markets. Further, the effectiveness of the individual corporate governance differs between the two countries.

Corporate governance and default prediction: A reality test

Declaration about the role and the contributions of authors

I (Ruwani Fernando) confirm that I am the principal author of the following paper. As the principal author, I developed the conceptual framework, collected the data, conducted the data analysis, interpreted the results, and wrote the research paper. Associate Professor Li provided conceptual advice, commented on and edited all versions of the paper. Greg Hou also commented on and edited all the versions of the paper.

Please see the Co-authorship form attached in Appendix 1.

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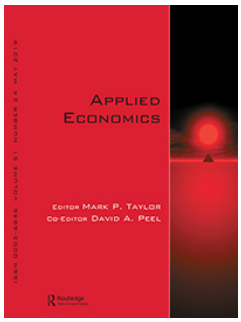
- Fernando, J.M.R., Li. L., & Hou. G. (2019). Corporate governance and default prediction: A reality test, *Applied Economics*, *51*(24), 2669-2686, doi: 10.1080/00036846.2018.1558351.



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Corporate governance and default prediction: a reality test

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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:

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

where the explained variable, y^{*}_{it+1}, i= 1, 2, …, N and t = 1, 2, …, 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

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

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:

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

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, blockholdings (*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 $\chi^{2,}$ 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.

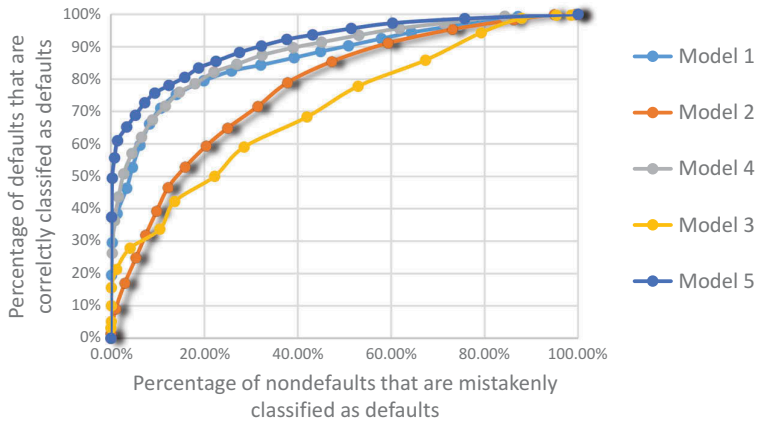

Figure 1. ROC curve for alternative models.

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

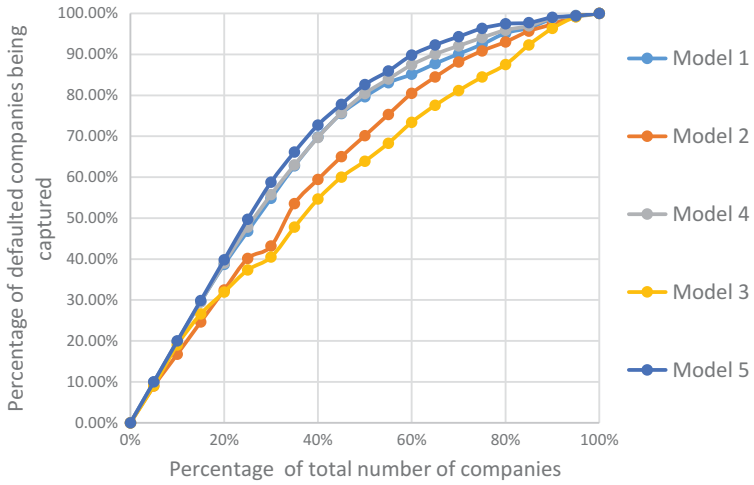

Figure 2. CAP curve for alternative models.

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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Financial versus Non-Financial Information for Default Prediction: Evidence from Sri Lanka and the USA

Declaration about the role and the contributions of authors

I (Ruwani Fernando) confirm that I am the principal author of the following paper. As the principal author, I developed the conceptual framework, collected the data, conducted the data analysis, interpreted the results, and wrote the research paper. Leon Li provided conceptual advice, commented on and edited all versions of the paper. Greg Hou also commented on and edited all the versions of the paper.

Please see the Co-authorship form attached in Appendix 2.

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Financial versus Non-Financial Information for Default Prediction: Evidence from Sri Lanka and the USA

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ABSTRACT: We report the effectiveness of corporate governance variables (GOVs) in default prediction, in a comparative study between Sri Lanka and the USA. Twelve GOVs are tested in addition to the standard financial data. A panel logit model framework is employed to conduct empirical tests on 730 Sri Lankan and 3280 USA observations from 2000 to 2015. Whilst an integrated model provides overall stronger predictive value; financial information is more relevant for USA firms. GOVs appear more relevant in emerging markets than in mature markets, but the effectiveness of the individual GOVs differs between countries.

KEYWORDS: corporate governance, default prediction, emerging markets, financial information, mature markets

JEL CLASSIFICATION: C01, C24, G21, G33, G34, N20, N25

Default prediction studies were initiated in the late 1960s, and most of those studies tested mature markets, predominately in the USA (Bellovary, Giacomino, and Akers 2007). Latterly, emerging markets have become the focus of a considerable number of studies (e.g., Lee and Yeh 2004; Wang and Deng 2006; and Liang et al. 2016). In both mature and emerging markets, bankruptcy[1] prediction has originated from financial information; however, attention has shifted to confirming the significance of corporate governance as a non-financial information source (e.g., Daily and Danton, 1994; Parker, Peters, and Turetsky 2002; Simpon and Gleason, 1999).

In this paper, we demonstrate the value of examining a comprehensive set of corporate governance variables (GOVs) in both an emerging and a mature market. Ignorance of essential governance aspects could devalue the overall default prediction. It is reasonable to assume that the effectiveness of the various corporate GOVs is different according to the market. Corporate governance practices in emerging markets are seen to be less effective in terms of ownership concentration and board effectiveness due to the share-ownership by founding families (Young et al. 2008) and weaker legal systems (Klapper and Love 2004).

Emerging markets present several institutional differences that are not present in mature markets. The rapid evolvement of emerging markets provides excellent experimental grounds for studying many financial issues. For instance, Lee and Yeh (2004) and Liang et al. (2016) examine the effect of ownership concentration and board composition on financial distress prediction using the data of firms from advanced emerging markets. Our study extends the research by testing sample firms in Sri Lanka, a representative secondary emerging market.[2] Secondary emerging markets possess less mature equity markets and lower transparency than advanced emerging economies (Classens and Yurtoglu, 2013). Although the literature on emerging and mature market comparisons treats all the emerging economies as one category, they have different characteristics. Classens and Yurtoglu (2013) find the quality of corporate governance is higher in mature markets compared to emerging

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markets. Further, emerging markets show substantial differences in the governance characteristics when compared to mature markets.

We follow the Standard and Poor's (2002) governance framework in which four dimensions of corporate governance are considered: ownership concentration, shareholder rights and relations, financial transparency, and board effectiveness. Thus, we contribute to the literature by adopting a comprehensive analysis of corporate GOVs to examine the effect on default prediction in firms in Sri Lanka and the USA.

We provide a comparative analysis between the two countries, which furnishes new evidence on the effectiveness of financial and non-financial information in default prediction. We argue that if markets are efficient and the quality of financial information is high, we may mainly rely on financial information for default prediction. However, if markets are not efficient, non-financial information becomes essential. Accordingly, we expect the effects of the financial versus non-financial information on default prediction will vary between mature and emerging markets. To the best of our knowledge, few studies have systematically looked at this aspect.

Further, our study explores the effectiveness of an integrated model, based on financial (accounting and market) and non-financial (corporate governance) information to reduce default prediction errors, when compared to a single predictor model. A number of studies reveal a combination of different approaches (e.g., Kealhofer and Kurbat 2001), and various information (Li and Miu 2010) improves default prediction. We extend these studies further by providing a comparative analysis between the USA and Sri Lanka. The rest of the paper is organized as follows. Section 2 reviews the literature and develops hypotheses. Section 3 presents the research methodology. Section 4 reveals the empirical results. And Section 5 concludes the paper.

Literature and Hypotheses Development

Information for Bankruptcy Prediction

The literature identifies two basic forms of financial information (Tinoco and Wilson 2013), being accounting information as in Beaver (1966)[3]; Altman (1968); and market information by Black and Scholes (1973); Merton (1974); using option pricing models. The early studies on bankruptcy develop from the seminal work by Beaver (1966). Since then some studies follow the univariate analysis (e.g., FitzPatrick 1932; Smith and Winakor 1935). The first multivariate study starts with Altman's study in (1968), and it introduces the "Z-score" model with five higher predictable ratios. The application of multivariate models is still popular since the 1960's, and a recent study by Kim (2018) also examines the bankruptcy threshold differences using the Z-score model. The main advantage of using accounting information is its wide availability and accessibility. However, accounting information is prepared on the basis of 'going concern' valuations whereas default violates this key concept of accounting (Hillegeist et al. 2004). Further, Hillegeist et al. (2004) argue that ratios based on a firm's assets do not consider the volatility in the value of those assets.

Due to the weakness in accounting information, researchers use market information to improve default prediction. Agarwal and Taffler (2008) point out the importance of market-based information as it is backed by sound theoretical underpinnings and is free from accounting accrual adjustments. Further, Beaver (1968) finds that, in an efficient market, the market information could anticipate the default probability more quickly than the accounting ratios. Therefore, the problem is how to incorporate the market information into the credit risk modeling directly. The issue is resolved using the theory of option pricing introduced by Black and Scholes (1973) and Merton (1974). See, for example, Vassalou and Xing (2004) and Bharath and Shumway (2008). 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; Campbell, Hilscher, and Szilagyi 2008; Li and Miu 2010).

Altman, Sabato, and, Wilson (2008) maintains qualitative or soft information can enhance the assessment of a borrower's credit quality. Bhimani, Gulamhussen, and Lopes (2013) endorse the importance of non-financial information to default prediction of non-listed firms. They highlight that evaluation of non-financial information is needed, such as institutional settings, firm type, and industry group. Chaganti, Mahajan, and Sharma (1985) pioneer examining differences in corporate governance information between failed and non-failed firms, by considering three board characteristics. Later, studies affirm the incorporation of corporate GOVs as non-financial information (for example, Gales and Kesner 1994; Simpson and Gleason 1999; Daily and Dalton 1994; and Lee and Yeh 2004).

Mature Markets

Beaver (1966) develops the first bankruptcy prediction model based on accounting information for credit risk modeling. He used data from publicly owned industrial USA firms. Altman (1968) follows by developing the Z-Score model based on the multivariate discriminant analysis (MDA),[4] using USA corporate data. Later, other studies also used USA data for bankruptcy prediction (e.g., Casey and Bartczak 1985; Daily and Dalton 1994; Li and Miu 2010).

Several studies of non-USA mature markets relating to bankruptcy prediction were initiated in the 1970s. Takahashi and Kurokawa (1984) use data from Japanese listed companies and suggest the auditor's report should be considered as well as financial statements data. Izan (1984) is the first study using Australia data. Elloumi and Gueyie (2001) use Canadian data and find corporate governance (board director composition) affects financial distress. Agarwal and Taffler (2008), and Tinoco and Wilson (2013) investigate listed companies in the UK. Tinoco and Wilson (2013) find the utility of combining accounting, market and macroeconomic data for bankruptcy prediction. However, no attention to firm-specific non-financial information has been given in their studies. Recently, Ciampi (2015) examines the impact of corporate governance using data from small and medium-sized enterprises in Italy and reveals the importance of GOVs information for SMEs default prediction. Overall, in studies on mature markets, governance aspects are limited to board composition and ownership structure.

Emerging Markets

In emerging markets, researchers use financial and non-financial information individually or collectively for bankruptcy prediction. Most of the emerging market literature focuses on accounting or corporate governance data. For example, Gupta (2014) tests the Z-score and ZETA model for the listed companies in India by using macro and accounting ratios. Samarakoon and Hasan (2003) apply three versions of Z-score models to predict financial distress of the listed companies in Sri Lanka. Salehi and Abedini (2009) and Sandin and Porporato (2008) predict financial trouble by using financial ratios of listed companies in Iran and Argentina, respectively.

Since the year 2000, using corporate governance data, Lee and Yeh (2004) and Liang et al. (2016) examine Taiwanese companies. Wang and Deng (2006) use Chinese companies, and Lakshan and Wijekoon (2012) use a dataset from Sri Lanka. Overall, studies on the emerging market do not develop the models further but extend the mature market-based studies to new locations.

Hypotheses Development

Default generally arises due to the poor financial performance of a company. Corporate governance is the system by which companies are directed and controlled (Cadbury, 1992). Therefore, the poor financial performance of firms is attributed to the failure of corporate governance of firms because studies has shown the effect of corporate governance on firm performances (Agrawal and Knoeber

1996; Thomsen, Pedersen, and Kvist 2006). Goktan, Kieschnickand, and Moussawi (2006) argue that if corporate governance affects company performance, the attributes of corporate governance also ensure the survival of the company. The literature on default prediction further confirms the effect of corporate governance on firm's default probability (e.g., Daily and Dalton 1994). Even though studies examine the incremental contribution of corporate governance on default prediction, few studies systematically conduct a comparative analysis between mature and emerging markets. Moreover, there is no single good corporate governance system that is applicable to all economies due to the differences in legal systems, institutional frameworks, cultures, and economic conditions. Therefore, in general, firms follow the best practices to attract investors. These best practices are different from one country to another. Thus, our research focuses on the effectiveness of governance information, categorized as non-financial information, on overall default prediction in an emerging market, SL, and a mature market, USA. We define effectiveness as the ability of the various corporate GOVs to identify default firms from non-default firms.

The corporate governance system of the US is deemed as a market-based system, and the system is characterized by widespread ownership structure, higher investor protection, and professional manager representation (Bhasa 2004). SL, which is an emerging market, carries the features of the relationship-based model where it consists of the characteristics of concentrated ownership, cross corporate shareholding, concentrated voting power (Maher and Andersson 2000). These differences stimulate our interest to explore the effectiveness of corporate governance information in classifying the default and non-default firms in both contexts. A recent study by Kim (2018) compares Korea with the U.S. and examines the reasons for bankruptcy threshold differences on institutional quality. It suggests that the Z-score bankruptcy threshold in the US is higher than that of Korea.

Even though there is extensive literature on the effect of corporate governance on default prediction, only the board characteristics in the mature markets are tested (e.g., Daily and Dalton 1994; Parker, Peters, and Turetsky 2002; Simpson and Gleason 1999). Research on emerging markets focuses primarily on ownership concentration and secondary board characteristics (e.g., Lee and Yeh 2004; Wang and Deng 2006). However, in order to compare the effectiveness of governance information in identifying default from non-default firms between two economies, it is necessary to consider a comprehensive set of governance information due to the differences in the governance systems. For this purpose, we use the Standard & Poor (2002) governance framework to systematically assess the effect of firms' corporate governance on default prediction. In contrast to other governance frameworks, Standard & Poor covers the aspects relating to individual company and country governance aspects (Manawaduge 2012) where we believe these dimensions account for the institutional differences between the two contexts. The four dimensions are ownership structure and influence, shareholder rights and relations, financial transparency and board effectiveness. Next, we describe how and why these four dimensions are critical in both contexts.

Corporate ownership has a more significant influence on building governance systems around the world. For example, the US governance system is characterized mainly by dispersed ownership where the managers have a higher power in decision-making. Therefore, the managers make decisions for their interest, increasing the agency cost. Hence, the agency theory argues that ownership concentration improves firm performances and reduces the agency cost. The governing system of SL is characterized by concentrated ownership (Senaratne and Guneratne 2012). However, studies in emerging markets support the view that ownership concentration (Claessens et al. 1999) and weaker legal systems (Klapper and Love 2004) lead to governing practices that are not as effective as those in the mature markets. Conversely, Manawaduge (2012) finds that concentrated firms in SL have higher financial performances compared to dispersed ownership ones.

From an agency theory perspective, the managers as the agents of the shareholders do not act for the interest of shareholders but their interest. This increases the agency costs and exasperates internal inefficiencies. Therefore, agency theory argues that one of the purposes of governance mechanism is

to assure shareholders that managers achieve the best to meet the shareholders' interest (Jensen and Meckling 1976). Therefore, shareholders should be given adequate rights to monitor the firms. Maher and Andersson (2000) show that relationship-based governance system provides concentrated voting rights due to concentrated ownership structure. The market-based model offers higher investor protection due to dispersed ownership. Therefore, it is necessary to find the effectiveness of shareholder rights on default prediction in both contexts because this dimension also implies the legal infrastructure of the two economies.

Transparency and disclosures are essential to reduce information asymmetry and to ensure that managers are accountable for the shareholders (Ashbaugh-Skaife, Collins, and LaFond 2006). The Cadbury report (1992) identifies that the foundation of a governance structure is the transparency and disclosures. This dimension emphasizes how a firm conveys the information to the stakeholders effectively. 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). We assume the effectiveness of the dimension varies across SL and US because if the controlling shareholders in the board dominate the firms in SL, the effect might be different from the US context.

The board structure is essential since the board provides an independent view on management performance and is responsible for the effective governance of the company (Simpson and Gleason 1999). Under the agency theory, Chaganti, Mahajan, and Sharma (1985) argue a larger board creates issues for coordination and increases managers' freedom in decision-making. In contrast, resources dependency theory states a larger board has the advantage of diversified skills and broader linkages to the external environment (Pearce and Zahra 1992). Platt and Platt (2012) find board composition and board member characteristics can prevent a firm from getting bankrupt relating to US context. 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. 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 is 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 and Gueyie (2001), Wang and Deng (2006) and Platt and Platt (2012) establish independent directors are significant in bankruptcy prediction.

Due to the importance of these four dimensions on individual and country governance aspects, the need for comprehensive application of governance information for default prediction is imperative. Specifically, the framework covers the aspects of market infrastructure, legal infrastructure, regulatory environment, and information infrastructure through ownership structure and influence, shareholder rights and relations, financial transparency, and board effectiveness (Manawaduge 2012). We henceforth hypothesize:

H1: Corporate governance as non-financial information plays a vital role in identifying default from non-default firms in both Sri Lanka and the USA.

There are definite limitations of using either accounting based values or market information for bankruptcy prediction, especially if markets are not efficient. As a result, most of the empirical studies have tested corporate governance as a critical non-financial factor to be used with conventional accounting measures for default forecasting (e.g., Daily and Dalton 1994; Parker, Peters, and Turetsky 2002; and Liang et al. 2016). However, the extant literature has not attempted to consider whether the non-financial information is a more important predictor for default probability in emerging markets when compared with mature markets. We expect the effects would vary with different information on default prediction across different markets. We argue that non-financial

information could be more relevant to emerging economies and that it should be given a higher weight when evaluating the likelihood of default.

Berglof (1990) identifies two forms of financial systems: bank-oriented and market-oriented. In bank-oriented financial systems, firms have close relations with banks to find their capital needs whereas in market-oriented financial systems the firms use numerous ways to fund their capital. Ali and Hwang (2000) find the relevance of financial reporting is less if economies have: (i) bank-oriented financial systems, (ii) less private sector involvement for accounting standard settings, and (iii) political and economic-oriented tax systems. Aguilera and Jackson (2003) suggest emerging markets are bank-oriented and mature market as market-oriented. Accordingly, we argue that non-financial information has higher default prediction ability than financial information in Sri Lanka, an emerging market. Additionally, we argue that the effectiveness of financial information (i.e., accounting and market information) has less relevance in default prediction in Sri Lanka than in the USA, a mature market. We hypothesize:

H2: Non-financial information has higher default prediction ability than the financial information in Sri Lanka than the USA.

Even though we propose that non-financial information is superior to financial information in emerging markets, Li and Miu (2010) argue that default models using financial information should not be neglected entirely. Many empirical studies using USA firm data test for the superiority of market-based models, with varying inputs, and varying results. Hillegeist et al. (2004) find the market information-based model performs better than the accounting-based model. Campbell, Hillscher, and Szilagyi (2008) find a model with accounting and market variables has higher prediction accuracy than that with either accounting or non-financial information. Further, Miller (1998), and Mitchell and Roy (2007) also find better performance by combining different types of information. Accordingly, we propose that integrating accounting, market, and corporate governance information may be more valuable for default prediction than any model with fewer types of information. We hypothesize:

H3: An integrated model, with accounting, market and corporate governance information, performs better than any other model with fewer categories of information in Sri Lanka and the USA.

Research Methodology

Panel Logit Model

This study employs a panel logit model framework to conduct empirical tests. The panel logit model allows the time-varying covariates (Shumway 2001; Tinoco and Wilson 2013). The 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}, with $i = 1, 2, \ldots, N$ 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 time $t + 1$. The x_{it} is a vector of the explanatory variables for firm's credit quality, and e_{it+1} 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, the panel logit model follows a conditional logit distribution. The conditional probability of $Pr\,(Y = 1 \,|\, x)$ is obtained with the following model:

$$prob(y_{it+1} = 1 | x_{i,t}) = \frac{e^{cont.+\beta x_{it}}}{1 + e^{(cont.+\beta x_{it})}}. \tag{2}$$

Then

$$prob(y_{it+1} = 1|x_{1t.}.....x_{kt.}) = \frac{1}{1 + e^{-(cont.+\beta x_{it})}}. \tag{3}$$

Therefore

$$prob(y_{it+1} = 1|x_{1t.}.....x_{kt.}) = \frac{1}{1 + e^{-\left(\sum_{i=1}^{k} \beta_1^0 x_{it}\right)}}. \tag{4}$$

Empirical Models

This study tests the effectiveness of financial and non-financial information in Sri Lanka and the USA for the default prediction. Specifically, the credit quality of firm is developed as follows:

$$y^*_{it+1} = cont. + \beta_1 ACC_{it} + \beta_2 MKT_{it} + \beta_3 GOV_{it} + e_{it+1}, \quad e_{it+1} \sim (0, \sigma). \tag{5}$$

The integrated model (INTG) described in Equation (5) includes three types of information for firm credit quality where *ACC* represents accounting information, *MKT* represents market information, and *GOV* represents corporate governance information. We test whether INTG provides incremental information for bankruptcy prediction than any non-integrated model (with one category of information only). We propose three alternative empirical models for comparison, being of ACC, MKT, and GOV separately.

Prediction Evaluation Methods

According to Anderson (2007), studies should not use a single measure to evaluate the performance of default prediction models. Therefore, we use five measures, that is, Receiver Operating Characteristics (ROC), Cumulative Accuracy Profile (CAP), Gini rank coefficient, Kolmogorov-Smirnov curve, and Pseudo R^2 to evaluate the prediction performance and test the consistency of the results.[5] The ROC curve identifies how correctly a model discerns default from non-default firms based on a cut-off point. Evaluation using the ROC curve requires the determination of a cut-off point. In a ROC curve, the *y*-axis represents the 'true positive rate' (percentage of defaults that are correctly classified as defaults) and the *x*-axis represents the 'false positive rate.' The resultant area under the curve (AUC) is a direct measure of predictive accuracy.

Using CAP, the companies are ranked according to their predicted default probabilities ranging from the highest to the lowest. CAP calculates the cumulative frequencies of the total number of companies based on default scores (*y*-axis) against the cumulative frequencies of the default companies captured as a percentage (*y*%) of a total number of default companies (*x*-axis).[6] The Gini rank coefficient and the Kolmogorov-Smirnov test are based on the AUC of the ROC curve. Gini rank coefficient is used to identify how well the model segregates default from non-defaults.[7] The Kolmogorov-Smirnov test is the most used evaluation method in the USA (Anderson 2007; Mays 2004). It identifies the maximum vertical deviation between the cumulative percentage of a number of defaults and percentage of a total number of companies with different default probability ranges.[8] Pseudo R^2 provides a general measure of goodness of fit of a logit model.

Measurements of Variables

To establish a non-financial information bankruptcy model, we employ 12 corporate GOVs, covering four dimensions of ownership structure, shareholder rights, financial transparency, and board effectiveness. These four dimensions are tested by Ashbaugh-Skaife, Collins, and LaFond (2006) who relate corporate governance to credit ratings. Panel A of Table 1 presents the definitions of non-financial corporate GOVs. The definitions of financial information (accounting and market) are given in panel B of Table 1.

Table 1. Variable definitions.

Variable	Definition
Panel A: Definition of corporate governance (non-financial) 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	
AUDCOM_QUA	1 = if the audit committee chair is an independent director, 0 = otherwise
AUD_OP	1 = if the opinion is qualified opinion, 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
Panel B: Definition of financial variables	
Accounting information	
WCTA	Working capital to total assets
CASHMTA	Cash to 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
LTDTA	Long term debt to total assets
TDTA	Total debt to total assets
CFCL	Cash flow from operation to current liabilities
CFTA	Cash flow from operation to total assets
CFTD	Cash flow from operation to total debt
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
SIZE	The logarithm of each firm's market capitalization
EXCESS RETURN	Quarterly return on the firm minus the market return based on S&P 500 (EXCESS $RETURN_{it}$ = $\log(1 + R_{it}) - \log(1 + RS\&P500_{it})$)

Empirical Results

Data

Measurement of default is a difficult task because defaults occur infrequently. We follow the definitions by Parker, Peters, and Turetsky (2002), Gilson (1989) and Ross et al. (2011) to recognize the default events for Sri Lanka.[9] That is, if a company, during the period from 2000 to 2015, suffers from losses, has negative net worth, or suffers from negative operating cash flows for more than three consecutive years; then it is deemed to default. There are 294 companies listed in the CSE at the end of 2016 representing 20 business sectors. We exclude the banking, finance, and insurance sectors from the sample selection. Accordingly, 79 companies meet at least one criterion of the above. Depending on the data availability, 73 default firms are taken for the sample. Then, by matching the sample, 73 non-default companies are selected on the basis of industry and size.

Firms encountering bankruptcy or liquidation events, as defined by the Compustat database from 2000 to 2015, are selected as default firms of the US. We use the sample matching design to choose non-default firms.[10] The initial sample contains 469 default firms. From the dataset, banks, insurance, and leasing firms, as well as firms with missing data for accounting variables and missing values for SIC codes are dropped to obtain the final sample of default firms. Finally, 136 firms are also dropped due to the unavailability of the data for corporate governance information. The remaining number of default firms is then 82. For each default firm, we choose a firm of similar size (defined by the value of total assets) in the same industry as a comparable non-default firm. The selection of comparable non-default companies effectively mitigates imbalance problems (Liang et al. 2016) .[11] For the purpose of prediction, the explanatory variables for the credit quality of firms are collected as panel data over five years before the default date on an annual[12] basis for Sri Lanka (hereafter referred to as SL) and on a quarterly basis for the US.[13] The sample of SL contains 730 firm-year observations, and that of the US has 3,280 observations. The literature demonstrates that the use of panel data may mitigate the time-varying risk of the variables (Altman and Sabanto, 2007; Shunway, 2001; Tinoco and Wilson 2013). Table 2 summarizes the final panel data sets for SL and US firms.

We obtain accounting and corporate GOVs from the published annual reports. Information on equity prices for market variables is from the CSE databases for Sri Lanka. For the US, we use the Compustat database to collect accounting and market data and proxy statements for the governance information.[14]

The Effectiveness of Governance Information for Bankruptcy Prediction

Table 3 provides the descriptive statistics of the corporate GOVs used to identify the effectiveness of governance attributes in determining the default and non-default firms in SL and the US. This analysis is conducted to address the first research hypothesis in our study which shows the corporate governance information is essential for overall default prediction. It is mainly the case for the comparison between the two economies. Therefore, we use the same set of GOVs under the four dimensions of Standard and Poor's governance framework to compare the effectiveness of governance information to differentiate defaults and non-defaults firms in both contexts.

Table 2. Distribution of firms in the final sample panel data for SL and the USA.

	Panel A: SL		Panel B: USA	
Group	No. of firms	Observations	No. of firms	Observations
Default	73	365	82	1640
Non-default	73	365	82	1640
Total	146	730	164	3280

Table 3. Descriptive statistics.

		Default		Non-default		
Predictor category	**Variables**	**Mean**	**St. Dev**	**Mean**	**St. Dev**	**T statistics**
Panel A: Descriptive statistics for Sri Lanka						
Ownership structure and influence	INST (%)	68.966	24.292	67.697	27.066	.716
	DIRECTOR (%)	10.498	18.875	14.365	23.491	**−2.956*****
	NUM_SHARE	2.888	1.449	3.093	1.638	−1.822
	BLOCK	0.945	0.228	0.923	0.266	1.299
Shareholder rights and relations	EXT_AUD	0.123	0.329	0.014	0.116	**5.914*****
	REM_MAG	0.992	0.090	1.000	0.000	−1.737
Financial transparency	AUDCOM_QUA	0.860	0.347	0.945	0.228	**−3.744*****
	AUD_OP	0.172	0.378	0.169	0.376	0.099
Board structure and effectiveness	BOARD SIZE	6.871	2.277	7.964	2.305	**−6.640*****
	CEO DUALITY	0.225	0.418	0.162	0.369	**2.034****
	IND_DIRE	2.838	1.570	3.282	1.548	**−3.830*****
	OUT_DIRE	4.274	2.168	5.603	2.096	**−8.464*****
Panel B: Descriptive statistics for the USA						
Ownership structure and influence	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	0.335	0.472	0.305	0.460	1.777
Shareholder rights and relations	EXT_AUD	0.624	0.484	0.841	0.365	**−14.171*****
	REM_MAG	0.905	0.293	0.990	0.098	**−11.063*****
Financial transparency and disclosures	AUDCOM_QUA	0.971	0.169	0.973	0.162	−0.417
	AUD_OP	0.573	0.494	0.570	0.495	0.170
Board structure and effectiveness	BOARD SIZE	6.946	1.954	7.254	2.141	**−4.196*****
	CEO DUALITY	0.539	0.499	0.520	0.500	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*****

This table presents the descriptive statistics for the predictor information for two countries based on matched paired sample design for each. The sample of SL represents 730 firm-year observations and 3280 observations for USA market over the period of 2000 to 2015. The descriptive statistics are given for mean standard deviation and the results of the paired sample t-test. *, ** and *** denote significance at 10%, 5% and 1% level, respectively.

Among the four dimensions of corporate governance information, ownership structure is particularly influential. Institutional shareholdings (INST %) of default firms is on average at 69% in SL compared to 32% in the US. The result is consistent with the emerging market studies on corporate governance (Claessens and Yurtoglu 2013). However, the US firms generally consist of dispersed ownership. The result shows that the variable (INST %)[15] does not show a significant difference between default and non-default firms in SL. However, the US firms show a significant and substantial mean difference between default and non-default firms (t-value = 8.269 for the US vs. t-value = 0.716 for SL). US-based research argues that institutional shareholders reduce the competitiveness and financial performance of the firms (Graves and Waddock 1994). Senaratne and Gunaratne (2012) find the ownership structure of the companies in SL is largely characterized by concentrated ownership where the companies are primarily influenced by controlling shareholders represented by other corporations, but not the professional institutions such as mutual funds and financial institutions. However, the role of institutional investors is vital among the firms in the US (Claessens and Yurtoglu 2013). Thereby, the INS% could significantly identify the default and non-default firms in the US.

The number of shareholders who hold more than 5% of shares (NUM_SHARE) has a significant difference between the default and non-default firms in the US but not in SL (t-value = 5.884 for the US vs. t-value = −1.822 for SL). NUM_SHARE of default firms in SL is on average 2.89 while that at U.S default firms is on average 3.97, indicating the beneficiary share-ownership is more dispersed in the US than SL. The variable BLOCK (the presence of one shareholder with 20% or more shares) is not significant in either economy (t-value = 1.777 for the US vs. t-value = 1.299 for SL); however, the average of the presence of block-holders is high in all firms in SL. In contrast, there are significantly lower block-holders in the US firms. Consequently, INST (%), NUM_SHARE, and BLOCK are not effective in signaling the default probability of firms in SL. Firms in emerging markets are controlled by either family or financial institutions (Claessens and Yurtoglu 2013). As a result, the shareholders control the firms either directly or indirectly. Our results are consistent with Holderness and Sheehan (1988) who point out that if a firm has block-holders, they usually represent management. Accordingly, the family or high shareholder-dependent structure in SL causes the block-holder attribute to be ineffective in distinguishing default from non-default firms.

Senaratne and Guneratne (2012) find that most of the listed companies in SL have concentrated ownership and they tend to have a controlling shareholder. Further, they explain that the controlling shareholder is usually represented by another corporation which is especially a parent company or a group of companies ultimately controlled by families. Manawaduge (2012) finds that firms with concentrated ownership have better performances through better corporate governance practices. Therefore, based on the previous literature our result confirms that generally the firms in SL exhibit higher ownership concentration and they show better performances. Thereby, low ownership concentration is a feature of the default firms in SL.

Low director and officers' share-ownership (DIRECTOR %) is a property of the default firms in both countries. The directors and officers of the default firms in the US own 19.9% of the equity shares compared to 10.5% in SL. In the US, due to the spread of ownership, company survival largely depends on the governing body. Therefore, to ensure better governance more company shares are allocated to board members in the US relative to in SL. However, the allocation is less in default firms than in non-default firms in both countries. But, DIRECTOR % could efficiently distinguish between the default and non-default firms in SL, but this is not the case in the USA (t-value = −1.200 for the US vs. t-value = −2.956 for SL). Jensen (1993) finds that 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). However, DIRECTOR% is more pronounced in the emerging market context due to the concentrated ownership. Overall, it is evident that ownership concentration is relatively higher in emerging markets. However, ownership concentration could effectively differentiate the default from non-default firms in a mature market due to the well-diversified shareholding structure of the survival companies compared to default counterparts and those of emerging markets.

The shareholder right to appoint the external auditor of the company (EXT_AUD) is significant in both countries at 1% level (t-statistics = −14.171 for the US vs. t-statistics = 5.914 for SL). The shareholder right to approve the remuneration (REM_MAG) of the executive management is only significant in the US (t-statistics = −11.063 for the US vs. t-statistic = −1.737 for SL). Therefore, the shareholder right as a means to control the power balance between management and owners could more effectively distinguish the default from non-default firms in mature markets compared to emerging markets. This is because a large mean difference in the two variables is found between default and non-default firms in the US. This finding accords with Gompers, Ishiiand, and Metrick (2003) who find the US firms with stronger shareholder rights have better company performance and higher market valuation. However, the default firms show a higher mean value compared to non-default firms in SL. One possible explanation is, SL as a relationship-based governance model possess concentrated voting power, thereby higher ownership concentration may bring about excessive shareholder rights in SL context leading to higher influence on management decisions.

Furthermore, Manawaduge (2012) indicates that due to the concentrated ownership in SL, the participation by the non-controlling shareholders for voting rights at the AGM is lower. Klapper and Love (2004) find shareholder rights are problematic in a country with a weaker legal system, which is the case for emerging markets. Therefore, we suggest that due to the higher concentrated ownership, the default firms are characterized by higher shareholder rights where largest shareholders' control the voting rights significantly. However, we could not neglect shareholder rights' dimension in the emerging market because we find EXT_AUD variable could significantly signal default firms compared to non-default counterparts.

The two proxies under financial transparency show default firms in the US have lower transparency than non-default firms, but higher financial transparency compared to default firms in SL on average. The variables audit committee quality (AUDCOM_QUA) and auditor opinion (AUD_OP) are not significant in the US. AUDCOM_QUA effectively distinguishes default from non-default firms in SL (t-statistic = −3.744 for SL vs. t-statistics = −0.417 for the US). Thereby the claim that corporate governance is effective[16] in distinguishing between the default and non-default firms in SL is validated, and the result is consistent with Patel, Balic, and Bwakira (2002). They find that Asian emerging markets have higher financial transparency than the other emerging markets in Latin America, the Middle East, and Eastern Europe.

Amongst the default companies, the average board size is seven. Board size is effective in distinguishing between default and non-default firms. But in SL, a higher mean difference is found compared to the US firms (t-statistic = −6.640 for SL vs. t-statistics = −4.196 for the US). A higher CEO duality exists in the US default firms compared to those in SL. However, CEO duality is only effective to differentiate between default from non-default firms in SL (t-statistics = 2.034 for SL vs. t-statistics = 1.149 for the US). The number of independent directors in default firms is on average five in the US, whereas, in SL the number of independent directors is three. The number of outside directors in the US default firms on average is five; however, in SL it is four. The significant feature in these two variables is the smaller number of independent directors on the board compared to outside directors in SL. Independent directors and outside directors are significant in both countries (Independent directors: t-statistics = −3.830 for SL vs. t-statistics = −5.942 for the US; Outside directors: t-statistics = −8.464 for SL vs. t-statistics = −7.509 for the US). Platt and Platt (2012)[17]; determine that board characteristics can predict bankruptcy in the case of US.

Similarly, we find that board effectiveness as governance information is effective in identifying default firms in SL and US. For the SL context, Senaratne and Guneratne (2012); find that participation in management by the controlling shareholders is high in the firms in SL and that enhances the corporate control. Therefore, the information relating to board structure and effectiveness is significant in the emerging market context. On the other hand, in order to reduce the agency cost board effectiveness also necessary to the US market due to the widespread ownership of the firms.

Overall, governance information is effective to distinguish default and non-default firms in both SL and US. Three of the four ownership concentration variables are insignificant in SL. Therefore, the results indicate, if we consider one aspect of corporate governance, for example, ownership concentration, in the case of SL, the results might be biased. Hence, it is necessary to capture comprehensive aspects of governance information to evaluate the overall picture of the governing process, and their impacts on default prediction are significant. Accordingly, we affirm our first hypothesis, that is, comprehensives analysis of non-financial information is necessary to effectively classify default from non-default firms in both Sri Lanka and the USA.

The Performance Comparison of Alternative Bankruptcy Information

Table 4 shows the prediction performance of accounting, market, and corporate governance information for both countries derived from the estimated logit model.[18] Corporate governance information shows higher prediction accuracy under the ROC curve with an AUC of 76.17% for SL.

Table 4. Accuracy ratio comparison of financial and non-financial model.

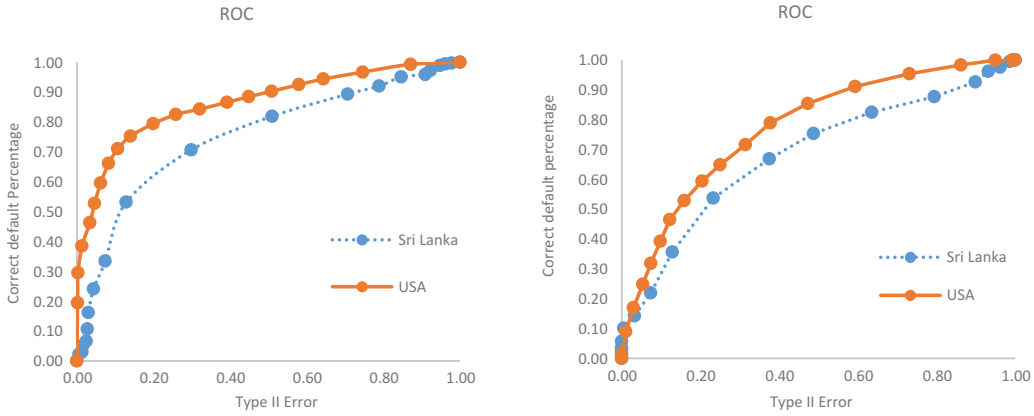
Performance Measures	ACC	MKT	GOV	FIN	INTG
Panel A: Model performances for Sri Lanka					
AUC of ROC	74.94%	68.31%	**76.17%**	77.51%	**84.11%**
Gini rank coefficient	49.89%	36.62%	**52.35%**	55.02%	**68.22%**
Kolmogorov-Smirnov	54.53%	53.65%	**58.22%**	57.37%	**63.84%**
CAP Accuracy ratio	51.04%	36.63%	**53.07%**	55.37%	**68.41%**
Pseudo R2	9.12%	7.26%	**13.16%**	15.63%	**27.66%**
Panel B: Model performances for the USA					
AUC of ROC	**86.48%**	77.31%	70.93%	88.07%	**91.02%**
Gini rank coefficient	**72.97%**	54.63%	41.87%	76.14%	**82.05%**
Kolmogorov-Smirnov	56.30%	**56.76%**	55.69%	57.79%	**57.88%**
CAP Accuracy ratio	**73.12%**	53.77%	40.18%	75.82%	**81.96%**
Pseudo R2	**33.98%**	17.22%	10.87%	37.88%	**45.75%**

This table summarizes the performance measures for SL and the USA based on five measures. ACC = accounting information, MKT = Market information, GOV = Corporate governance information, FIN = Market plus accounting information and ING = Integrated model. Bold values represent the highest prediction when considering single predictor information (GOV, ACC, and MKT) and the highest prediction considering combined information (FIN, INTG).

The AUC generated by accounting (ACC) and market (MKT) information in SL is 74.94% and 68.31%, respectively. However, the accounting information-based model possesses a higher AUC for the USA firms with a value of 86.48%. Market and governance (GOV) information-based models have AUC of 77.31% and 70.93%, respectively. The results indicate that non-financial information has relatively higher prediction capacity in SL whereas accounting information has impressive prediction accuracy for the USA firms. Accordingly, the accounting information has the second highest prediction accuracy for the firms in SL and market information provides the lowest accuracy. However, the market information has the second highest prediction accuracy for the USA firms, and the non-financial information (GOV) has the lowest accuracy. The Gini rank coefficient derived from the AUC follows a similar pattern. As pointed out by Anderson (2007),[19] the Gini-coefficient above 50 percent is more satisfactory and that less than 35 percent means the performance of the model is doubtful. A figure below 30 percent suggests unacceptable accuracy. Thus, all the models in the two markets have generated a value of above 35%. Therefore, the results are reasonable.

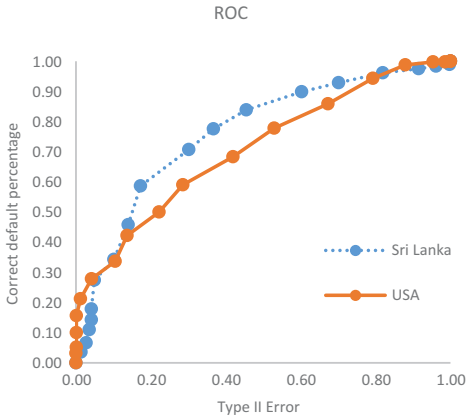
The acceptable percentage under the Kolmogorov-Smirnov[20] test ranges from 20% to 70%. The highest prediction accuracy generated from the Kolmogorov-Smirnov test is 58.22% from corporate governance in SL and 56.76% from market information for the USA. The results of the Kolmogorov-Smirnov test are consistent with other alternative methods in Sri Lanka: GOV figures are highest in every performance test. But in the USA, the MKT figure generated by the Kolmogorov-Smirnov test is not consistent with all the other predictor performance measures, which shows the financial information is the most effective, indicating the importance of using different approaches for decision marking.

The accuracy ratio of the CAP curve also measures the prediction performance. Although the calculation of CAP is different from the previous measures, it provides consistent results. The Pseudo R^2 measures the goodness of fit of the models. Accordingly, GOV shows relatively higher explanatory power than ACC and MKT for the firms in SL. The ACC has the higher Pseudo R^2 for the USA firms. Overall, the non-financial GOV shows relatively higher prediction accuracy than the financial information in the SL. In the USA financial information, particularly the accounting information, has higher prediction capacity. Thus, we affirm our second hypothesis (*H2: Non-financial information has higher default prediction ability than the financial information in Sri Lanka than the USA*).



Panel A: Accounting information

Panel B: Market Information

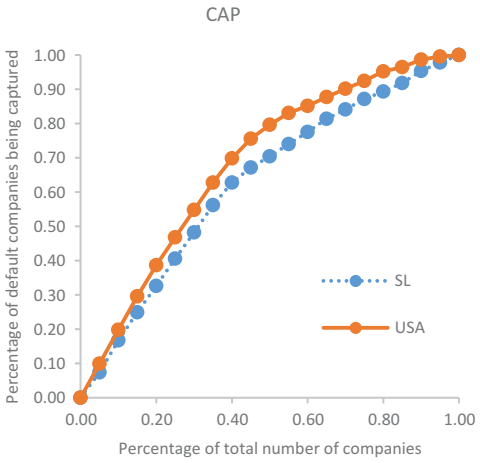


Panel C: Corporate governance information

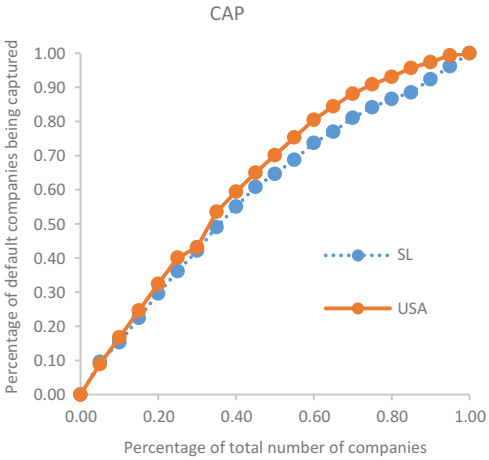
Figure 1. ROC curve for various types of information: Sri Lanka versus the USA. Panel A: Accounting information. Panel B: Market Information. Panel C: Corporate governance information.

In addition to the above measures, we also use the analysis of the ROC and CAP curves. Figures 1 and 2 respectively show the ROC and CAP curves under three panels, namely, A (accounting), B (market), and C (corporate governance) for both countries. Higher prediction accuracy is illustrated by the curve which is further to the top left. Accordingly, in both figures, the USA reaches a more upper curve for accounting in panel A (accounting), and for SL the more upper curve is achieved in panel C (corporate governance).

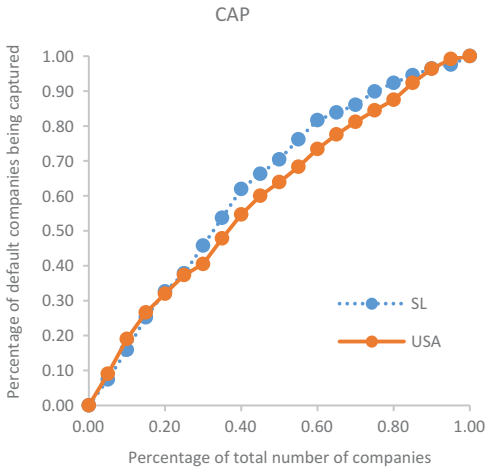
The overall results of different performance measures for both markets imply that the financial institutions in Sri Lanka should focus more on non-financial information, compared to the USA, reconfirming our second hypothesis. The result is consistent with Tinoco and Wilson (2013), they ascertain accounting information has higher prediction ability than the market and macroeconomic factors in the UK as an example for a mature market. Our findings are supported by Ali and Hwang (2000), who establish that the value relevance of financial reporting is smaller in emerging markets due to the bank-oriented financial systems. As a result, the credibility of financial information is such that it does not reveal the true financial position of companies in emerging economies. On the other hand, the market information shows the least accuracy for the default prediction in emerging market. The share markets in emerging economies[21] have been judged to be inefficient by Kim and



Panel A: Accounting information



Panel B: Market Information



Panel C: Corporate governance information

Figure 2. CAP curve for various types of information: Sri Lanka versus the USA. Panel A: Accounting information. Panel B: Market Information. Panel C: Corporate governance information.

Shamsuddin (2008). In summary, our results propose that the corporate governance information has more relevance for the default prediction in emerging markets than in the mature markets.

Column IV (INTG) in Table 4 tests the overall accuracy of the single measures of prediction and the integrated model based on three measures. The integrated model shows 84.11% of AUC for the companies in SL whereas the USA firms shows a 91.02% of AUC. The Gini rank coefficient and Kolmogorov-Smirnov values are 68.22% and 63.84% for SL, respectively, whereas the values are 82.05% and 57.88% for USA firms, respectively. The accuracy ratio of CAP curve is 68.41%, and Pseudo R^2 is 27.66% for SL firms. USA firms show an accuracy ratio of 81.96% under the CAP curve and a 45.75% of Pseudo R^2 for the integrated model. For all tests, the integrated model provides the highest values for both countries. Therefore, it is the superior model for default prediction.

These findings suggest that the financial institutions in emerging markets should not ignore the accounting and market information even though we find the governance information-based model is superior for emerging markets. Consistent with Li and Miu (2010), we find one model might be superior to another, but the combination of models can enhance the prediction performance further. Our study discovers that the integrated model has higher prediction accuracy than any counterpart with a single information category.[22] This is evident in both Sri Lanka and the USA. We thus affirm our third hypothesis (*H3: An integrated model, with accounting, market and corporate governance information, performs better than any other model with fewer categories of information in Sri Lanka and the USA*). Therefore, the financial institutions should pay attention to the importance of integration of information for default prediction.

Table 4 (column FIN) further reports the prediction performances of the integrated model excluding governance information. The purpose of this testing is to identify the power of risk differentiation in the absence of governance information, i.e., to test the prediction performances of the financial information, that is, accounting and market information. The results of both countries show that significant reduction in the accuracy percentages comes across from integrated model to financial model. Therefore, the findings suggest that the role of governance information in predicting default probability is vital for both countries. However, when analyzing the percentage changes from INTG model to FIN model, the changes are higher in SL than the US. For example, the area under the ROC shows 7% reduction from INTG model to FIN model for SL whereas reduction of the US is 3%. This implies that the influence of governance structure is higher for firms in SL compared to the US.

Conclusions

This study contributes to the literature by examining the effectiveness of several variables of corporate governance information to predict default, from a new perspective of providing an international comparison between an emerging market (Sri Lanka) and a mature market (USA). Most past studies suggest corporate governance is only useful in mature markets. In contrast, we confirm corporate governance information should be considered in depth with more variables in an emerging market, as well as in a mature market because essential aspects differ across different contexts. We test the prediction performance of financial (accounting and market) information and non-financial (corporate government) information, in Sri Lanka and in the USA, to examine whether or not non-financial information is relevant for prediction.

Overall, corporate governance information is useful in default prediction in both Sri Lanka and the USA. In both cases, seven out of the twelve variables we tested are significant. Our results indicate that the corporate governance information may have more relevance for the default prediction in emerging markets than in the mature market. Further tests are conducted to unveil the importance of individual variables according to the context and level of maturity of the market. We find that ownership variables have less prediction ability in Sri Lanka. We find that the relative prediction performance of accounting, market and governance information varies across the two markets. ACC carries higher prediction accuracy for a mature market (USA), followed by the MKT and GOV. However, non-financial corporate governance information has a higher prediction ability than financial information in emerging markets (Sri Lanka). Moreover, we argue both emerging, and mature markets should utilize the joint predictive power of integrated information because it could provide incremental effectiveness in predicting corporate default. We establish that an integrated model, with accounting, market, and corporate governance information, performs better than any other model with fewer categories of information in Sri Lanka and the USA.

Although the findings of the study are significant, there are several limitations. First, the comparison is made between only two countries, Sri Lanka, and the United States. Second, the model estimation is based solely on the logit regression. Third, a statistical test to examine the significant differences among the prediction performances of the models among the two countries will be left for

a future study. Therefore, it would be desirable to expand the country of study onto more emerging and mature markets.

Further, the multivariate discriminant analysis and neural network also could be alternative models to estimate the default probabilities. Testing the model with these methods and examining the significance of the differences among the prediction performances of the countries would make the results more pronounced. Analyzing different legal frameworks of best practices of the countries also remains for future research.

Notes

1. 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.
2. The FTSE country classification defines four types of markets: Developed, advanced emerging, secondary emerging, and frontier.
3. Beaver used univariate analysis to differentiate failed firms from non-failed companies. The results based on prediction error test in Beaver's study found, cash flow to total debt has the highest prediction ability.
4. MDA is technique used to classify the observations into a group in order to reduce the variations between variables.
5. See Li and Miu (2010) for more explanations of ROC and CAP curve.
6. Accuracy ratio by CAP curve = (the area under a model's CAP)/(the area under the ideal CAP).
7. The accuracy ratio is calculated as ((2*AUC)-1).
8. For calculations please refer to Anderson (2007).
9. Lakshan and Wijekoon (2012) use losses and negative cash flows to identify the failed listed companies in Sri Lanka.
10. Matched pairs design has been used by more than 70% of the studies in this area (Zmijewski 1984).
11. The bankruptcy prediction results are 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).
12. Quarterly data are not available for the selected sample of Sri Lanka.
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. Most of studies based on the USA have predicted for maximum of five years. (e.g., Beaver 1966).
14. To avoid biased results due to outliers, we winsorize accounting and market variables at 5% level as a solution to the outliers found after applying the median absolute deviation (MAD). After detecting outliers, we use trimming 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.
15. In this paper, institutional shareholder represents share-ownership by any institutions including mutual funds, banks, investment banks, insurance companies, private and public companies, and governments.
16. Rainsbury Bradbury, and Cahan (2009) find audit committee quality has no significant effect on the quality of financial reporting. However, we are still consistent with our notion that even though the financial transparency and disclosures are effective in SL it does not necessarily mean the financial reporting quality is high.
17. The proxies are board-size, CEO duality, independent directors, and director share-ownership.
18. Results of the estimated models are available upon request.
19. Anderson (2007, p. 205).
20. Anderson (2007, pp. 195–196).
21. Kim and Shamsuddin (2008) characterized secondary emerging markets as inefficient; however, advanced emerging markets, e.g., Singapore, Japan, Korea, Hong Kong, and Taiwan are weak-form efficient.
22. Consistent with Bhimani, Gulamhussen, and Lopes (2013), and Liang et al. (2016), the combination of different models enhances bankruptcy prediction.

Data availability

Data analyzed in the study are collected from public sources.

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Chapter Three

Corporate governance and default correlation

Chapter three consists of one research paper that has been submitted for review and publication. The title of the paper is "Corporate governance and default correlation." This paper is under the second-round of review by *Corporate Governance: An International Review* (SSCI and ABDC ranking = A). In this paper the impact of corporate governance on the correlation in corporate defaults is tested. It is hypothesized that the degree of default correlations would increase disproportionally for firms with weak corporate governance in terms of concentrated ownership, low board effectiveness, low financial transparency, and high shareholder rights. This work employs Lucas's (1995) method to provide empirical evidence based on the historical default data in the United States from 2000 to 2015. The empirical results imply that corporate governance is essential for credit risk management because poor corporate governance increases not only individual default risk but also the domino effect of credit defaults. Moreover, the impact of corporate governance on correlation in corporate defaults is more pronounced during a financial crisis. This paper was also presented at the 31st Australasian Finance and Banking Conference in Sydney, Australia, during December 2018.

Corporate governance and correlation in corporate defaults

Declaration about the role and the contributions of authors

Declaration about the role and the contributions of authors

I (Ruwani Fernando) confirm that I am the principal author of the following paper. As the principal author, I developed the conceptual framework, collected the data, conducted the data analysis, interpreted the results, and wrote the research paper. Leon Li provided conceptual advice, commented on and edited all versions of the paper. Greg Hou also commented on and edited all the versions of the paper.

Please see the Co-authorship form attached in Appendix 3.

This paper has been submitted and is under review by *Corporate Governance: An International Review.*

- Fernando, J.M.R., Li. L., & Hou. G. (2019). Corporate governance and default correlation.

Corporate governance and correlation in corporate defaults

Abstract

Manuscript Type: Empirical

Research Question/Issue: This study examines the effect of weak corporate governance in terms of concentrated ownership, low board effectiveness, low financial transparency and higher shareholder rights on default correlation given the different credit qualities.

Research Findings/Insights: Using historical default data in the United States from 2000 to 2015, we find that the degree of default correlation increases disproportionally for firms with concentrated ownership, low board effectiveness, low financial transparency and disclosures, and higher shareholder rights. More importantly, the effect of weak corporate governance on default correlation is high during a financial crisis.

Theoretical/ Academic Implications: This study is one of the first studies testing the impact of corporate governance on the correlation in corporate defaults. It strongly indicates new avenues of research for both corporate governance and credit risk management on why the joint default probabilities vary among firms.

Practitioner/ Policy Implications: Our results imply that good corporate governance is essential for credit risk management because poor corporate governance may increase not only individual default risk but also create the domino effect of credit defaults. Practitioners and policy makers should enhance control over poor governance practices to reduce the probabilities of default. Moreover, the impact of corporate governance on correlation in corporate defaults is more pronounced in the financial crisis and could warrant policy makers taking steps to cushion its effects.

Keywords: Default correlation, corporate governance, credit quality

1. Introduction

Evaluating the default correlation among credit portfolios is a crucial process for bank credit risk management. Default correlation implies the relationship between a firm's individual default probability and joint default probability among firms. Thus, the estimation of default correlation depends not only on the individual firm's default probability but also on joint default probabilities among firms. For example, in a crisis default correlation arises as a result of events of particular firm default and the collective default among firms. Researchers have identified cyclical, contagion and learning from others as the factors that cause the joint default probabilities over the last few decades (Das et al., 2007). However, why the joint default probabilities vary among firms is still under investigation. In this paper, we provide convincing reasons for the variations based on the results of an empirical investigation of firms' corporate governance practices. Thus, we make theoretical contributions by testing the impact of corporate governance on corporate default correlation. In brief, we hypothesize that the degree of default correlations increases disproportionally for firms with weak corporate governance. The dynamic nature of default correlations due to corporate governance implies that weak corporate governance not only increases individual default risk but also may accompany a disproportional increase in the credit risk of a portfolio.

The issue of correlation in corporate defaults has been generated considerable interest and research has expanded focusing on methodology and examinations of factors causing defaults. Default correlations can be estimated by any one of three methods. The first method is to estimate default correlations based on asset correlations (e.g., Das et al., 2007). The second method is to use the credit default swap (CDS) or bond spread data (e.g., Jorion and Zhang, 2007). The third method proposes using a standard binomial approach to measure default correlation based on realized historical default data (e.g., Lucas, 1995). Notably, default correlations have not been satisfactorily modelled. Lucas's method, which we adopt in this research, takes advantage of model-free estimation techniques (see Li and Chen, 2018).

Research to examine the factors causing correlation in corporate defaults has generated considerable interest. Das et al. (2007) identifies the three main reasons for default clustering as cyclical correlation, (Duffie, 1998, Keenan, 2000

and Duffie et al., 2007); contagion effect (Aharony and Swary, 1983, Lang and Stulz, 1992 and Giesecke, 2004); and learning from defaults (Jarrow and Yu, 2001). A recent study by Li and Chen (2018) tests the default correlation due to liquidity, systematic risk and size as an extension to the three primary sources of default correlation proposed by Das et al. (2007).

This paper contributes by hypothesizing and examining the impact of corporate governance on the correlation in corporate defaults. Extensive studies test the effect of corporate governance on individual corporate defaults in the literature (see Daily and Dalton, 1994). We have been unable to find any studies that systematically investigate the impact of corporate governance on correlations in corporate defaults. Following Standard and Poor's governance framework (2002), we define four critical domains of corporate governance as ownership structure and influence, board effectiveness, financial transparency and disclosures, and shareholder rights. Accordingly, we develop four research hypotheses regarding the impact of corporate governance on correlations in corporate defaults. Our empirical results further indicate that default correlation is high for firms with concentrated ownership, low board effectiveness, low financial transparency and disclosures, and higher shareholder rights.

Moreover, differing from the previous research, we follow Lucas (1995) approach to test the impact of corporate governance on correlations in corporate defaults using the realised default data in the U.S. over the period of 2000 to 2015. In addition, following with the studies of Lemmon and Lins (2003) and Erkens et al. (2012), which indicate the effect of corporate governance on firm performance varies during a financial crisis, we retest our research to add a fifth hypothesis relating to default correlation in both crisis and non-crisis periods.

The results of this research can provide policy implications to banks and regulatory authorities. As hypothesized in this study, the degree of the domino effect of credit defaults increases disproportionally for firms with weak corporate governance, and the phenomena are more pronounced during the crisis periods. Regulators should consider these findings and develop a viable regulatory capital framework for credit risk management to mitigate the potential consequences of underestimating default clustering due to poor corporate governance. Our empirical results imply that poor corporate governance might cause an increase in individual default risk and also exaggerate the domino effect of credit defaults. The increase

in default correlations will, in turn, reveal an increase in portfolio credit risk. Without considering the impact of corporate governance on default correlations, we indicate that the benefit of reductions in risk stemming from credit portfolio diversification is likely to be overestimated for firms with weak corporate governance. Firms with weak corporate governance are associated with higher default correlations and, hence, are less effective in risk reduction if included in credit portfolio diversification efforts. Our findings support the argument that regulators should further adjust capital requirements for banks which make loans to weak governance firms at crisis periods.

The rest of the paper is organized as follows. Section 2 reviews the literature on sources of default correlation, modelling for default correlations and develops the research hypotheses. Section 3 describes the sample and research design. Section 4 presents the results of empirical findings. Section 5 presents robustness tests. Section 6 concludes and provides future research directions.

2. Literature review and hypotheses development

2.1. Sources of default correlation

There are three main reasons for default correlation, that is, common factors or cyclical correlation, contagion effect, and learning from others (Das et al., 2007). Cyclical correlation arises due to a similar pattern of correlated risk factors among firms. Common economic factors include interest rate, inflation, GDP, business cycle, and stock market performances. Duffie (1998) explains that the aggregate default rates are correlated due to the general interest rate movements. Further, Duffie et al. (2007) find that personal income growth and term structure levels also affect the changes of default probabilities. De Servigny and Renault (2002) report that joint default probabilities are higher in recession periods than non-recession periods. During a recession or a financial crisis, all businesses are adversely affected by their sensitivity to the general economic conditions. Li and Chen (2018) suggest firms with a low beta, which represents the systematic risk, have high default correlation.

The contagion effect implies that the default of one company induces the default of another company.[5] For example, the default of a subsidiary company creates a default for its parent company. Accordingly, the default clustering phenomena are invariably observed between closely related companies with buyer-supplier relations. The initial studies on the contagion effect focus mainly on stock market information (e.g., Lang and Stulz, 1992). Later studies focus on industry-related factors as the reason for the contagion effect. Among them, Jorion and Zhang (2007) record a positive correlation among credit derivatives due to the contagion effect and a negative correlation due to competition. They assume the contagion effect is created among firms with similar cash flows[6]. Accordingly, they choose equity, industry concentration, and leverage to measure the correlation among the bankruptcy firms and their competitors.

The third reasoning for the default correlation is learning from defaults. For example, the failures of Worldcom and Enron highlight the importance of regulatory changes to firm irregularities which affect surviving companies (Das et al., 2007). Learning from others implies that the reason for one company's default also could exist in other companies, thereby, recognizing or revealing those reasons could benefit the various stakeholders of other companies.

2.2. Modelling default correlation

There are different approaches for estimating default correlation. The first approach is to estimate the default correlation on a structural model based on assets correlation. The most popular method is Merton's (1974) model. An extension of this model is developed and tested by Black and Cox (1976). The Merton model demonstrates stock as a call option where the strike price equals the face value of debt payment. It identifies two common factors for firms' defaults, that is, a firm's debt ratio and volatility of assets. Based on this model, the default probability is transformed into a hazard rate. Geske (1977) generates the default correlation by using the hazard rate and the default probabilities from the model. However, this assumes that default only occurs at a single point in time (i.e., at maturity), which

[5] See Lucas (1995) for real world examples due to contagious effect.

[6] They follow Lang and Stulz (1992) to select the variables to measure contagion effect.

is unrealistic because some credit instruments may default more than once. Also, the default probability of a firm is recognized when its assets' value falls below its debt. Zhou (2001) uses the implications of the asset return model to establish the default correlation. Yet, Das et al. (2006) suggest that asset volatility is more important than asset return in modelling default correlation.

The second approach is called a reduced-form method which is based on default intensity. This is an implicit approach where some observable market information, such as swap spreads and prices of bonds, is used to generate the default probabilities (Li, 2000). Default intensities are derived by estimating a model based on state variables such as interest rates, credit spreads and company ratings relating to the changes of business cycles. Duffie et al. (2003) use this method to find the correlation among sovereign spreads. This approach assumes that although the default events are independent, the correlation arises through the common influence of the changes of the state variables. Jarrow and Yu (2001) extend this approach to gauge default clustering due to firm-specific risk factors such as counter-party risk. The above methods recognize the default probability based on credit losses due to credit downgrading.

An alternative approach is proposed by Lucas (1995) that estimates default correlation based on historical default data, using actual default probabilities. It takes advantage of model-free estimation techniques and has proven useful in modelling default correlations in practice. Using the same approach, Li (2000) introduces a 'copula framework' for default correlation, which solves the problem of joint distribution in a credit portfolio.

2.3. Hypotheses development: Corporate governance attributes and default correlations

Agency theory forms a part of the bigger picture of corporate governance and it suggests that the separation of ownership from management is a cost to the organization (Jensen & Meckling, 1976). There are two types of agency conflicts, that is, the conflicts between managers and stakeholders, including shareholders and debtholders, and the conflicts between shareholders and debtholders. These two types of conflicts eventually increase default risk and reduce firm value. Agency

cost is particularly extensive in the U.S. where the firms' ownership is diffused. The widespread share ownership requires managers to control the operations of the firms. Thus, the manger-shareholder conflicts arise due to the self-serving behavior of managers over other stakeholders' interest.

The second conflict, between shareholders and debtholders, incurs the agency cost of debt. The value maximization objective of shareholders frequently conflicts with the interest of debtholders. Galai and Masulis (1976) and Jensen and Meckling (1976) show that shareholders engage in risk-shifting behavior. For example, shareholders of highly levered firms that suffer financial distress tend to undertake risky investments with negative NPV. Such actions could lead to issues for firms' future cash flows and creates uncertainties to debtholders.

The hypotheses of our study focus on examining the effect of corporate governance on default correlations. The literature on corporate governance and default risk establishes that default firms are associated with weak corporate governance mechanisms. Bhojraj and Sengupta (2003) show that governance mechanisms have an impact on default risk by mitigating agency cost. Ashbaugh-Skaife et al. (2006) find that firms with stronger governance mechanisms enjoy higher credit ratings due to lower default risk.

In the following sections, we develop our hypotheses on the relationship between corporate governance and default correlation in terms of four important attributes, that is, ownership structure and influence, board effectiveness, financial transparency and disclosures, and shareholders rights. Most of the governance attributes we test in this study aim to reduce the two types of agency conflicts and to ensure that the governance mechanisms provide independent monitoring of management and avoid managerial opportunism. We hypothesize that the default correlations are not homogenous across firms and could increase asymmetrically for firms with poor corporate governance attributes.

a. Ownership structure and influence

Generally, firms with dispersed ownership heavily rely on governance mechanisms to reduce managerial opportunistic behavior and agency cost. Strong corporate governance mechanisms should be able to protect the interest of all stakeholders

including debtholders. However, the effectiveness of governance mechanisms varies depending on the ownership structure and its influence.

Ownership concentration can have a positive or negative impact on the organization (Jensen and Meckling, 1976; Ashbaugh-Skaife et al., 2006). The positive effect stems from block-holders and institutional investors who have financial interest and independent views, and therefore they are expected to have a positive influence on company monitoring processes (Jensen and Meckling, 1976; Shleifer and Vishny, 1997). Thus, the agency cost is lower in firms with concentrated ownership implying low default risk and high credit quality.

However, concentrated ownership might be a challenge for management in performing their managerial functions for the betterment of all stakeholders. For example, Jensen and Meckling (1976) and Galai and Masulis (1976) introduce the problem of risk-shifting behavior from shareholders to debtholders where firms with concentrated ownership can influence the management on investing in risky projects where the success of projects increases the wealth of the shareholders, while the bondholders should equally bear the failure of the project.

La Porta et al. (1999) and Claessens et al. (2000) point out that if the controlling shareholders have significantly higher voting rights than their cash flow rights, there is a negative effect on minority interests. Further, Shleifer and Vishny (1997) suggest that if ownership concentration exceeds a certain threshold, controlling shareholders try to increase their personal benefits at the expense of minority shareholders and debtholders. La Porta et al. (1999) and Johnson et al. (2000) further suggest that under concentrated ownership, poor corporate governance transfers the value from the firm to the controlling shareholders.

The literature presents mixed findings on the relationship between concentrated ownership and firm credit quality. For example, Bhojraj and Sengupta (2003) find that firms with high institutional share ownership tend to have high credit ratings, which suggests a low default risk. Yet, Ashbaugh-Skaife et al. (2006) find that large shareholders have a negative effect on credit ratings. Further, Elloumi and Gueyie (2001), Parker et al. (2002) and Fernando et al. (2019) find that firms with concentrated ownership are more likely to default, suggesting poor credit

quality. We employ the percentage of institutional ownership[7], the percentage of the five largest shareholders' ownership, and blockholdership to measure the ownership structure and influence. Switzer et al. (2018) find that institutional share ownership negatively effects default risk. Erkens et al. (2012) find that concentrated institutional share ownership positively associates with risk-taking behaviour before the financial crisis occurred during the period 2007-2009. Thus, we posit that the potential risk-shifting behaviour of shareholders increases the default correlation among the firms with concentrated ownership due to a cyclical effect.

Ashbaugh-Skaife et al. (2006) suggest that under the "management disciplining" hypothesis [8] ownership concentration reduces default risk and increases credit quality, whereas under the "wealth distribution" hypothesis [9] concentrated ownership increases default risk and reduces credit quality. Given the mixed findings and arguments about the ownership structure and its influence on agency cost, our first hypothesis is non-directional:

H1: Firms with different ownership structures are associated with different levels of default correlation.

b. Board effectiveness

An active board provides an independent view on management performance and is responsible for the effective governance of the firm (Simpson and Gleason, 1999). It is also observed that an effective board of directors should be comprised with greater independence (see, for example, Zahra and Pearce, 1989). Board effectiveness includes factors such as board size, board composition, and leadership structure. To represent board effectiveness, we use board size, CEO duality, and the number of independent and external directors on the board. Resource dependency theory suggests that the board of directors is the mechanism for reducing environmental uncertainty (Pfeffer, 1972), and managing external dependencies

[7] Ashbaugh-Skaife et al. (2006), describe that under the wealth distribution hypothesis, when the % of share ownership by institutions increases it affect the wealth transfer to bondholders. They suggest a negative relationship between institution share ownership and credit ratings.

[8] They described the role of corporate governance under the management disciplining hypothesis is to avoid the managerial opportunism.

[9] The wealth distribution hypothesis is defined as the role of governance mechanisms is to ensure the wealth distribution among all stakeholders.

(Pfeffer and Salancik, 1978). Accordingly, it is expected that an effective board reduces the moral hazard problem and the agency cost of debt.

The first attribute under board effectiveness is board size. Resource dependency theory suggests that a larger board brings a greater amount of experiences, skills, and views to the board table. A larger board creates barriers for insiders to exercise managerialism by better monitoring. Therefore, that will lead to reducing the risk of bankruptcy. Switzer et al. (2018) find that board size is positively associated with default risk. However, Lipton and Lorsh (1992) show that a larger board is less effective when considering the coordination and free-riding problems. Platt and Platt (2012) find that default firms are characterized by a small board and a few independent directors. Thus, there is no clear conclusion on the larger board and board effectiveness. However, based on resource dependency theory we argue that a larger board is necessary to increase board effectiveness and to reduce default risk.

The second attribute we consider is CEO duality. Governance mechanisms are effective when there is greater independence of the insiders. Dalton and Kesner (1987) argue that an effective board is created when one person does not hold the positions of board chairman and CEO. Daily and Dalton (1994) and Ashbaugh-Skaife et al. (2006) suggest that CEO duality increases default risk. Lorsch (1989) further suggests that firms could face a financial crisis effectively when it occurs, when they have an independent board structure and separate positions of the CEO and the board chairman. On the other hand, CEO duality could enhance the effectiveness as the CEO would be more aware than outsiders about what is happening with the organization. Regarding bank credit risk, Pathan (2009) finds a negative effect of CEO duality. However, we posit that firms with CEO duality possess reduced board effectiveness and increased credit risk because it is less likely for board members to provide independent monitoring and to control the managerialism.

The third element is board independence. We posit that greater the board independence, the greater the board effectiveness because board independence is necessary to provide independent monitoring and to reduce managers' self-directed behaviours. Further, the literature shows that board independence has a significant

effect on reducing a firm's default risk (Ashbaugh-Skaife et al., 2006, Switzer and Wang, 2013) suggesting board independences increase credit quality.

Further, the lack of board effectiveness could mean that firms are less exposed to growth opportunities. The literature well documents a positive relationship between firm performance and board effectiveness. Thus, better firm performance provides benefits to all stakeholders, and that increases credit quality. With these reasons, we assume that firms with less effective boards reflect high default correlation due to the board's inability to adjust to external environmental shocks. Our hypothesis:

H2: Firms with the low/high effective board are associated with high/low default correlation.

c. Financial transparency and disclosures

Governance mechanisms should be able to ensure financial transparency to reduce information asymmetry between managers and all other stakeholders. Therefore, timely and adequate information helps shareholders and debt-holders to make appropriate financing decisions. Thus, we posit that firms with greater financial transparency have reduced management discretionary actions and increased value-relevant information. We use audit committee quality measured through audit committee independence and auditor opinion as to the proxies for financial transparency and disclosures.

Financial transparency through an independent audit committee reduces fraudulent financial reporting, accounting irregularities (Dechow et al., 1996); and reduces overstatement of earnings (Klein, 2002). It also reduces information asymmetry and increases investor confidence (Ashbaugh-Skaife et al., 2006). Sarbanes-Oxley Act of 2002 (SOX) requires all the members of the audit committee to be independent. However, Choen et al. (2010) point out that there is a substantial variation of the audit committee composition and their effectiveness. Klein (2002) finds audit committee independence significantly affects abnormal accruals whereas Bédard et al. (2004) find that 100 percent audit committee independence reduces aggressive earnings management.

Ensuring the reliability of financial information and reporting is an integral part of governance mechanisms. As a proxy for quality of disclosures, we use a dummy variable, coded as one if a firm receives unqualified opinion and zero otherwise. The literature shows that firms receiving a qualified auditor opinion tend to have higher accruals (e.g. Francis and Krishnan 1999; Bradshaw, Richardson, and Sloan 2001), suggesting higher managerial opportunism. Further, the literature relating to bankruptcy prediction also shows the effect of auditor opinion on default risk (e.g., Altman and McGough, 1974; Lensberg, Eilifsen, and McKee, 2006). Lensberg et al. (2006) point out that the most significant variable in their final model of bankruptcy prediction is the auditor's opinion validating the value relevance information of auditor's reports. According to the above literature, we include a qualified auditor opinion to reflect the low financial transparency and disclosures. We assume that the firms receiving a qualified auditor opinion reflect higher agency costs due to higher earnings management.

If corporate governance ensures better monitoring and financial reporting, then it reduces managerial opportunism and enhances financial transparency and disclosures. Therefore, firms with low financial transparency are deemed as firms with poor governing practices. Moreover, Sengupta (1998) finds that firms with higher disclosure ratings could enjoy lower interest cost of issuing debt, suggesting higher financial transparency and disclosures reflects higher credit quality. Hence, we assume that firms with low financial transparency reflect low credit quality. Thus, the potential information asymmetry and earnings management due to weak financial transparency and disclosures may increase the contagion effect on default correlation (being low credit quality firms). Our hypothesis:

H3: Firms with high/low financial transparency and disclosusres are associated with low/high default correlation.

d. Shareholder rights

The attribute of shareholder rights reflects the power balance between shareholders and management. The role of governance mechanisms on this attribute is to ensure that the managers do not use their discretionary power to gain personal benefits. Another role is to ensure that shareholders' rights do not conflict with minority shareholders' and bondholders' interests. Many have argued shareholders' rights

relate to corporate governance. However, evidence of such a relationship, as reported in the extant literature, is inconclusive.

Shleifer and Vishny (1997) find that enhanced shareholders rights increases their ability to monitor managers' actions and reduces biases in financial reporting. Healy and Wahlen (1999) identify the lower shareholders rights with poor governing practices on the basis that lower shareholders rights increase managerial opportunistic behavior for earnings management, and as a result, increase agency cost. Gompers et al. (2003) suggest companies with stronger shareholders rights have higher firm value, higher profits, and higher sales growth. Moreover, strong shareholders rights can mitigate managers' opportunistic behaviors which may have a negative impact on firm value (Ashbaugh-Skaife et al., 2006). These studies support the view that higher shareholders rights represent good corporate governance and reduce agency problems.

The conflict between shareholders and debtholders creates the agency cost of debt. By giving a greater power to shareholders, on the decisions of the ownership control and the changes of management, can be detrimental to bondholders (FitchRatings, 2004). FitchRatings (2004) further indicates greater power to shareholders brings an undesirable influence on management, which adversely affects the bondholders and thus creates a negative impact on wealth distribution. Ashbaugh-Skaife et al. (2006) demonstrate that greater power to shareholder leads to lower credit ratings because stronger shareholders rights increase the risk of wealth transfers from bondholders to shareholders. The risk-shifting behavior also could be more obvious in the case of greater shareholders rights over management, and agency costs of debt increases as a result. Klock et al. (2005) show that firms with higher shareholders rights are associated with a higher cost of debt financing. Chava et al. (2008) find firms with higher shareholder rights are charged with higher loan spreads.

The two proxies we use to measure the shareholders rights are the powers to ratify the independent auditors and to approve the remuneration of executive

management.[10] Coffee (2006) stresses that independent auditors are crucial in the corporate governance framework. Sarbanes Oxley Act of 2002 provides that the audit committee is responsible for the appointment and oversight of the independent auditors. Dao et al. (2012) stress that most of the boards consist of management and they hold a significant influence on the auditor appointment. Therefore, it is necessary that the shareholders ratify the auditor selection to ensure the chosen auditor is matched with the company size and financial reporting needs. The literature shows that the final decision of auditor selection by the shareholders brings benefits to organizations (Mayhew and Pike, 2004; Dao et al.2012). Therefore, based on this reasoning, we assume that higher shareholders rights in terms of auditor ratification ensure auditor independence and reduce the managerial opportunism that causes low credit quality.

Agency theory (Jensen and Mackling, 1976) stresses that the shareholders should be the agents to design the compensation of executive management. However, the widespread ownership of US public companies provides an incentive for the board of directors to design the compensation for executives. Core et al. (1999) find that less effective boards result in excessive CEO compensation.[11] Further, Davis (2007) and Deane (2007) find that having an input on-pay decisions, ensures better alignment of the owner-manager interest and enhances governance quality. Therefore, we assume that giving shareholders the rights to approve the remuneration of executive directors reduces compensation and increases value to the shareholders. Given the mixed evidence on the relationship between the level of shareholders rights and corporate governance, our hypothesis is non-directional, as follows:

H4: Firms with different levels of shareholder rights are associated with different levels of default correlations.

[10] The Advisory Committee on the Auditing Profession (ACAP), appointed by the U.S. Department of Treasury, recommends public companies to use the shareholder voting to ratify the auditor appointment.

[11] The say-on-pay legislation was included in Dodd-Frank Wall street reform and consumer protection act in 2010. However, we consider the variable in our study as we cover the time period from 2000 to 2015.

e. Corporate governance effect on default correlation in crisis and non-crisis periods

Crouhy et al. (2000) and Gersbach and Lipponer (2003) show that default clustering is high in recessions. De Servigny and Renault (2002) find the default correlation among non-investment grade firms are higher in a recession than in a growth period. Further, Li and Chen (2018) reveal that firms with very low credit quality have a high correlation in the crisis period. Accordingly, we expect that the impact of weak corporate governance (i.e., ownership concentration, low board effectiveness, low financial transparency and disclosures, and higher shareholders' rights) on correlations in corporate defaults is more pronounced during crisis periods. Our hypothesis differentiates the impact of corporate governance on default clustering risk in crisis periods from that of non-crisis periods. Our hypothesis:

H5: Firms with weak corporate governance practices have higher default correlation in a crisis period than a non-crisis period.

3. Research method and data

3.1. Data

We recognize the firms encountering bankruptcy or liquidation as those defined by the Compustat database as default firms over the period 2000-2015. Due to the infrequent nature of default events, it is necessary to control the number of non-default firms to minimize the bias results caused by having a relatively small number of default firms. Accordingly, we couple the default firms with non-default firms by selecting five firms with the largest market capitalization from each industry using the first two-digit of the Standard Industrial Classification (SIC) codes. The rationale for the non-default firms' selection criteria is that firms with the highest market capitalization arguably and relatively have a strong financial position with high credit quality and possess good corporate governance practices. Thus, our non-default firms ensure that they necessarily differ from default firms in terms of credit quality and corporate governance practices. We exclude the financial firms (representing SIC codes 6000-6999) from the sample selection because of their different operating activities and capital structures. The final sample consists

of 160 default and 675 non-default firm-year observations over the period of 2000-2015. We collect financial information from the Compustat database to calculate the credit quality of each firm. Equity prices are obtained from the Center for Research in Security Prices (CRSP) database. Corporate governance data are collected through company proxy statements and the Data Stream Database.

3.2. Estimation of default correlation

Testing default correlation first requires recognizing the companies with different credit qualities. For this purpose, following Li and Chen (2018), we use the Altman (1968) Z-score model to measure the credit quality. Thus, the five financial ratios, being sales to total assets, working capital to total assets, earnings before interest and tax to total assets, retained earnings to total assets and market value of total assets to book value of total liabilities, are used with the original Altman model's weights. It is well documented in the literature that high credit rating firms imply a high score. After calculating the Z-score values, we define three credit ranges: high credit quality (Z-score ≥ 2.99), medium credit quality (2.99 < Z-score ≥1.81), and low credit quality (Z-score < 1.81). These ranges are based on the original work by Altman's (1968) study, where he identified 2.99 as the highest and 1.81 as the lowest value for recognizing bankrupt and non-bankrupt firms. A Z-score value above 2.99 clearly identifies a non-bankrupt firm and a Z-score below 1.81 is recognized as bankrupt. The area between 1.81 and 2.99 is defined as a gray area with uncertainity about bankruptcy.

We follow Lucas's (1995) approach to measure default correlation among the firms with different credit qualities associated with corporate governance practices. Here, we briefly describe the procedure. Assume that there are two types of firms: firms A and B. Then we define A_i (t) = 1 if firm *i* defaults at time t, and 0 otherwise. A represents default under high credit quality. Let B_i(t) = 1 if firm *i* defaults at time t, and 0 otherwise. B represents default under low credit quality. Then, the default correlation is computed as follows:

$$Correlation_{AB}(T) = \frac{P_{AB}(T) - P_A(T) \times P_B(T)}{\sqrt{P_A(T) \times P\left(1 - P_A(T)\right)} \times \sqrt{P_B(T) \times P\left(1 - P_B(T)\right)}} \quad (1)$$

Where $P_A(T)$ and $P_B(T)$ represents the average default probabilities of high and low credit quality firms over T years, i.e. total number of years. $P_{AB}(T)$ is the average joint default probability over T years. Lucas (1995) suggests a standard binomial approach to estimate the individual and joint default probabilities based on a historical number of default data.

Let $N_{A(t)}$ and $N_{B(t)}$ be the total number of firms with high credit quality and low credit quality at time t, respectively. Thus, we define, $N_{A(t)} = N_{A,1} + N_{A,0}$, where $N_{A,1}$ is the total number of default firms with high credit quality at year t and $N_{A,0}$ is the total number of non-default firms with high credit quality at the same year. Accordingly, $N_{B(t)} = N_{B,1} + N_{B,0}$, where $N_{B,1}$ is the total number of default firms with low credit quality at year t and $N_{B,0}$ is the total number of non-default firms with low credit quality at the same year.

Following this method, the number of all the possible pairs of high and low credit quality firms could be computed as $N_{A(t)} \times N_{B(t)}$. Similarly, the number of all possible pairs of high, low and medium credit quality default firms is $N_{A(t),1} \times N_{B(t),1}$. Accordingly, the average joint default probability over T years among the high and low credit quality firms is,

$$P_{AB}(\mathrm{T}) = \frac{\left[\sum \frac{N_{A(t),1} \; X \; N_{B(t),1}}{N_{A(t)} \; X \; N_{B(t)}}\right]}{T} \tag{2}$$

Following the same concept, we estimate the individual default probability for high credit quality and low credit quality firms as follows:

$$P_A(\mathrm{T}) = \frac{\left[\sum \frac{N_{A(t),1}}{N_{A(t)}}\right]}{T} \tag{3}$$

$$P_B(\mathrm{T}) = \frac{\left[\sum \frac{N_{B(t),1}}{N_{B(t)}}\right]}{T} \tag{4}$$

3.3. Research design

To test the hypotheses of asymmetric default correlation among firms on corporate governance we develop indices for each governance dimension. Hypothesis 1, described in section 2.3, is to test the default correlation on concentrated/dispersed ownership. For this purpose, we use three proxies, viz., institutional share

ownership (INS%), shareholding by five major shareholders (FIVE_SH), and a dummy variable to measure the existence of a major shareholder holding 20% of the total shares outstanding (BLOCK_20). We define the total index value to be the sum of the three variables. We use the ownership structure index to divide our sample firms into two subgroups: (1) concentrated ownership, and (2) dispersed ownership. Dispersed ownership is where the sum equals to 0 or 1, and concentrated ownership is where the sum is equal to 2 or 3 (refer Table 1 for variable definition and Table 2 for indices development). Then, we estimate the default correlations separately for each subgroup under each pair of three credit qualities as described in Section 3.2.

Table 1: Definitions for governance indicators

Indicator	Definition
Ownership structure and influence	
INS_SH	Percentage of share ownership by institutions
FIVE_SH	Percentage of share ownership by five largest shareholders
BLOCK_20	1= if at least one shareholder has more than 20% shares, 0=otherwise
Board effectiveness	
BOARD_SIZE	Number of board members in the board
CEO_DUA	1= if CEO and Chair are the same person, 0= otherwise
IND_DIRE	Number of independent directors
OUTS_DIRE	Number of outside directors
Financial transparency and disclosures	
AUD_QUALITY	1= if audit committee chair is an independent director, 0= otherwise
AUD_OP	1= if the opinion is unqualified, 0= otherwise
Shareholder rights	
EX_AUDITOR	1= if shareholders appoint the external auditor, 0= otherwise
REM_MGT	1= if shareholders approve the remuneration of management, 0= otherwise

Table 2: Construction of indices for governance dimensions

Indicators	criteria for the indices	Construction of the indices
Ownership Concentration		
INS_SH	1 if the percentage is greater than 25%; 0 otherwise	If the total equals to 0 or 1, the company is considered to have dispersed ownership, If the total equals to 2 or 3 the company is considered to have concentrated ownership.
FIVESH	1 if the percentage is greater than 25%; 0 otherwise	
BLOCK_20	1 if the company has single shareholder with 20% ownership; 0 otherwise	
Board effectiveness		
BOARD_SIZE	1 if the board size is equal to or greater than 12[12]; 0 otherwise	If the total equals to 3 or 4, company is considered to have high board effectiveness; and if the total is 0, 1 or 2, company is considered to have low board effectiveness.
CEO_DUA	1 if the CEO and the chairman is separate; 0 otherwise	
IND_DIRE	1 if the company has 75% or more independent director from the total board members[1]; 0 otherwise	
OUTS_DIRE	1 if the company has 75% or more independent director from the total board members[1]; 0 otherwise	
Financial transparency		
AUD_QUALITY	1 if the audit committee is chaired by an independent director; 0 otherwise	If the total equals to 2 the company is considered to have high financial transparency; if the total is equals to 1or 0 the company is considered to have low financial transparency
AUD_OP	1 if the company received unqualified opinion; 0 otherwise	
Shareholder rights		
EX_AUDITOR	1 if shareholders appoint the external auditor; 0 otherwise	If the total equals to 2 the company is considered to have high shareholder rights; if the total is equals to 1 or 0 the company is considered to have low shareholder rights

[12] The criteria is consistent with S&P corporate governance survey (2012) results.

The second hypothesis is based on board effectiveness. Board effectiveness is measured through four indicators: board size, CEO duality, and the number of independent (IND_DIRE) and outside directors (OUTS_DIRE) on the board. As this dimension includes four variables, we define the companies with high board effectiveness, if the sum of the index value is 3 or 4, whereas if the sum is 0, 1 or 2, the companies are presumed to have low board effectiveness. We then split our sample into two subgroups: (1) high board effectiveness, and (2) low board effectiveness. Next, we estimate the default correlations separately for each subgroup under each pair of three credit qualities as described in Section 3.2.

Hypothesis 3 relates to financial transparency and disclosures. This is measured by two indicators: the audit committee quality (AUD_QUALITY) and the auditor opinion (AUD_OP). The higher financial transparency is captured by the companies with the sum of index value equal to 2. If the amount of the index value is 0 or 1, this means low financial transparency and disclosures. We use the financial transparency and disclosures index to divide our sample firms into two subgroups: (1) high financial transparency and disclosures, and (2) low financial transparency and disclosures. Then we estimate the default correlations separately for each subgroup under the three credit qualities as described in Section 3.2.

To test the shareholder rights (Hypothesis 4), a shareholder rights index is constructed by using two indicators: shareholder rights to ratify the external auditor of the companies (EX_AUDITOR) and shareholder rights to approve the remuneration of the executive management (REM_MGT). As the index includes only two indicators the higher and low shareholder rights, the higher shareholders' rights is indicated by a sum of index value equal to 2. If the sum of the index value is equal to 0 or 1, this indicates low shareholders rights. We then split our sample into two subgroups (1) High shareholder rights, and (2) low shareholder rights. Next, we estimate the default correlations separately for each subgroup under each pair of three credit qualities as described in Section 3.2.

To test the effect of corporate governance on default correlation in the crisis and non-crisis periods (hypothesis 5), we split the whole sample of firms into two groups under each dimension. For example, for ownership concentration, we split the whole sample into two subsamples in terms of concentrated/ dispersed ownership. Then each subsample is divided further into two more subsamples of

crisis and non-crisis periods. Thus, the correlation is identified on the basis of concentrated/ dispersed ownership in crisis and non-crisis periods. The crisis period represents the periods of 2001-2002 and 2007-2009 whereas the remaining periods are considered as the non-crisis period. We follow the same procedure of splitting the sample for all the other dimensions we test.

4. Empirical results

4.1. Descriptive statistics

Tables 3 and 4 summarize the descriptive statistics and correlations of the Z-score components and corporate governance variables, respectively. Panel A of Table 3 presents a comparative analysis of descriptive statistics between default and non-default firms for Z-score variables. Accordingly, non-default firms show higher mean values than default firms for all the ratios except for sales to total assets, indicating that the default firms have low working capital, market value, and earnings. Panel B of Table 3 reports the correlation among the Z-score components; however, no significant or high correlation is reported among the variables.

Table 3: Descriptive statistics and correlation among Z-score variables

Panel A: Descriptive statistics of Z-score values

	Default firms (N=160)		**Non-default firms (N=675)**		**Test of equal means**	
	Mean	Std. Dev.	Mean	Std. Dev.	T-value	P-value
WC/TA	.068	1.158	.123	.169	-1.194	.233
MVE/TL	6.601	16.526	198.991	2042.431	-1.191	.234
S/TA	1.153	1.065	.853	.578	4.884	.000
RE/TA	-4.650	10.608	.317	.322	-12.164	.000
EBIT/TA	-.811	3.837	.128	.078	-6.368	.000

Panel B: Correlation matrix for Z-score variables

Variables	WC/TA	MVE/TL	S/TA	RE/TA	EBIT/TA
WC/TA	1.0000				
MVE/TL	-0.0107	1.0000			
S/TA	-0.1166	-0.0728	1.0000		
RE/TA	0.1746	0.0107	-0.0343	1.0000	
EBIT/TA	0.0579	0.0013	-0.1509	0.3184	1.0000

Note: The sample consists of 835 firm-year observations (160 default firms and 675 non-default firms) for the period of 2000-2015. The Z-score components are defined as: WC/TA= Working capital/ Total assets, MVE/TL= Market value of equity/ Total liabilities, S/TA= Sales/ Total assets, RE/TA= Retained earnings/ Total assets, and EBIT/TA= Earnings before interest and tax/ Total assets. This table shows the mean, standard deviation (Std. Dev.), T-statistics and the significant of T-values.

Panel A of Table 4 provides a comparative analysis of the descriptive statistics between default and non-default firms for the governance variables. Default firms show higher mean values for ownership concentration variables. The proxies for board effectiveness are lower in default firms than non-default firms in terms of a small board, low independent and few outside directors. Under financial transparency and disclosures, the mean value of audit committee quality is low in default firms. They also show a lower mean value for auditor opinion (low unqualified opinion[13]) indicating low financial transparency and disclosures.

Shareholder rights and relations reveal a mixture of findings. Shareholder right to ratify an external auditor in non-default firms is higher than in default firms. However, the shareholder right to approve the remuneration of executive management (REM_MGT) is higher in default firms than non-default firms. All the proxies are significantly different between the two groups except for REM_MGT. Panel B of Table 4 reports the correlation among governance variables. All variables show low correlation except for independent (IND_DIRE) and outside director (OUT_DIRE) variables.

[13] Compustat database defines Unqualified Opinion as "there are no unresolvable restrictions in company financial statements and auditor has no significant exceptions as to the accounting principles, the consistency of their application, and the adequacy of information disclosed".

Table 4: Descriptive statistics and correlation among governance variables

Panel A: Descriptive statistics for governance variables

	Default firms		Non-default firms		Test of equal means	
	Mean	S.D	Mean	S.D	*t-value*	*P-value*
Ownership structure and influence						
INS	37.258	25.368	21.270	27.354	6.738	0.000
FIVE_SH	50.853	24.039	26.278	28.307	10.147	0.000
BLOCK_20	0.425	0.496	0.240	0.427	4.768	0.000
Board effectiveness						
BOARD_SIZE	6.450	2.040	12.671	3.955	-19.293	0.000
CEO_DUA	0.519	0.501	0.609	0.488	-2.089	0.037
IND_DIRE	4.375	2.012	9.116	3.679	-15.745	0.000
OUTS_DIRE	4.613	2.113	9.679	3.755	-16.453	0.000
Financial transparency and disclosures						
AUD_QUALITY	0.931	0.254	0.987	0.115	-4.160	0.000
AUD_OP	0.263	0.441	0.630	0.483	-8.780	0.000
Shareholder rights						
EX_AUDITOR	0.956	0.205	1.000	0.000	-5.551	0.000
REM_MGT	0.556	0.498	0.554	0.497	0.050	0.960

Note: The sample consists of 835 firm-year observations (160 default firms and 675 non-default firms) for the period of 2000-2015. The variables are defined as: INST (%)=Institutional share ownership, FIVE_SH= Shareholding by five largest shareholders, BLOCK_20= A dummy variable for the presence of block shareholder with at least 20% of shareholding, EXT_AUD= shareholder rights to appoint external auditor, REM_MAG= shareholder rights to approve remuneration of executive management, AUDCOM_QUA= audit committee quality, AUD_OP=auditor opinion, BOARD SIZE, CEO DUALITY, IND_DIRE= number of independent directors in the board, OUT_DIRE= number of outside directors in the board. Panel A shows the mean, standard deviation (Std. Dev.), T-statistics and the significant of T-values and panel B reports the coefficients for Pearson's correlation among governance variables.

Panel B: Co-efficient for Pearson's Correlation matrix for corporate governance variables

	INST (%)	FIVE_SH	*BLOCK _20*	*EXT_AU D*	*REM_MA G*	*AUDCOM_ QUA*	*AUD_OP*	*BOARD SIZE*	*CEO DUALITY*	*IND_DIR E*	*OUT_DIR E*
INST (%)	1										
FIVE_SH	.682	1									
BLOCK_20	.446	.748	1								
EXT_AUD	-.024	-.098	-.090	1							
REM_MAG	-.039	-.070	-.111	.050	1						
AUDCOM_QUA	-.034	-.084	-.114	-.014	.049	1					
AUD_OP	.023	-.038	-.036	.077	.063	.066	1				
BOARD SIZE	.015	-.198	-.162	.114	-.053	.165	.162	1			
CEO DUALITY	-.226	-.284	-.202	.030	-.156	.045	-.050	-.042	1		
IND_DIRE	-.201	-.444	-.421	.103	-.011	.197	.162	.729	-.003	1	
OUT_DIRE	-.152	-.349	-.319	.104	.030	.203	.171	.778	-.057	.898	1

4.2. Default correlation among credit qualities over different time horizons

We examine the default correlation among the firms with different credit qualities over one, five and ten-year time horizons. As described in section 3.3, the credit quality is derived by using Z-score value. According to Table 5, a low default correlation is found for a one-year horizon. However, the default correlations in five-year and ten-year horizons are higher particularly for the firms with low credit quality. The result is consistent with previous findings (e.g., Crouhy et al., 2000; Zhou, 2001; and Li and Chen, 2018) indicating firms with low credit quality are unable to adjust to the external environmental shocks, and they have less capacity to repay their loans than high credit quality firms.

Table 5: Default correlation over short and long time horizon

Time Horizon	Credit quality	Credit quality		
		High Grade	Medium Grade	Low Grade
One year	High Grade	2.80% (2.44)*		
	Medium Grade	3.24% (2.06)*	1.66% (0.39)	
	Low Grade	6.39% (5.45)**	7.19% (3.13)**	12.15% (5.29)**
Five year	High Grade	23.73% (23.84)**		
	Medium Grade	29.33% (24.43)**	34.62% (11.11)**	
	Low Grade	29.27% (44.34)**	33.84% (29.97)**	56.97% (64.88)**
Ten year	High Grade	34.95% (32.90)**		
	Medium Grade	40.78% (35.29)**	48.48% (19.22)**	
	Low Grade	40.42% (68.29)**	50.62% (55.39)**	69.61% (104.49)**

Note: This table presents the estimates of default correlations for various credit qualities over one, five and ten-year time horizons. Default correlations are calculated by using Equation (1) for each pair of firms. T-statistics are in parentheses. ** and * represent significance at 1% and 5%, respectively. The sample consists of 835 firm-year observations (160 default firms and 675 non-default firms) for the period of 2000-2015. Five-year and ten-year time horizons indicate that five years and ten years following the default year respectively.

4.3. The effect of ownership structure and influence

Table 6 shows the results of the impact of ownership concentration on default clustering. Default correlation among firms with concentrated ownership is higher than those with dispersed ownership. Default correlation of high credit grade firms is lower for those with dispersed ownership, while the high credit grade firms in the concentrated ownership category show higher correlation. The default correlation among the low credit grade firms with the dispersed ownership concentration is 61% whereas the correlation of the low credit grade firms with the concentrated ownership is 75%. Therefore, the result supports Hypothesis 1, that firms with concentrated/ dispersed ownership are associated with high/low default correlation.

Table 6: Default correlation: High versus low ownership structure and influence

Ownership Concentration	Credit quality	Credit quality		
		High Grade	Medium Grade	Low Grade
Dispersed	High Grade	15.16% (7.19)**		
	Medium Grade	18.11% (5.54)**	-2.68% (-0.26)	
	Low Grade	27.13% (18.69)**	28.55% (8.81)**	60.84% (29.72)**
Concentrated	High Grade	52.23% (23.85)**		
	Medium Grade	54.46% (28.18)**	55.94% (16.10)**	
	Low Grade	52.73% (51.60)**	56.37% (43.69)**	75.32% (77.12)**

Note: This table reports the default correlations among different credit qualities under high and low ownership concentration windows. Default correlations are calculated by using Equation (1) for each pair of firms. T-statistics are in parentheses. ** and * represent significance at the 1% and 5%, respectively. The sample consists of 835 firm-year observations (160 default firms and 675 non-default firms) for the period of 2000-2015.

4.4. The effect of board effectiveness on default correlation

We analyze the effect of board effectiveness on default clustering. Table 7 reports the correlations among low board effectiveness firms and high board effectiveness firms. The comparative analysis indicates that low board effectiveness firms have higher correlation than the high board-effective firms. For example, low credit grade firms with the low board effectiveness show 72% correlation, whereas low

credit grade firms with the high board effectiveness show only 58% correlation. High credit grade firms with the high board effectiveness exhibit only 19% correlation; however, high credit grade firms with the low board effectiveness have 44% correlation. Thus, these empirical finding support Hypothesis 2 that firms with the low/high effective board are associated with high/low default correlation.

Table 7: Default correlation: High versus low board effectiveness

Board effectiveness	Credit quality	Credit quality		
		High Grade	Medium Grade	Low Grade
Low	High Grade	43.85% (26.82)**		
	Medium Grade	46.64% (26.84)**	51.76% (14.39)**	
	Low Grade	46.87% (58.35)**	51.06% (42.53)**	72.22% (90.73)**
		High Grade	Medium Grade	Low Grade
High	High Grade	18.77% (6.11)**		
	Medium Grade	28.55% (8.20)**	38.50% (4.42)**	
	Low Grade	28.23% (11.29)**	50.66% (12.40)**	58.52% (13.79)**

Note: This table reports the default correlations among different credit qualities under high and low board effectiveness windows. Default correlations are calculated by using Equation (1) for each pair of firms. T-statistics are in parentheses. ** and * represent significance at the 1% and 5%, respectively. The sample consists of 835 firm-year observations (160 default firms and 675 non-default firms) for the period of 2000-2015.

4.5. The effect of financial transparency and disclosures

Table 8 presents the correlation result for low financial transparency and disclosures and high financial transparency and disclosures with different credit grades. For each pair of grades, firms with low financial transparency and disclosures show higher default correlation. Under low financial transparency and disclosures, a correlation of 71% is reported by low credit grade firms whereas medium and high credit grade firms have only 59% and 45% correlations, respectively. The correlations among the high, medium and low credit grade firms with high financial transparency and disclosures are 25%, 39%, and 65%, respectively. Hence, the result confirms Hypothesis 3, that firms with high/low financial transparency and disclosures are associated with low/high default correlation.

Table 8: Default correlation: High versus low financial transparency

Financial transparency	Credit quality	Credit quality		
Low		High Grade	Medium Grade	Low Grade
	High Grade	45.40% (22.95)**		
	Medium Grade	51.33% (25.27)**	59.17% (13.69)**	
	Low Grade	49.38% (54.30)**	62.71% (46.88)**	70.93% (83.14)**
High		High Grade	Medium Grade	Low Grade
	High Grade	24.66% (10.88)**		
	Medium Grade	30.49% (11.45)**	39.36% (6.20)**	
	Low Grade	33.31% (18.06)**	37.68% (12.21)**	65.46% (21.20)**

Note: This table reports the default correlations among different credit qualities under high and low financial transparency windows. Default correlations are calculated by using Equation (1) for each pair of firms. T-statistics are in parentheses. ** and * represent significance at the 1% and 5%, respectively. The sample consists of 835 firm-year observations (160 default firms and 675 non-default firms) for the period of 2000-2015.

4.6. The effect of shareholder rights

Table 9 reveals firms with high shareholder rights exhibit a higher default correlation compared to firms with low shareholder rights. The correlation among the low credit grade firms with high shareholder rights is 75% correlation; however, low credit grade firms with low shareholder rights show only 64% correlation. More importantly, firms other than the low-grade firms show close correlation for both low and high shareholder rights.

The result is consistent with Ashbaugh-Skaife et al. (2006), who find a positive association between weaker shareholder rights and credit ratings.[14] This suggests firms that place more power in their shareholders' hands affect negatively the bondholders and this is viewed as detrimental by the credit rating agencies. Moreover, FitchRatings (2004) documents higher shareholders rights are not

[14] They measure the shareholder rights by using Gomper et al. (2003) governance index, where they found a positive association between the governance index and credit ratings. The higher score of the governance index indicates weaker shareholder rights.

considered necessarily as good governing practice. Chava et al. (2008) also provide supporting evidence for our findings as their results indicate banks charge higher interest to firms with higher shareholder rights than firms with lower shareholder rights. They suggest firms with higher shareholder rights have higher financial risk due to lower takeover defenses. Our results confirm that higher shareholder rights reduce the effectiveness of the corporate governance mechanisms and companies with higher shareholder rights exhibit higher default correlation due to the contagion effect. Thus Hypothesis 4, in which firms with higher shareholders rights are associated with high default correlations, is accepted.

Table 9: Default correlation: High versus low shareholder rights

Shareholder rights	Credit quality	Credit quality		
Low		High Grade	Medium Grade	Low Grade
	High Grade	31.17% (15.13)**		
	Medium Grade	39.83% (19.32)**	47.98% (11.31)**	
	Low Grade	39.34% (31.01)**	51.03% (28.19)**	63.76% (40.18)**
High		High Grade	Medium Grade	Low Grade
	High Grade	38.12% (17.13)**		
	Medium Grade	42.67% (16.18)**	46.73% (7.10)**	
	Low Grade	40.12% (36.11)**	48.15% (25.69)**	75.54% (66.71)**

Note: This table reports the default correlations among different credit qualities under high and low shareholder rights windows. Default correlations are calculated by using Equation (1) for each pair of firms. T-statistics are in parentheses. ** and * represent significance at the 1% and 5%, respectively. The sample consists of 835 firm-year observations (160 default firms and 675 non-default firms) for the period of 2000-2015.

4.7. The effect of the crisis on default correlation through corporate governance

We test the effect of firm governance practices on default correlation in both the financial crisis and non-financial crisis periods. Table 10 presents the results of the default correlations for the firms in both crisis and non-crisis periods under different levels of corporate governance practices. Panel A shows firms with the

concentrated ownership have higher default correlation in both crisis periods (17%) and non-crisis periods (5%). The correlation is higher in the crisis period than in the non-crisis period. The default correlations among firms with the low board effectiveness in both crisis and non-crisis periods are 18% and 4%, respectively, as indicated by Panel B. Firms with high board effectiveness show a correlation of 14% in the crisis and 5% in the non-crisis period. Panel C shows the default correlation among the firms with low financial transparency shows a higher correlation in the crisis period (14%) than in the non-crisis period (2%). The respective default correlations for firms with high financial transparency show 11% in the crisis and 1% in the non-crisis period. Panel D indicates in the crisis period the correlation among firms with higher shareholder rights is higher when compared to those with low shareholder rights (14% vs. 10%). However, the default correlation in the non-crisis period among firms with lower shareholder rights is high when compared to the other corporate governance dimensions. The reason might be mixed evidence on shareholder rights as poor or good corporate governance from different company perspectives (i.e., credit ratings, firm values, etc.).

All the indicators of weak governance (ownership concentration, low boards effectiveness, low financial transparency and disclosures, and higher shareholder rights) show a higher correlation to default in periods of crisis. Accordingly, Hypothesis 5, that firms with weak corporate governance practices have higher default correlation in the crisis period than a non-crisis period, is accepted.

Table 10: Default correlation: Good and poor corporate governance effect in crisis and non-crisis period

Panel A: Ownership concentration (Owner_con)			
		Dispersed_Owner	Concentrated_Owner
Crisis	Dispersed_Owner	2.17 % (0.94)	
	Concentrated_Owner	9.65 % (5.10)**	**17.46 % (6.57)****
Non-crisis	Dispersed_Owner	0.24 % (0.18)	
	Concentrated_Owner	1.24 % (1.12)**	5.41 % (2.93)**
Panel B: Board effectiveness (Board_eff)			
		Low Board_eff	High Board_eff
Crisis	Low Board_eff	**17.61% (8.07)****	
	High Board_eff	14.74% (8.01)**	14.48% (4.53)**
Non-crisis	Low Board_eff	4.27 % (3.01)**	
	High Board_eff	5.12 % (4.68)**	5.33 % (3.22)**
Panel C: Financial transparency (Fin_trans)			
		Low Fin_trans	High Fin_trans
Crisis	Low Fin_trans	14.24 % (4.79)**	
	High Fin_trans	**15.25 % (6.30)****	10.89 % (2.91)**
		Low Fin_trans	High Fin_trans
Non-crisis	Low Fin_trans	2.43 % (1.41)	
	High Fin_trans	-4.59 % (-3.90)**	0.66 % (0.54)
Panel D: Shareholder rights (Share_rights)			
		Low Share_rights	High Share_rights
Crisis	Low Share_rights	10.54 % (4.16)**	
	High Share_rights	15.08 % (8.02)**	13.94 % (5.66)**
		Low Share_rights	High Share_rights
Non-crisis	Low Share_rights	**15.28 % (8.75)****	
	High Share_rights	1.37 % (1.20)	-3.50 % (-2.74)**

Note: This table reports the default correlations among poor and good corporate governance firms in crisis and non-crisis periods. Poor corporate governance defined as high ownership concentration, low board effectiveness, low financial transparency and high shareholder rights. Default correlations are calculated by using Equation (1) for each pair of firms. T-statistics are in parentheses. . ** and * represent significance at the 1% and 5%, respectively. The sample consists of 835 firm-year observations (160 default firms and 675 non-default firms) for the period of 2000-2015. Bold numbers represent the highest correlation.

4.8. Implications of the findings

The findings of this research provide implications on credit portfolio management of banks and corporate financiers. A credit portfolio manager is concerned about not only the defaults of the individual borrower but also the possible multiple defaults in a portfolio. Therefore, it is necessary to recognize the sources behind correlated defaults among multiple firms. The findings of this study open a new discussion on refining the current strategies to reduce default risk in a portfolio in terms of firms' corporate governance practices. First, the hypothesis regarding ownership concentration confirms that firms with concentrated ownership reflect higher default correlation than firms with dispersed ownership. Therefore, when diversifying a credit portfolio to reduce potential credit losses, financiers should consider the ownership structure of a company and should allocate more funds to firms with dispersed ownership. It appears that the perceived benefit of reductions in risk stemming from credit portfolio diversification is likely to be overestimated for firms with weak corporate governance.

This research also considers the impact of board effectiveness, financial transparency and disclosures, and shareholders rights because these governance dimensions also show a significant effect on default clustering probabilities. That is, if the credit portfolio consists of corporate borrowers having a less effective board, low financial transparency and disclosures, and high shareholders rights, the portfolio should be changed, or higher interest rates imposed to compensate for the high risk. Alternatively, the portfolio could be extended to select firms with more effective governance practices.

Further, financiers should re-examine their portfolio in a crisis period as a higher default correlation exists in the crisis period than the non-crisis period. Consequently, they should give substantial consideration on the borrowers with high ownership concentration, less effective board structure, and low financial transparency and disclosures in the crisis periods. Overall, if banks consider the dynamic nature of firms' corporate governance practices, they could create a high-return portfolio with risk being effectively controlled.

5. Robustness test

We conduct various tests to check the robustness of our primary results. These tests use alternative measures of credit quality, financial transparency and shareholder rights.

5.1. Alternative measurement for credit quality

First, we use firm credit rating as an alternative measurement for credit quality. For this purpose, we use the long-term issuers' credit ratings complied by Standard and Poor's from the Compustat database. The credit ratings reflect the creditworthiness of the issuers' debt obligations. These ratings range from AAA (highest rating indicating lowest default risk) to D (lowest credit rating indicating highest default risk). For our analysis we divide the ratings into three categories, namely, high credit quality (from AAA to A-), medium credit quality (from BBB+ to B-), and low credit quality (CCC+ to D). We retest the four hypotheses relating to corporate governance using these classifications of credit quality. The results of Table 11 reconfirm our findings above. First, firms with concentrated ownership show a higher default correlation than the dispersed ownership firms (e.g., 75.32% and 67.92%). Second, firms with low board effectiveness show a 73.53% correlation whereas those with higher board effectiveness at 69.11%. Third, firms with low financial transparency show a higher default correlation than those with high financial transparency (e.g.,79.51% and 62.97%). Lastly, firms with higher shareholder rights show a higher default correlation compared to firms with low shareholder rights (e.g.,73.64% and 72.64%). All these results are significant at the 1% level.[15]

[15] Note that, all the results relating to higher credit quality and governance attributes report zero correlation because none of the default firms do not secure higher credit ratings and do not belong in the high credit quality.

Table 11: Non-uniform default correlations: Using credit ratings as an alternative measurement for credit quality

Governance attributes	Credit quality	Credit quality		
		High Grade	Medium Grade	Low Grade
Panel A: Ownership structure and influence				
Dispersed	High Grade	0.00% (0.00)		
	Medium Grade	0.00% (0.00)	-2.57% (-0.22)	
	Low Grade	0.00% (0.00)	27.23% (8.76)**	67.92% (37.81)**
Concentrated	High Grade	0.00% (0.00)		
	Medium Grade	0.00% (0.00)	56.06% (5.00)**	
	Low Grade	0.00% (0.00)	56.22% (31.00)**	75.32% (115.00)**
Panel B: Board effectiveness				
Low	High Grade	0.00% (0.00)		
	Medium Grade	0.00% (0.00)	28.75% (3.32)**	
	Low Grade	0.00% (0.00)	38.52% (25.01)**	73.53% (128.36)**
High	High Grade	0.00% (0.00)		
	Medium Grade	0.00% (0.00)	41.00% (2.46)*	
	Low Grade	0.00% (0.00)	47.98% (8.49)**	69.11% (15.52)**
Panel C: Financial transparency and disclosures				
Low	High Grade	0.00% (0.00)		
	Medium Grade	0.00% (0.00)	34.21% (3.40)**	
	Low Grade	0.00% (0.00)	35.57% (20.63)**	79.51% (123.78)**
High	High Grade	0.00% (0.00)		
	Medium Grade	0.00% (0.00)	28.41% (2.16)**	
	Low Grade	0.00% (0.00)	45.41% (13.43)**	62.97% (33.19)**
Panel D: Shareholder rights				
Low	High Grade	0.00% (0.00)		
	Medium Grade	0.00% (0.00)	21.89% (1.98)*	
	Low Grade	0.00% (0.00)	37.31% (15.79)**	72.64% (65.52)**
High	High Grade	0.00% (0.00)		
	Medium Grade	0.00% (0.00)	35.92% (2.92)**	
	Low Grade	0.00% (0.00)	43.50% (20.24)**	73.64% (89.40)**

Note: This table reports the default correlations among poor and good corporate governance firms using credit rating as an alternative measurement for credit quality. Default correlations are calculated by using Equation (1) for each pair of firms. T-statistics are in parentheses. ** and *

represent significance at 1% and 5%, respectively. The sample consists of 835 firm-year observations (160 default firms and 675 non-default firms) for the period of 2000-2015.

5.2. Alternative measurement for financial transparency and disclosures

The second robustness test we conduct is based upon alternative proxies for financial transparency and disclosures. We use two new proxies for financial transparency, i.e., audit committee independence (measured by a binary variable where it equals one if firms audit committee is formed 100% from outsiders, and zero otherwise) and financial expertise (a binary variable that equals one if the firm has at least independent financial expert on the audit committee and zero otherwise).[16] Table 12 shows that firms with low financial transparency tend to have a higher default correlation at the 1% significant level compared to those with low financial transparency. For example, under low financial transparency and disclosures, a 74% correlation is reported by low credit grade firms, whereas high financial transparency and disclosures firms have only 48% correlation among low credit grade firms.

Table 12: Non-uniform default correlations: An alternative measure for financial transparency and disclosures

Financial transparency	Credit quality	Credit quality		
		High Grade	Medium Grade	Low Grade
Low	High Grade	65.35% (127.75)**		
	Medium Grade	65.67% (96.14)**	65.39% (35.21)**	
	Low Grade	66.98% (143.32)**	67.10% (75.66)**	74.16% (87.63)**
		High Grade	Medium Grade	Low Grade
High	High Grade	21.02% (8.65)**		
	Medium Grade	15.26% (4.85)**	19.96% (2.28)*	
	Low Grade	17.69% (12.27)**	33.86% (12.78)**	48.12% (27.88)**

Note: This table reports the default correlations among different credit qualities under high and low financial transparency windows. In this table, we employ audit committee independence (a binary variable where 1 if firms audit committee is formed 100% from outsiders, otherwise 0) and financial expertise (a binary variable where 1 if firm has at least independent financial expert in the audit committee; otherwise 0) to serve as an alternative measure of financial transparency. Default

[16] Financial expertise is defined as the audit committee member having a CPA or being a CFO.

correlations are calculated by using Equation (1) for each pair of firms. T-statistics are shown in parentheses. ** and * represent significance at 1% and 5%, respectively. The sample consists of 835 firm-year observations (160 default firms and 675 non-default firms) for the period of 2000-2015.

5.3. Alternative measurement for shareholder rights

Finally, we employ an alternative measure for shareholder rights using the governance index (GOV_INDEX) used by Gompers et al. (2003). GOV_INDEX covers 24 provisions to measure the balance of power between investors and management. These are categorized into five areas: voting rights, tactics for delaying hostile bids, other takeover defenses, director/officer protection and state takeover laws. According to Gompers et al. (2003), a higher score (GOV_INDEX $\geq$ 14) indicates higher managerial power and weaker shareholder rights. A lower score (GOV_INDEX $\leq$ 5) indicates higher shareholder rights and lower managerial power. The median GOV_INDEX of our sample is 8. Thus, we categorize the firms as having lower shareholder rights if the GOV_INDEX is greater than or equal to 8. If the GOV_INDEX is less than 8, the firms are considered to possess higher shareholder rights.[17] The results presented in Table 13 show that firms with higher shareholder rights tend to have higher default correlation when compared to those with lower shareholder rights. For example, the correlation among the low credit grade firms with high shareholder rights is 58%; whilst, low credit grade firms with low shareholder rights show only 50% correlation.

[17] The data for GOV_INDEX is available on Andrew Metric's website: http://faculty.som.yale.edu/andrewmetrick/data.html. The data of this score is available until 2006. Thus, for this analysis we limit our sample firms from 2000 to 2006. Accordingly, 437 firms were included in this test.

Table 13: Non-uniform default correlations: An alternative measure for shareholder rights

Shareholder rights	Credit quality	Credit quality		
		High Grade	Medium Grade	Low Grade
Low	High Grade	14.90% (2.87) **		
	Medium Grade	23.28% (3.37) **	9.33% (0.45)	
	Low Grade	23.36% (7.15) **	39.34% (6.42) **	50.19% (11.98) **
		High Grade	Medium Grade	Low Grade
High	High Grade	17.32% (4.88) **		
	Medium Grade	20.48% (6.57) **	17.40% (3.04) **	
	Low Grade	24.66% (10.29) **	29.88% (9.96) **	57.85% (17.40) **

Note: This table reports the default correlations among different credit qualities under high and low shareholder rights windows. In this table, we use Gompers' et al. (2003) governance index as an alternative measure for shareholder rights. Default correlations are calculated by using Equation (1) for each pair of firms. T-statistics are in parentheses. ** and * represent significance at 1% and 5%, respectively. The sample consists of 437 firm-year observations for the period of 2000-2006.

6. Conclusion and future research directions

This study addresses the effects of the corporate governance practices of firms on default correlations. Das et al. (2007) identify three causes of default correlations: cyclical effect, contagion effect, and effect of learning from others. This paper contributes to the literature by extending the reasoning of Das et al. (2007). We find the corporate governance practices of firms significantly affect the clustered default risk among firms. We apply the Lucas's (1995) method to test five hypotheses. The historical U.S. default data of 835 firm-year observations throughout the period from 2000 to 2015 is employed for the analysis. First, we find firms with concentrated (dispersed) ownership are associated with high (low) default correlation. Second, firms with the low (high) effective board are associated with high (low) default correlation. Third, firms with low (high) financial transparency are associated with high (low) default correction. Fourth, high (low) shareholder rights create high (low) default correlation among firms. Fifth, firms

with weaker corporate governance practices have higher default correlation in a crisis period than a non-crisis period. Our results imply that firms with weak corporate governance may have high default correlations and, hence, they could be less effective in risk reduction if included in a credit portfolio for diversification tasks.

This research has implications for financiers, and regulatory authorities. We recommend financiers consider corporate governance information for portfolio credit risk management. They should closely monitor firms with concentrated ownership, low board effectiveness, low financial transparency and high shareholders rights regarding the credit portfolio management. Overall, our findings indicate that regulators should adjust capital requirements for banks that make loans to firms with weak governance during crisis periods.

Our empirical results should be interpreted with caution. First, the results are limited by the selection of variables. Although we conduct several robustness tests using alternative measures of credit quality and corporate governance, some other proxies might be used for the firm characteristics. Second, the Lucas's method for default correlation, which we adopt in this paper, takes advantage of model-free estimation techniques and measures default correlation based on the realized historical default data. Since there are a few ways to estimate default correlations, it would be of academic interest to determine if this method is superior, because default correlations have not always been satisfactorily modelled and each method has its own merits and disadvantages. Third, we collect the historical data of credit quality and corporate governance until the last available year before the occurrence of the default event to examine the impact of corporate governance on default correlations. Future studies may examine the mutual relationship between them and address the issue of endogeneity.

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Chapter Four

Capital structure adjustments and corporate defaults

Chapter four consists of two completed and submitted research papers. The title of the first paper is "Heterogeneity in capital structure adjustment revisited: Default versus non-default firms and short versus long time horizons." It is under the first round of review by *Journal of Banking and Finance* (SSCI and ABDC ranking = A*). This paper shares the tests conducted to examine the heterogeneity of capital structure adjustments over two types of firms (default and non-default firms), and two types of measures (cumulative versus marginal). The fixed effect panel regression is employed to provide empirical evidence from U.S. 6,203 and 51,371 firm-year observations for default and non-default firms, respectively, over the period from 1975 to 2015. The empirical results show that the default firms are associated with a higher speed of adjustment than non-default firms and firms take multiple periods to reach to target leverage. Further, the marginal speed of adjustment accelerates from the beginning period to the end period, as is consistent with the anchoring and adjustment bias heuristic.

The title of the second paper is "Do leverage dynamics strengthen bankruptcy prediction? A comprehensive test." This paper is under the first round of review by *Applied Economic Letters* (SSCI and ABDC ranking = B). Herein the effect of leverage deviation on measuring firms' default risk in a comprehensive information environment is examined. A logistic model is employed to estimate the explanatory power of leverage deviation together with information from accounting, market and corporate governance variables for default prediction over five-year time horizons. The in-sample and out-of-sample tests suggest that taking into account leverage deviation enhances the capacity of measuring corporate borrowers' default risk and this enhancement is persistent over five-year time horizons.

Heterogeneity in capital structure adjustment revisited: Default versus non-default firms and short versus long time horizon

Declaration about the role and the contributions of authors

I (Ruwani Fernando) confirm that I am the principal author of the following paper. As the principal author, I developed the conceptual framework, collected the data, conducted the data analysis, interpreted the results, and wrote the research paper. Leon Li provided conceptual advice, commented on and edited all versions of the paper. Greg Hou also commented on and edited all the versions of the paper.

Please see the Co-authorship form attached in Appendix 4.

This paper has been submitted and is under review by *Journal of Banking and Finance.*

- Fernando, J.M.R., Li. L., & Hou. G. (2019). Heterogeneity in capital structure adjustment revisited: Default versus non-default firms and short versus long time horizons.

Heterogeneity in capital structure adjustment revisited: Default versus non-default firms and short versus long time horizon

Abstract

This paper reexamines the issue of the heterogeneity of the speed of capital structure adjustment in firms. In contrast to previously documented contemporaneous results, we test the issue through distinguishing two types of the firm (default and non-default firms), and two measures of the speed of adjustment (cumulative versus marginal). Our empirical results show that the speed of adjustment is non-uniform across firms and over time. In particular, default firms are associated with a higher speed of adjustment than non-default firms. The completion of leverage adjustment takes multiple periods. The marginal speed of adjustment accelerates from the beginning period to the end period, which is consistent with the anchoring and adjustment bias heuristic. Our empirical results are robust using a book/market leverage and a two-/one-step estimation approach.

Keywords: Capital structure, speed of adjustment, default firms, cumulative adjustment, marginal adjustment

1. Introduction

Capital structure decisions vary across firms, time, industries, and general economic conditions. Therefore, the concept of target leverage has become one of the major concerns of the recent capital structure literature searching for the reasons behind the heterogeneity of leverage adjustments among firms. Research suggests that the leading cause for the firms to lag behind their optimal leverage is the transaction cost (Myers, 1984). Further, literature suggests, investment opportunities (Elsas et al., 2014), corporate governance (e.g. Chang et al. 2014), debt covenants (Devos et al. 2017), credit ratings (Huang and Shen, 2015), and macroeconomic conditions (e.g. Korajczyk and Levy, 2003; Cook and Tang, 2010) also affect the speed of adjustment (SOA) towards target leverage.

Recent studies in this area examine the heterogeneity of SOA by splitting samples using different firm characteristics (e.g., Dang et al., 2012). New insights are supported by the dynamics of capital structure adjustments relating to different financial conditions of firms (e.g., Korajczyk and Levy, 2003; Dang et al., 2012). A few studies have addressed and examined the heterogeneity of leverage adjustment speed across various conditions, for example, high versus low financing imbalances (Dang et al., 2012), financial constraints versus non-constraints (Korajczyk and Levy, 2003), financially distressed firms before and after restructuring their debt (Gilson, 1997), and firms with financial deficit versus surplus when they are below and above the target leverage (Byoun, 2008). In this study, we first investigate the heterogeneity of leverage adjustment across default and non-default firms. To run the investigation, we define default [18] as the firms that have gone through bankruptcy or liquidation. Our empirical results indicate that firms that are close to default should exhibit a different pattern of capital structure and adjustment speed when compared to non-default firms. Next, we examine the heterogeneity of leverage adjustment across various periods. To run examination, we estimate the speed of adjustment over various time horizons and propose the two measurements for the speed of adjustment, that is, cumulative and

[18] In this paper the terms bankruptcy and liquidation are used interchangeably as each represents the situation where a firm is placed in default and investors suffer credit losses.

marginal. Our empirical results indicate that the degree of leverage adjustment is smaller at the beginning period and becomes larger as time increases.

Our study differs from those of Korajczyk and Levy (2003), Byoun (2008), and Dang et al. (2012) by choosing firms that are based on realized defaults and presume no continuity in the future. More specifically, there are two types of credit risk in finance, default and downgrade, but the most important is default risk. Korajczyk and Levy (2003), Byoun (2008), and Dang et al. (2012) discuss the issue of heterogeneity in leverage adjustment across firms with various credit ratings (e.g., high versus low rating). Our focus is on the comparison between default and non-default firms. Our argument is that although prior studies have investigated the issue of leverage adjustment as the credit rating of firms moving up and down, this is not the risk that investors should be focused on. The risk that should be focused on is when investing in a business, whether the chances that we are going to lose our money are high or low, and whether there is likely to be a permanent loss. The risk is default risk.

Therefore, we examine the heterogeneity in the speed of adjustment toward target leverage between default firms and non-default firms using realized data of default events. We estimate the speed of adjustment over various time periods and address two measurements of leverage adjustment speed: cumulative and marginal adjustment. Our study provides two main contributions to the literature. First, we offer new insights on the speed of adjustment of capital structure among default and non-default firms using a realized default sample. Secondly, we address an essential issue in this arena by understanding how firms' capital structure adjustment varies across various periods. We note that, firms' leverage adjustment is slower at the beginning and faster at the ending period and the phenomenon is consistent with the anchoring and adjustment heuristic.

To estimate the target leverage, we use a standard set of explanatory variables from the literature. Both book and market values of leverage are used, and the results are compared. Our empirical results highlight that the leverage adjustment speed of default firms is significantly faster than that of the non-default firms. To test the issue of leverage adjustment at the beginning versus ending period, we estimate the speed of adjustment over various time horizons and then define the time of completion when the degree of adjustment reaches 100 percent. Then we

specify the cumulative and marginal speed of leverage adjustment and analyse the speed of adjustment at various periods.

The rest of the paper is organized in sections: Section 2 reviews the literature and develops research hypotheses; Section 3 presents the data and model specification and Section 4 discusses the empirical results. The summary and conclusions are presented in Section 5.

2. Literature review and hypotheses development

2.1. Literature review

The focus of our study is to examine the heterogeneity in the SOA of capital structure across default and non-default firms and over various time periods. To examine this, we follow the literature to determine the optimal leverage and split sample firms according to their financial conditions. After estimating the SOA over various time horizons, we address the issue of cumulative versus marginal SOA.

Seminal work by Modigliani and Miller (1958) paved the way for many researchers to examine the implications of static trade-off theory on optimal capital structure. Under the trade-off theory, optimal leverage demands a balance between the tax benefit of borrowing debt and the cost of financial distress/bankruptcy. Traditional capital structure research suggests that firms have target leverage; however, due to the adjustment cost, firms deviate from their target leverage.[19] Empirical studies show that firms adjust their actual leverage to the target slowly (e.g., see Fama and French, 2002) and thus the SOA lies between zero and one. Some studies examine how fast the firms adjust their leverage towards the target and identify various factors causing the heterogeneity in the SOA (e.g., Hovakimian et al., 2001; Flannery and Rangan, 2006). The factors identified include transaction cost (e.g., Korajczyk and Levy, 2003; Gilson, 1997) as the main, and additionally, financial behaviour (e.g. Jalilvand and Harris, 1984), investment opportunities (Elsas et al., 2014), corporate governance (e.g., Chang et al., 2014), financing needs (Byoun, 2008), macroeconomic conditions (e.g., Korajczyk and Levy, 2003), debt

[19] For examples of studies, see Flannery and Rangan (2006); Byoun (2008); and Lemmon et al. (2008).

covenants (e.g., Devos et al., 2017), and growth opportunities (e.g., Dang et al., 2012).

Gilson (1997) examines the transaction cost on leverage ratio choices by financially distressed firms when reorganized through Chapter 11 US bankruptcy code and out of court restructuring. Gilson finds that, in general, the financially distressed firms tend to have higher leverage after contracting with their creditors. However, the transaction cost is higher when the firms are restructured out of court because various factors increase the cost of reducing debt/ or issuing equity. Korajczyk and Levy (2003) split the sample based on financial constraints to examine the effect of macroeconomic and firm-specific factors on target capital. They find financially unconstrained firms' leverage varies counter-cyclically whereas constrained firms' leverage matches macroeconomic conditions. Further, they find that macroeconomic conditions significantly affect issue-choice (either debt or equity) of unconstrained firms, but the effect is less pronounced with constrained firms.

A critical study by Byoun (2008) provides reasons why and how firms adjust their capital structure. His research suggests that firms change their leverage to the target when they face a financial deficit/surplus. Notably, he indicates that firms adjust the leverage mostly when they are overleveraged with financial surplus or underleveraged with financial deficit. Further, he notes that when firms have financial surplus and associate with over-target leverage, they try to reduce the debt with financial surplus (adjustment speed on an average is 30%). For firms with leverage below target leverage and financial deficit, the debt would be raised to meet firms' financial deficit (adjustment speed on an average is 24%). Korajczyk and Levy (2003) define financially constrained firms as firms that have insufficient cash flows to undertake new investment. Similarly, Byoun (2008) identifies the financial deficit[20] based on cash flows, considering operating cash flows of a firm to cover investment, dividend, and changes in working capital expenses. A recent study by Dang et al. (2012) focuses on the SOA among firms with different degrees of financing imbalances, growth opportunities, and investment. They use the same definition as Byoun (2008) to define financial imbalance. They also find that firms

[20] Financial deficit = (Net investment+ dividends+ net change in working capital) – operating cash flows; if the value is positive it is known as financial deficit; otherwise financial surplus.

with higher financial imbalance have higher SOA (75%) compared to firms with lower financing imbalance SOA (50%). They argue that firms with higher financing imbalance have a faster leverage adjustment due to the high pressure to cover their financial deficit.

Further, Elsas and Florysiak (2011) affirm the findings of Byoun (2008), where they find that firms with high deficit or surpluses adjust their leverage faster than the moderate financing deficits. They examine the SOA differences among the firms by using long-term issuer credit ratings as a measure of default risk because they argue the credit ratings are an important part of debt policy, providing signals for default risk. Interestingly, they found that higher SOA by low-credit rating firms compare to highest credit rating firms. Their finding is consistent with Gilson (1997) as he discovered that financially distressed firms adjust the leverage faster (when restructuring their debt out of court) in order to avoid bankruptcy. Although Elsas and Florysiak (2011) study may capture the credit losses due to downgrade, as credit rating moves up and down frequently, it is not that which short-term risk investors should focus on. We argue that the more relevant risk is the chance of losing money where there is to be a permanent loss. The risk is default risk or bankruptcy risk which is captured through realized default considering the firms that have gone through bankruptcy and liquidation processes.

2.2. Hypotheses development

While researchers have investigated the issue of heterogeneity in the SOA of capital structure, to our knowledge, none has yet specifically examined the issue across default and non-default firms and over various periods. To address these gaps in the literature, this study distinguishes the two types of firms: default versus non-default firms, and two measures of the SOA: cumulative versus marginal, and links those with the issue of heterogeneity in capital structure adjustment.

The definition of default is the inability of the counterparty to meet their obligations because they suffer from large financial deficits which trigger from a few years back to the date of default. Trade-off theory suggests (Myers, 1977) that firms are limiting their debt level by considering the cost of bankruptcy and tax benefits. Therefore, default arises as a result of increasing the cost of debt rather than from the benefits discussed under the trade-off theory.

Researchers in this area confirm that firms do have target leverage; however, they reach the target slowly to adjust their capital structure to the target due to the transaction cost (Fama and French, 2002). Researchers who focus on leverage adjustment of firms with financial issues suggest that they adjust their target leverage faster compared to financially healthy firms (e.g., see Dang et al., 2012; Byoun, 2008). Dang et al. (2012) show that firms with financial imbalances adjust their leverage faster in order to reduce bankruptcy cost and liquidation cost and also to face the pressure of financial deficit. Byoun (2008) explains that firms with financial deficits tend to have higher SOA by increasing debt to reduce financial deficit. Korajczyk and Levy (2003) also argue that financially constrained firms face a high cost of issuing equity, which forces them to adjust leverage faster toward their target leverage. In general, the SOA of the firms ranges from 10 percent (Fama and French, 2002) to 34 percent (Flannery and Rangan, 2006). However, Faulkender et al. (2012) and Dang et al. (2012) argue that studies which impose the same SOA for all the firms in the sample possibly produce misleading results. Recent studies examine this issue by splitting the sample on a different basis; among them, some studies show that firms with financial problems have higher SOA compared to financially healthy firms. For example, Dang et al. (2012) finds that firms with high financial imbalances have an SOA of 75 percent compared to the SOA of 50 percent of the low counterpart. Byoun (2008) finds that when firms' leverage is above the target leverage with financial surplus tend to have, on average a SOA of 30 percent . On the other hand, the firms that are below the target leverage with financial deficit have a SOA of 24 percent. Elsas and Florysiak (2011) find that low credit rating firms show SOA of 51 percent whereas high credit rating firms show SOA of only 29 percent.

In alignment with the literature, we postulate that default firms are associated with higher SOA than non-default firms. When the firms are deviating from the target either they issue debt/equity, pay down their debt, or repurchase shares. Therefore, default firms being a special case of financial issues, we assume that they need to pay down their debt at the expense of the shareholders with a large adjustment either to avoid default/ bankruptcy or to prepare for the liquidation. Hence, we present our first hypothesis:

H1: *Default firms have a higher speed of leverage adjustment than non-default firms.*

Most of the extant literature on the issue of the SOA focuses on examining the contemporaneous effect of leverage deviation on leverage changes (e.g., Dang et al., 2012, Byoun, 2008). Leary and Roberts (2005) argue that the studies focusing on temporary and cross-sectional leverage adjustment could be unable to fully capture firms' financial decisions behaviour. Baker and Wurgler (2002) conclude that capital structure is formed as a result of the cumulative outcome of historical reactions to the market changes. Therefore, we argue that recognizing the SOA over a long time horizon is necessary.

A few studies have addressed the dynamics of capital structure over a longer horizon. Dang et al. (2012) examine the persistence of the determinants of target leverage in the long run. Welch (2004) finds that firms are failing to rebalance their capital structure even over a long time horizon and indicate modest mean reversion of leverage. Kayhan and Titman (2007) examine the effect of the long time horizon on the changes of capital structure decisions through financial deficit, stock return, leverage deficit, and target leverage changes. They find that firms' histories influence the capital structure and their results show that firms have faster SOA towards a new target than the current target.

The literature has documented that transaction cost has a direct impact on leverage changes (e.g., see Fischer et al., 1989; Strebulaev, 2007; Altinkilic and Hansen, 2000). Altinkilic and Hansen (2000) suggest that the transaction cost of equity and debt issues consist of fixed and variable components. Leary and Roberts (2005) further examine the adjustment to target leverage when fixed and variable cost components in the transaction cost are considered. Faulkender et al. (2012) find that firms could adjust their leverage at a lower marginal cost for reasons other than the transaction cost.

Kayhan and Titman (2007) examine the changes of capital structure over a long time horizon to determine the effect of cash flows, stock prices and investment opportunities on the changes of debt ratios over five- and ten-year periods. Flannery and Rangan (2006) offer a controversial finding against that previously expressed

in the literature[21] on the speed of leverage adjustment. They conclude that a firm achieves the target leverage each year by one-third of the target as a fixed proportion of adjustments.

Based on the studies mentioned above, we extend the literature to examine the degree of SOA over various time horizons. However, we argue that market imperfections, such as adjustment costs or other constraints, lead firms to have a lower SOA in the short term but a higher SOA in the long term since firms may reduce the transaction cost of leverage adjustment at a greater extent in the long term. We thus develop the second hypothesis as follows:

H2: *The short (long) time horizons are associated with a low (high) degree of leverage adjustment.*

The initial studies on the issue of the SOA suggest that firms adjust their leverage slowly (Fama and French, 2002) suggesting that firms take a long time to reach their optimal leverage. Studies show that there are various reasons to have different SOA among firms and different economies. However, all the firms tend to actively rebalance their leverage in order to reduce the gap between the current and the target leverage (Leary and Roberts, 2005). Although the literature suggests that the optimal leverage is achieved in the long run, no study has made an attempt to examine the dynamic behaviour of the leverage adjustment during the adjustment period. An adjustment period is a period in which a firm rebalances the capital structure from a beginning year to a final year of adjustment. Leary and Roberts (2005) indicate that firms do not adjust their leverage every period, but when they adjust, they do so within a target range rather than to a specific level. Also, they note that the transaction cost is the main reason for firms to deviate from their target, and they suggest that firms could lower the transaction cost by making frequent adjustments. Thus, we assume, from beginning to end, a number of frequent adjustments could emerge. Notably, Leary and Roberts (2005) also argue that under a fixed cost of the transaction cost, the number of adjustment frequencies increases over time, thus the average fixed cost decreases.

Thus, we argue that firms not only achieve the target leverage in multiple years but also the adjustment speed varies over various periods. Consistent with

[21] For example, Fama and French (2002)

Leary and Roberts (2005), we hypothesize that firms start their adjustment at a slower rate at the beginning of an adjustment period and faster at the ending year of the adjustment. We argue that during an adjustment period, i.e., from the beginning year of an adjustment onwards, the adjustment frequency increases thereby reducing transaction cost. Our hypothesis is further supported by the "anchoring and adjustment" heuristic. The anchoring effect has been documented in studies on behavioural finance, for example, stock return estimates (Kaustia et al., 2008), capital asset pricing model (Siddiqi, 2018), mergers and acquisitions (Baker and Wurgler, 2012), and credit spread (Douglas et al., 2015). Shiller (1999) argues that the behaviour of financial markets is affected by anchoring heuristic. Anchoring and bias adjustment are one of the three decision-making heuristics described by Tversky and Kahneman (1974). The decision-making process is affected by an anchor, and even experienced managers are concerned and cause the adjustment bias towards an anchor. The anchor is a starting value, which is chosen arbitrarily, and the process is continued or the adjustment made until a final estimate is achieved (Fiedler, 1999). Thus, our third hypothesis is:

H3: *The leverage adjustment is completed in multiple periods, and the speed of adjustment is slower/faster at the beginning/ending year of adjustment.*

3. Data and model specification

3.1. Data

American firms encountering bankruptcy and liquidation, as defined by Compustat database over the period from 2000 to 2015, are used to define default firms in our study. Each default firm is coupled with five non-default firms by considering the highest market capitalization in the same industry (defined by the first two digits of SIC) and the default year. Accordingly, 568 default and 2840 non-default firms are included in the sample. We exclude financial (6000-6999) and utilities (4900-4999) firms from the sample as there are different regulations pertaining to these industries. We further exclude firms with missing values and the leverage ratio outside the range of zero and one. All other variables are winsorized at 1 percent and 99 percent level in order to avoid extreme outliers. Our final sample consists of

6,203 and 51,371 firm-year observations for default and non-default subsamples, respectively, over the period from 1975 to 2015. The sample selection is summarized in Table 1. We extracted the financial statement information from the Compustat database and collected the information on stock prices from the Center for Research in Security Prices (CRSP) database. GDP growth rates were obtained from the Federal Reserve Bank. Commercial paper rates and Treasury bill rates were obtained from the Federal Reserve Board's web page.

Table 1: Sample selection

Selection criteria	**Number of firms**
Default firms	
Total number of firms encountering bankruptcy and liquidation events	1753
Non-US firms	(191)
Financial and Utilities firms	(674)
Missing data	(351)
Final default firms	**537**
Total number of firm-year default firm observations	3733
Non-default firms (1:5 non-default firms)	**2685**
Total number of firm-year non-default firm observations	**42036**

Notes: The table describes the procedure followed to obtain the final sample of default firms and the number of non-default firms. Firms encountering bankruptcy or liquidation events, as defined by the Compustat database from 1990 to 2015, are selected as default firms of the US. After filtering 537 firms are qualified as default firms and we select five non-default firms to each default firm by considering highest market capitalization matched with default year and industry of the default firm.

3.2. Model specification

This section describes how the target leverage of the firms is measured and how the measurements of the SOA, i.e., the cumulative SOA and the marginal SOA, are derived over various time horizons. The literature suggests two distinct partial adjustment models for estimating SOA. For our purpose, the standard partial adjustment approach (two-step approach) is more flexible, which allows us to examine the leverage deviation among the default and non-default firms under the

first step. It also enables estimation of the cumulative and marginal SOA over various time horizons based on a determined leverage target obtained from the first step estimation. Following the literature (Hovakimian et al., 2001; Heshmati, 2001), the typical target leverage estimation model can be written as:

$$Lev^*_{it} = \pi X_{it} + u_{it} \quad (1)$$

We estimate Equation (1) by using the panel fixed effect model where we specify the target leverage (Lev^*_{it}) as a function of the exogenous firm-specific and macroeconomic factors represented by X_{it} .[22] Both book and market value of leverage ratios are used in this study (Book leverage = long-term debt plus short-term debt/book value of total assets; Market leverage = long-term debt plus short-term debt/market value of total assets) as separate models. As shown in Equation (1), the target leverage ratio varies across firms and time in our study. Following the literature (Titman and Wessels, 1988; Rajan and Zingalies, 1995; Hovakimian et al., 2001; Fama and Fench, 2002; Flannery and Rangan, 2006, Kayhan and Titman, 2007), we consider most commonly used determinants of the target leverage (see Table A of Appendix for the variable definition). Next, the fitted values from Equation (1) known as the target leverage (Lev^*_{it}) apply to the second step in the following model.

$$Lev_{it} - Lev_{it-1} = \alpha + \beta\,(Lev^*_{it} - Lev_{it-1}) + \varepsilon_{it} \quad (2)$$

The model in Equation (2) regresses the leverage change (i.e., $Lev_{it} - Lev_{it-1}$) on the leverage deviation (i.e., $Lev^*_{it} - Lev_{it-1}$). In the equation, Lev_{it} denotes the year-end leverage for the i^{th} firm, and Lev_{it-1} is the lagged leverage of the i^{th} firm. β in Equation (2) represents the SOA, which measures how fast firms adjust their current leverage towards the target leverage.

In a real world, it is assumed that firms do not fully adjust to their target leverage due to transaction cost (Hovakimian et al., 2001), thereby the value of β is expected to be between zero and one. If $\beta = 1$, it represents firms fully adjust for any deviation from their target leverage. The literature suggests that the SOA (measured by the coefficient on leverage deviation) is inversely related to

[22] Flannery and Rangan (2006) and Hovakimian and Li (2011) apply the panel fixed effect model. Blundell and Bond (1998) introduce the GMM estimator as a solution to the bias estimation due to endogeneity issues. Elsas and Florysiak (2011) use a tobit model highlighting the censored dependent variable in the model. We replicate our baseline results by using System GMM and tobit model to estimate the SOA, and our results are robust to different models.

transaction cost. [23] In particular, if $\beta = 1$, it implies that the transaction cost is zero, and thus $Lev_{it} = Lev^*_{it.}$ This particular case is under the assumption that firms could adjust to the target leverage in the absence of transaction cost. However, the literature indicates that firms adjust their leverage slowly (Fama and French, 2002) and the adjustment process might be non-uniform across time (Leary and Roberts, 2005). Therefore, this study examines the SOA across various time horizons. The procedure is described below.

First, we estimate Equation (2) across various time horizons. For instance, we use Lev_{it-2} to replace Lev_{it-1} and rewrite Equation (2) as follows:

$$Lev_{it} - Lev_{it-2} = \alpha + \beta\,(Lev^*_{it} - Lev_{it-2}) + \varepsilon_{it.} \quad (3)$$

Notably, now the coefficient on the leverage deviation (i.e., β) gives the SOA over two periods. This equation can be used recursively to get the SOA over n periods:

$$Lev_{it} - Lev_{it-3} = \alpha + \beta\,(Lev^*_{it} - Lev_{it-3}) + \varepsilon_{it.} \quad (4)$$

$$Lev_{it} - Lev_{it-4} = \alpha + \beta\,(Lev^*_{it} - Lev_{it-4}) + \varepsilon_{it.}$$

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$$Lev_{it} - Lev_{it-n} = \alpha + \beta\,(Lev^*_{it} - Lev_{it-n}) + \varepsilon_{it.}$$

Notice that these are the cumulative speed of adjustment.

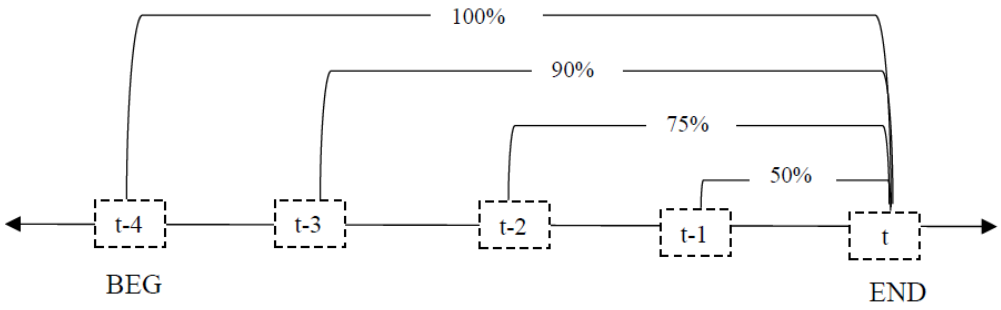
The other measure of SOA is also of interest to us: the marginal speed of adjustment. The marginal SOA is the leverage adjustment that the firm completes in any given period. It is calculated by taking the difference in the cumulative SOA. For instance, the cumulative SOA over one period is 50 percent, over two periods it is 75 percent, over three periods it is 90 percent, and over four periods it researches to 100 percent. These results imply that the firm uses four periods to reach its optimal leverage. In other words, the firm started to adjust its leverage four periods ago. We thus define the period of (t-4) as the beginning period (i.e., BEG) of leverage adjustment. The current period t is defined as the end period (i.e., END) of leverage adjustment. Last, the marginal SOA at a given period would be 10

[23] See for example, Gilson (1997) and De Miguel and Pindado (2001).

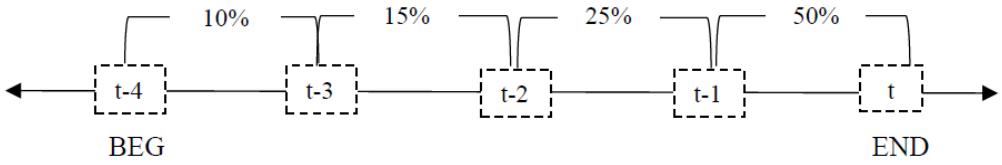
percent (100% - 90%), 15 percent (90% - 75%), 25 percent (75% - 50%), and 50 percent (50% - 0%) from the beginning period to the ending period. Panels A and B of Figure 1 illustrate the cumulative and marginal SOA for the example, respectively.

Figure 1: An illustration of cumulative and marginal SOA

Panel A: Cumulative SOA



Panel B: Marginal SOA



4. Empirical results and the discussion

4.1. Summary statistics

Table 2 reports the mean and median of firm leverage (including book and market value) and the variables used to determine the target leverage. First, the differences between default and non-default are significant at the 1 percent level, except the dummy variable No R&D for the difference in the median. Second, default firms in the study are associated with a lower level of book leverage than non-default firms. In particular, the mean and median of book leverage for default firms are 0.185 and 0.157, respectively. The corresponding values for non-default firms are 0.192 and

0.184. However, the mean of market leverage for default firms is 0.257, higher than the corresponding value for the non-default firm, 0.241. Last, the market value of leverage is higher than the book value of leverage for both default and non-default firms. The reason could be that the market leverage is subject to higher non-controllable factors than the book leverage (e.g., Drobetz and Wanzenried, 2006).

The determinant variables for the target leverage also present a significant difference between default and non-default firms. For instance, the mean and median of profitability ratio for default firms are -0.092 and 0.032, respectively. The corresponding values for non-default firms are 0.130 and 0.127. This result implies that default firms are less profitable than non-default firms. Next, the growth ratio, the mean and median growth ratio for default firms are 1.711 and 0.881, respectively. The corresponding values for non-default firms are 1.640 and 1.105. The result implies that default firms, on average, tend to have a high growth level compared to non-default firms. Drobetz and Wanzenried (2006) suggest that high-growth firms may have low profitability and limited internal funds and depend heavily on external financing, which we observe as characteristics of a default firm. The mean and median values of the depreciation shield for default firms are slightly higher than the non-default firms. In particular, the mean and median depreciation shield of default firms are 0.050 and 0.037, respectively. The corresponding values for non-default firms are 0.043 and 0.039.

The mean and median of the size variable for default firms are 3.627 and 3.627, respectively. The corresponding values for non-default firms are 6.733 and 6.889, respectively. Consistent with the literature, default firms report a lower mean and median value for tangible assets compared to non-default firms. In particular, the mean and median values for default firms are 0.263 and 0.210 whereas non-default firms report 0.324 and 0.290 for mean and median respectively. The result implies that default firms less equipped with collateral against external financing. The variable No R&D is a dummy variable, taking a value of 1 if a firm's research and development expenses are not reported in a particular financial year; and 0 otherwise. It is a proxy for a firm's uniqueness. Accordingly, the mean value for default firms is 0.369 and the corresponding mean value for non-default firms is 0.364, suggesting when the firms are near default/bankruptcy the value of intangible assets diminishes. The mean value of the median industry debt of default firms is

slightly lower than non-default firms. In particular, the mean and median industry debt values for default firms are 0.228 and 0.186, respectively. The corresponding values for non-default firms are 0.247 and 0.198. respectively.[24] Last, Table 3 shows the correlation among the leverage ratios and the determinants of the target leverage. We find there is no multicollinearity among these variables due to low correlations among the variables.

Table 2: Summary statistics

	Mean		Median		Default vs. Non-default	
	Default firms	Non-default firms	Default firms	Non-default firms	Mean Diff.	Median Diff.
Leverage						
Book leverage	0.185	0.192	0.157	0.184	-0.007***	-0.027***
Market leverage	0.257	0.241	0.150	0.158	0.016***	-0.007
Determinants of target leverage						
Profitability	-0.092	0.130	0.032	0.127	-0.221***	-0.096***
Growth	1.711	1.640	0.881	1.105	0.071***	-0.224***
Depreciation shield	0.050	0.043	0.037	0.039	0.006***	-0.002***
Size	3.627	6.733	3.627	6.889	-3.106***	-3.263***
Tangibility	0.263	0.324	0.210	0.290	-0.061***	-0.080***
No R&D	0.369	0.364	0.000	0.000	0.005***	0.000
Industry median debt	0.228	0.247	0.186	0.198	-0.019***	-0.012***
GDP	3.529	3.115	3.555	3.555		
Spread	1.139	1.152	1.114	1.114		

Notes: This table reports the mean and median comparison of the leverage ratios and explanatory variables of target leverage among the default and non-default firms for years 1975-2015. The sample contains an unbalanced panel of 537 default and 2685 non-default firms covering 3733 and 42036 observations respectively. Book leverage is long term debt plus debt in current liabilities to total assets; Market leverage is the ratio of long term debt plus debt in current liabilities to market value of total assets (number of shares outstanding times share price). Profitability is defined as the ratio of earnings before interest and taxes to total assets; growth ratio is the ratio of market to book equity; non-tax shield is the ratio of depreciation expenses to total assets; size is natural logarithm of total assets; tangibility is the ratio of fixed assets to total assets. Uniqueness is defined as a dummy variable, 1 if firm did not report R&D expenses, 0 otherwise, Industry median debt is the median market leverage ratio for each industry defined by the first two digits of SIC number; GDP is the GDP growth rate; and term spread is defined as three-month commercial paper rate over three-month

[24] The minimum GDP and term spread values during this period are 2.776 and 1.048, and the maximums are 7.259 and 3.324, respectively.

treasury bill rate. Kolmogorov-Smirnov and K-sample equality of median test was used to test the distribution equality of mean and median respectively. *** represents the significant level at 1%.

Table 3: Correlation coefficients of determinants of target leverage

	BLEV	MLEV	PROFIT	GROWTH	DEP	SIZE	TANG	NO R&D	IND_MEDIAN	GDP	CP.Spread
Panel A: Default firms											
Profitability	0.000	0.173	1.000								
Growth	-0.082	-0.372	-0.388	1.000							
Depreciation shield	0.130	0.053	-0.394	0.033	1.000						
Size	0.043	0.251	0.376	-0.327	-0.090	1.000					
Tangibility	0.281	0.254	0.029	-0.072	0.350	0.139	1.000				
No R&D	0.149	0.199	0.177	-0.141	-0.021	0.115	0.199	1.000			
Industry median debt	0.015	0.140	0.220	-0.140	-0.155	-0.001	0.056	0.102	1.000		
GDP	0.042	0.031	0.023	-0.028	-0.018	-0.007	0.014	0.015	-0.110	1.000	
Commercial paper spread	-0.026	0.004	-0.071	-0.033	0.027	0.028	-0.015	-0.037	-0.056	-0.225	1.000
Panel A: Non-default firms											
Profitability	-0.202	-0.322	1.000								
Growth	-0.306	-0.506	0.314	1.000							
Depreciation shield	0.047	0.030	-0.092	-0.061	1.000						
Size	0.175	0.106	0.042	-0.086	0.075	1.000					

Tangibility	0.245	0.218	-0.051	-0.198	0.534	0.105	1.000				
No R&D	0.096	0.111	-0.027	-0.123	-0.037	-0.148	0.109	1.000			
Industry median debt	0.000	0.146	0.104	-0.186	-0.088	-0.230	0.088	0.104	1.000		
GDP	-0.008	-0.006	0.026	0.002	0.011	-0.076	0.020	0.014	-0.066	1.000	
Commercial paper spread	0.012	-0.012	0.021	-0.007	-0.026	0.173	-0.065	-0.035	-0.089	-0.263	1.000

Notes: This table reports the correlation coefficient between the leverage ratios and the explanatory variables of target leverage. Book leverage is long term debt plus debt in current liabilities to total assets; Market leverage is the ratio of long term debt plus debt in current liabilities to market value of total assets (number of shares outstanding times share price). Profitability is defined as the ratio of earnings before interest and taxes to total assets; growth ratio is the ratio of market to book equity; non-tax shield is the ratio of depreciation expenses to total assets; size is natural logarithm of total assets; tangibility is the ratio of fixed assets to total assets. Uniqueness is defined as a dummy variable, 1 if firm did not report R&D expenses, 0 otherwise. Industry median debt is the median market leverage ratio for each industry defined by the first two digits of SIC number; GDP is the GDP growth rate; and term spread is defined as three-month commercial paper rate over three-month Treasury bill rate.

4.2. Target leverage

The results of the fixed effect panel method to estimate the target leverage for default and non-default firms are reported in Table 4. Our results on target leverage determinants are similar to those found in the literature. We found that target leverage is negatively related to the firm's profitability and growth. The depreciation shield is negatively related with non-default firms' target leverage whereas default firms report a positive effect on firm leverage and this is consistent with the findings of Bradley et al. (1984) and Titman and Wessels (1983). Bradley et al. (1984) and Ozkan (2001) suggest that firms that invest highly intangible assets have higher depreciation and tax credits, leading to higher leverage. Further, Scott (1977) states that firms can borrow at a lower interest rate due to the more highly secured debt under the "secured debt" hypothesis.

The variables of firm size and tangibility are positively related to a firm's target leverage for both default and non-default firms. The dummy variable (No R&D) is used as a proxy for the firm uniqueness. The result for the variable No R&D is consistent with the default firms. However, non-default firms show an adverse effect from that variable on target leverage. [25]Industry median debt ratio is positively related to leverage for both default and non-default firms. Considering the effect of macroeconomic conditions, GDP is positively related to target leverage. The commercial paper spread shows a positive and significant impact on firm leverage. [26] Notably, all the firm-specific and macroeconomic variables significantly differ from default to non-default firms with market leverage. Except for the industry median debt and GDP, all other variables are also significant with book leverage.

[25] However, Flannery and Rangan (2006) also report a negative association between these two variables under fixed effect panel model. One possible justification for this relation is, in general, non-default firms are operated on a large scale and they possess a good reputation in the market, thus, even though there is no uniqueness of their assets they can attract more shareholders due to their profitability, stability or large operations.

[26] Following Korajczyk and Levy (2003), we defined commercial paper spread as an annualized 3-month commercial paper rate over Treasury bill rate. They find a positive and significant effect with firm target leverage under unconstrained firms' category. The reason for the positive relation is the higher commercial rate over Treasury bill rate would be attractive to the debtholders to invest in issuing firms rather than the government security thereby increasing a firm's leverage.

To sum up, these results confirm the preliminary evidence of the differences in leverage and its determinants between the default and non-default firms shown in Table 2. Some of the results of target leverage shown in Table 4 are consistent with the pecking order theory (e.g., a negative relation with profitability and leverage) and trade-off theory (e.g., a negative relation with depreciation shields).

Table 4: Regression results for target leverage estimation

$$Lev^*_{it} = \pi X_{it} + u_{it}$$

	Default firms		Non-default firms		Default vs. Non-default Coefficient differences	
	Book leverage	Market leverage	Book leverage	Market leverage	Book leverage	Market leverage
Firm specific determinants						
Profitability	-0.055 ***	-0.090***	-0.192 ***	-0.579***	0.137***	0.489***
	(-5.230)	(-5.410)	(-12.910)	(-22.910)		
Growth	-0.003 ***	-0.024***	-0.012 ***	-0.039***	0.009***	0.015***
	(-2.520)	(-12.270)	(-13.600)	(-26.960)		
Depreciation shield	0.286 ***	0.475***	-0.114	-0.404***	0.400***	0.879***
	(3.980)	(4.200)	(-1.550)	(-3.240)		
Size	0.011 ***	0.040***	0.011 ***	0.006***	-0.001**	0.035***
	(3.250)	(7.880)	(11.170)	(3.390)		
Tangibility	0.232 ***	0.268***	0.094 ***	0.137***	0.138***	0.130**
	(10.080)	(7.400)	(7.510)	(6.490)		
No R&D	0.040 ***	0.062***	-0.010**	-0.040***	0.050***	0.101***
	(4.060)	(3.980)	(-2.300)	(-5.310)		
Industry median debt	0.001	0.064**	0.004	0.176***	-0.003	-0.112***
	(0.070)	(2.110)	(0.590)	(14.940)		
Macroeconomic factors						
GDP	0.002	0.001	0.0004	0.0002	0.002	0.001**
	(1.300)	(0.390)	(0.130)	(0.280)		
Commercial paper spread	0.011	0.070**	0.003	0.010	0.008***	0.060***
	(0.500)	(2.030)	(0.630)	(1.100)		
Constant	0.039	-0.070	0.134***	0.274***		
	(1.250)	(-1.450)	(11.880)	(14.300)		
R^2 within	0.083	0.136	0.065	0.162		
R^2 between	0.087	0.175	0.183	0.372		
R^2 overall	0.084	0.183	0.151	0.295		
Wald test (F-Test)	32.12***	55.56***	89.31***	249.92***		
Hausmann test	27.26***	354.93***	57.18***	163.70***		

Notes: This table reports the results from the fixed effects panel regression of the leverage ratios on firm specific and macroeconomic determinants. The sample contains an unbalanced panel of 537 default and 2695 non-default firms covering 3733 and 42036 observations, respectively. Book leverage is long term debt plus debt in current liabilities to total assets; Market leverage is the ratio of long term debt plus debt in current liabilities to market value of total assets (number of shares outstanding times share price). Profitability is defined as the ratio of earnings before interest and

taxes to total assets; growth ratio is the ratio of market to book equity; non-tax shield is the ratio of depreciation expenses to total assets; size is natural logarithm of total assets; tangibility is the ratio of fixed assets to total assets. Uniqueness is defined as a dummy variable, 1 if firm did not report R&D expenses, 0 otherwise; Industry median debt is the median market leverage ratio for each industry defined by first two digits of the SIC number; GDP is the GDP growth rate; and term spread is defined as three-month commercial paper rate over three-month treasury bill rate. The last two columns show the results of the coefficient differences of each variable among default and non-default firms with significant levels. These significant levels were obtained by using interaction terms with a default dummy where 1=if the firm is in default; 0 otherwise. The coefficient results are not included for brevity. The significant level of 1% and 5% are represented by * and ** respectively.

4.3 Speed of adjustment: Default versus non-default firms

After estimating the optimal leverage using Equation (1), we estimate the SOA using Equation (2), and the results are presented in Table 5. To test our first hypothesis (1) regarding the heterogeneity in capital structure adjustment between default versus non-default firms, we run Equation (2) for the default and non-default firms samples individually and make a comparative analysis between them. Last, we consider two measurements of firm leverage: book and market value. The results of book and market leverage are presented in Panels A and B of Table 5, respectively.

Restated, the SOA is derived by regressing the change in leverage, Lev_{it} - Lev_{it-1}, on the leverage deviation, Lev^{*}_{it} - Lev_{it-1} (see Equation (2)). Panel A of Table 5 provides the results by using book leverage. First, the estimated coefficients on the leverage deviation for default firms and non-default firms are 0.567 and 0.392, respectively. This result implies that the SOA of default and non-default firms is 56.7 percent and 39.2 percent, respectively. The SOA of default firms is faster than non-default firms by 17.5 percent (17.5% = 56.7% - 39.2%).[27] In other words, assuming a constant SOA over time, a default firm, on average, takes 1.76 (100/56.7) years to adjust its leverage to the target leverage whereas a non-default firm takes 2.55 (100/39.2) years to change its capital structure to the optimal level. These

[27] We always used dummy variable to test the difference in SOA between default and non-default firms (not tabulated). The results show the difference is significant at a 1% level. We also used a set of control variables in the regression. The inclusion of the control variables did not changes our conclusion.

results indicate that default firms are associated with a higher speed of adjustment to target leverage than non-default firms. Panel B of Table 5 presents the results of market leverage, an alternative measure of leverage. The estimated coefficients on the leverage deviation ($Lev^{*}_{it} - Lev_{it-1}$) for default firms and non-default firms are 0.630 and 0.510, respectively. The result indicates the SOA of default firms is faster than non-default firms by 12 percent (0.12 = 0.63 – 0.510). This result supports that our H1 holds for both market and book leverage.

Table 5: Speed of adjustment towards target leverage: Default vs. Non-default firms

$$Lev_{it} - Lev_{it-1} = \alpha + \beta\,(Lev^{*}_{it} - Lev_{it-1}) + \varepsilon_{it}$$

where $\beta = SOA$

	Default firms	Non-default firms
Panel A: Book leverage		
Constant	-0.001(-0.54)	-0.002***(-3.38)
$Lev^{*}_{it} - Lev_{it-1}$	0.567***(32.04)	0.392***(54.38)
Fixed effect	Yes	Yes
R^2	0.145	0.116
Panel B: Market leverage		
Constant	-0.002 (-0.69)	-0.009***(-7.61)
$Lev^{*}_{it} - Lev_{it-1}$	0.630***(33.85)	0.510***(67.82)
Fixed effect	Yes	Yes
R^2	0.170	0.192

Notes: This table reports the results of estimating Equation (2) for default and non-default firms controlling for firm fixed effects and with robust standard errors. Panels A and B present the results for book and market leverage, respectively. The value in the parenthesis is the standard error of the estimate. The *** denotes significance at 1% level.

4.4. Speed of adjustment over various time horizons: Cumulative SOA

Table 6 provides the estimated SOA over different time horizons. The time horizons from one to seven years are considered in this study. Panels A and B present the results of book and market leverage, respectively. Figure 2 further graphs the results.

Notice that the SOA over multiple periods shown in Figure 2 and Table 6 is cumulative SOA. Apparently, the cumulative SOA is continuing to increase as time passes and has a ceiling value of 100 percent.

First, the upward-sloping pattern of the SOA shown in Figure 2 supports our H2 that the short (long) time horizons are associated with a low (high) degree of leverage adjustment. We define the time of completion as when the degree of cumulative SOA reaches 100 percent for the first time. As shown in Panel A of Table 6, the estimate of SOA for default and non-default firms researches 100 percent in four and six years, respectively. In other words, default firms use a shorter period to complete their leverage adjustment than non-default firms. This finding further supports our H1 that default firms have a higher speed of leverage adjustment than the non-default firms. Last, Panel B of Table 6 and Figure 2 presents the results of market leverage. Comparing Panels, A and B indicates that our conclusion is robust with the two measures of leverage.

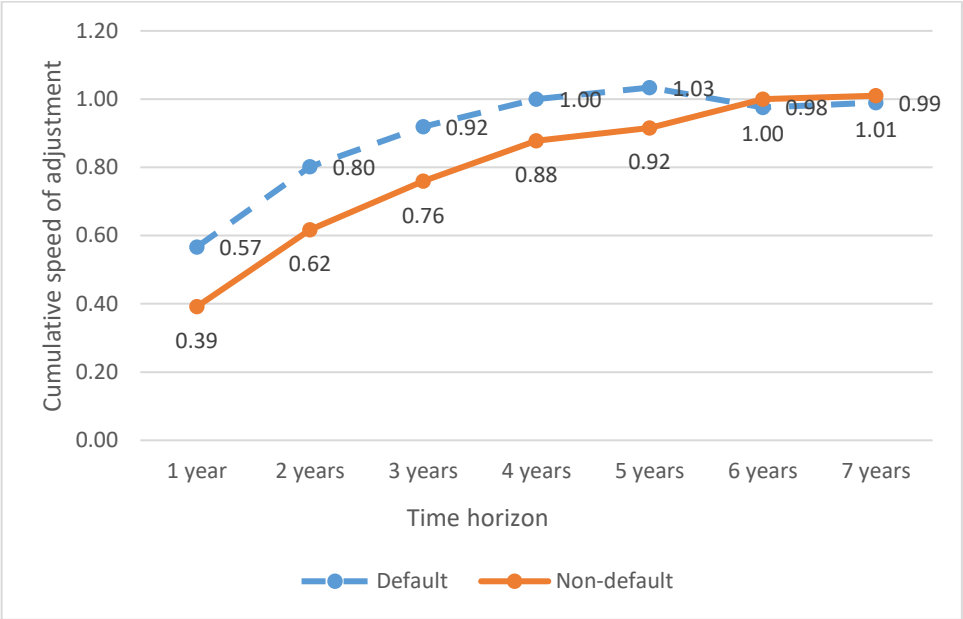
Table 6: Speed of adjustment over various time horizons: Cumulative SOA

Time	Default firms			Non-default firms		
horizons	SOA	t-stat.	R^2	SOA	t-stat.	R^2
Panel A: Book leverage (in years)						
One	0.57	32.04	0.145	0.39	54.38	0.116
Two	0.80	39.43	0.239	0.62	70.06	0.177
Three	0.92	40.11	0.275	0.76	78.77	0.221
Four	1.00#	41.77	0.329	0.88	82.84	0.242
Five	1.03	40.40	0.349	0.92	85.99	0.264
Six	0.97	37.36	0.363	1.00#	90.50	0.289
Seven	0.99	36.04	0.398	1.01	89.63	0.307
Panel B: Market leverage (in years)						
One	0.63	33.85	0.170	0.51	67.82	0.192
Two	0.82	38.83	0.257	0.72	86.15	0.278
Three	0.94	40.25	0.296	0.85	96.74	0.331
Four	1.00#	43.49	0.348	0.93	103.64	0.373
Five	1.08	38.84	0.345	0.97	106.15	0.396
Six	1.05	35.49	0.344	1.00#	108.36	0.424
Seven	1.03	32.00	0.344	1.02	107.15	0.448

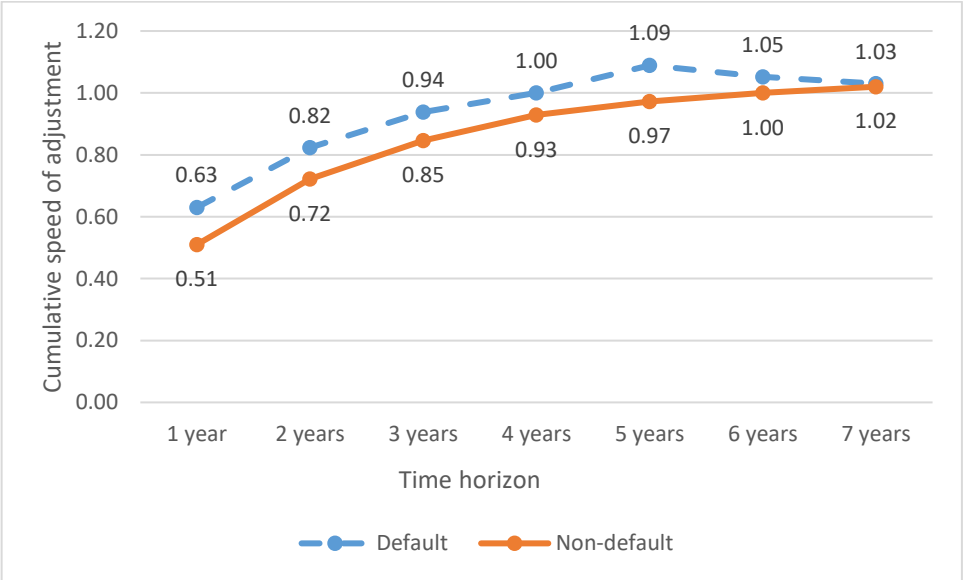
Notes: This table presents the estimate of the SOA over various time horizons, from one to seven years. The # denotes the SOA researching 100% (i.e., the value of one) for the first time.

Figure 2: Cumulative speed of adjustment over various time horizons

Panel A: Book leverage



Panel B: Market leverage



4.5. Speed of adjustment for a given period: Marginal SOA

The other measure of SOA of interest is the marginal SOA. As illustrated in Figure 1, the marginal SOA is calculated by taking the difference in the cumulative SOA and it represents the degree of leverage adjustment in a given period. Table 7 shows the results of marginal SOA for default and non-default firms. The results are also graphed in Figure 3. The results of book and market leverages are listed in Panels A and B, respectively. The upward-sloping pattern of the marginal SOA shown in Figure 3 supports our H3 that the speed of leverage adjustment is slower/faster at the beginning/ending year of adjustment.

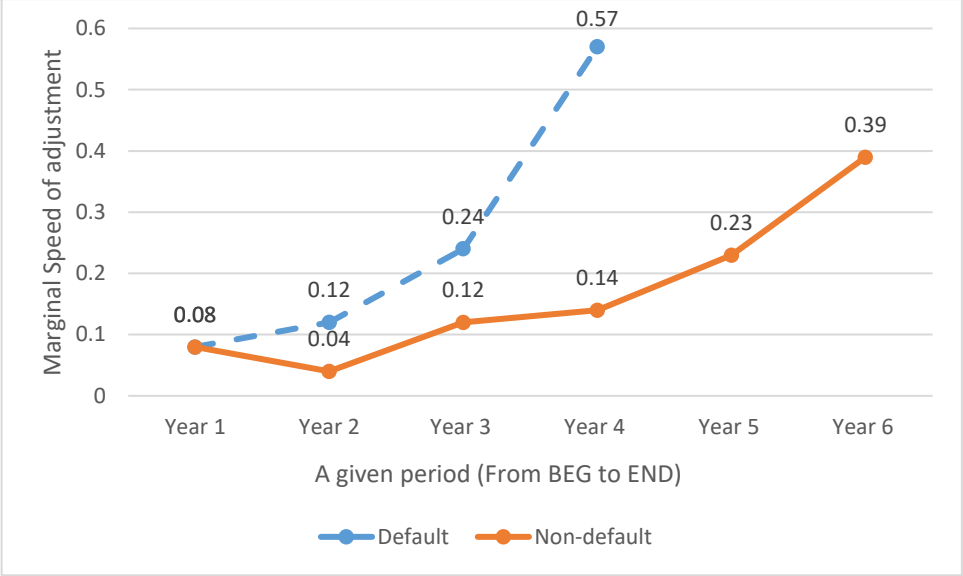
Table 7: Speed of adjustment for a given period: Marginal SOA

Given period (BEG to END)	Default firms	Non-default firms
Panel A: Book leverage		
Year 1	0.08	0.08
Year 2	0.12	0.04
Year 3	0.24	0.12
Year 4	0.57	0.14
Year 5	NA	0.23
Year 6	NA	0.39
Year 7	NA	NA
Panel B: Market leverage		
Year 1	0.06	0.03
Year 2	0.12	0.04
Year 3	0.19	0.08
Year 4	0.63	0.12
Year 5	NA	0.21
Year 6	NA	0.51
Year 7	NA	NA

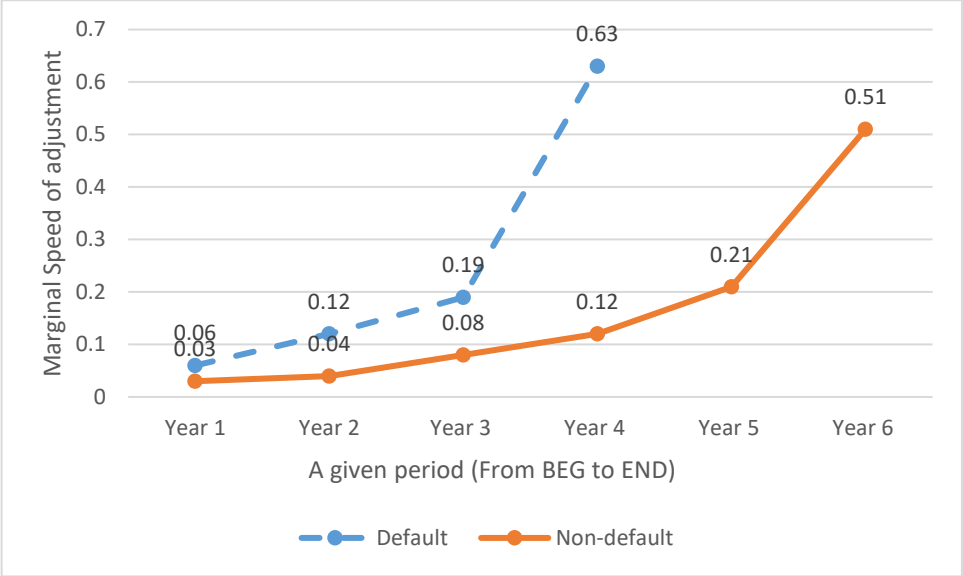
Notes: This table presents the speed of adjustment for a given period, i.e., marginal SOA. The marginal SOA is calculated by taking the difference in the cumulative SOA and it represents the degree of leverage adjustment in a given period. Figure 1 illustrates an example. We define the time of completion when the degree of cumulative SOA reaches 100% for the first time under the cumulative SOA. The marginal SOA is therefore not available after completion and is denoted as NA.

Figure 3: Marginal speed of adjustment for a given period

Panel A: Book leverage



Panel B: Market leverage



4.6. Discussion and implications

This section presents the discussion and the implications relating to our findings. First, the results reveal that default firms are associated with a higher speed of adjustment than the non-default firms. These results support our first hypothesis (H1) and are consistent with the literature (Dang et al., 2011; Dang et al., 2012; Elsas and Floyrsiak, 2011). They find that firms with high financial imbalances exhibit a higher speed of adjustment. They argue that highly leveraged firms have a higher risk of bankruptcy and higher liquidation cost; therefore, they adjust their target capital structure faster. Elsas and Floyrsiak (2011) find that low credit rated firms have higher SOA compared to firms with high/moderate credit rating. They argue that the firms with low credit rating (i.e., close to default) would attempt to get rid of defaults and thus offset their debt faster than the non-default firms. As a result, low/high credit rating firms are associated with a higher/lower SOA. Dang et al. (2012) suggest that firms with low financial imbalances are under relatively lower pressure to adjust their target leverage due to low transaction cost of retiring debt or repurchasing equity when they adjust their leverage to the target.

Thus, based on the literature we suggest that firms that are close to default events should exhibit a higher speed of adjustment in order to avert bankruptcy and liquidation cost. This finding provides implications for credit risk managers of banks. Banks analyse the current leverage of borrowers when making their credit decisions. We suggest that banks should consider the changes in capital structure, more precisely considering the speed of change of the borrower's leverage ratio. Further, if a firm is having an unusual change in leverage ratio that might signal the risk of default. Thus, credit risk managers should take this into their rating system's consideration in order to reduce potential credit losses.

Next, we find that firms have low adjustment degrees in a short time horizon compared to high adjustment degrees in the long time horizon. We provide the reasons on the basis of explicit transaction cost and other constraints for leverage adjustments. Consistent with the literature, we suggest that transaction cost has an impact on rebalancing firms' leverage in the short and long runs. Following Gilson (1997), we define transaction cost first. Transaction cost equals the inverse of SOA (i.e., Transaction cost=1-SOA), and De Miguel and Pindado (2001) carry the same

definition to support their findings. [28] Accordingly, we find higher transaction cost in the short run for default (0.43= 1.00-0.57) and non-default (0.61=1.00-0.39) and lower transaction cost in the long run; for example the three years' implied transaction cost is 0.08 (1-0.92) for default and 0.24 (1-0.76) for non-default firms, suggesting the long run firms experience lower transaction cost. The results imply that the firms have the advantage of reducing transaction cost in the long run might be due to the different components of transaction cost as suggested by Altinkilic and Hansen, (2000); Leary and Roberts (2005); and due to other constraints (e.g. Faulkender et al., 2012). This result provides policy implications for firms in general; showing that ignoring the heterogeneity of SOA in short and long time horizon could underestimate the effect of transaction cost on leverage adjustment.

Finally, we find a typical firm takes multiple years to adjust their capital structure and this is consistent with Flannery and Rangan (2006). They suggest that a firm adjusts their leverage each year, that is, firms achieve one-third of their target every period. Our result is partially consistent with Flannery and Rangan (2006); additionally, we suggest that firms adjust at a slower adjustment speed at the beginning year of an adjustment period and increase the adjustment when they are close to the end year of the adjustment horizon. Flannery and Rangan (2006) find that firms chose a fixed proportion of SOA each period within few years: in contrast, we show that firms adjust their leverage every period but with different degrees of adjustment. Our results are consistent with Leary and Roberts (2005) since they suggest that over time when the adjustment frequency increases the transaction cost decreases. Thus, the higher adjustment speed at the ending year of adjustment suggests that during an adjustment period firms increase the number of adjustments compared to the beginning year.

Additionally, we suggest that the low (high) adjustment speed of leverage at the beginning (ending) of an adjustment period is consistent with the decision-making behaviour described under anchoring and adjustment bias. Literature has already documented the effect of anchoring and adjustment bias on the other areas in finance; for example, credit spread (Douglas et al., 2015); capital asset pricing

[28] They compare the SOA differences among Spain and the USA and suggest that the main reason for the difference is the transaction cost due to different institutional characteristics.

model (Siddiqi, 2018). Studies using anchoring and adjustment bias emphasize that in an adjustment process, the initial adjustment starts arbitrarily, and then adjustments are frequently updated until the final adjustment is reached.[29] The variations of the adjustment across time periods reemphasize the extant literature of capital structure adjustment on the influence of the transaction cost and other market constraints for adjustment towards the target.

4.7. Speed of adjustment: One-step approach

In the previous discussion, we use a two-step approach to estimate the SOA. In brief, we use Equation (1) to obtain the optimal leverage, then run Equation (2) to estimate the SOA. We may merge Equations (1) and (2) to obtain a reduced-form partial adjustment leverage model:

$$Lev_{it} = \alpha + \beta(\pi X_{it-1}) + (1-\beta)\, Lev_{it-1} + \upsilon_{it.} \quad (6)$$

We may generalize Equation (6) as:

$$Lev_{it} = \alpha + \gamma X_{it-1} + \theta\, Lev_{it-1} + \upsilon_{it.} \quad (7)$$

Where $\theta = 1 - \beta$, or β (i.e., SOA) $= 1 - \theta$.

The results of SOA over various time horizons via the one-step approach are presented in Table 8. Comparing this with Table 6 and Figure 2, the upward-sloping pattern of the cumulative SOA is pronounced. That is, the cumulative SOA increases as time passes. The ceiling value of 100 percent for the cumulative SOA repeats. Lastly, Table 9 presents the marginal SOA for a given period via the one-step approach. Comparing Table 9 with Table 7 and Figure 3, the upward-sloping pattern of marginal SOA is robust with the alternative estimation method. Notably, we also replicate our results by using different statistical models to test the robustness of our results under different models. To run these tests, we employ Tobit (Elsas and Florysiak, 2011) and the system GMM model suggested by Arellano and Bond (1991) for dynamic panel data. The results (not tabulated) support our hypotheses.[30] We use these two methods only to find the contemporary

[29] In a study based on real estate auctions and anchoring effect suggests that people start the adjustment at a low rate and ends at a high rate (Ku et al., 2006) opposing the view of start high and end high effect in anchors in the process of individual judgements.

[30] Tobit model is appropriate if the dependent variable is censored. Elsas and Florysiak (2011) use Tobit model as they argue that the leverage ratio is censored between 0 and 1. Under the one-step approach, the lag dependent variable creates the issue of endogeneity, and Arellano and Bond (1991) suggest the Generalized Method of Movements (GMM) provides the consistent estimator. We used

SOA due to the assumption that we made on constant target leverage by using one-step approach.

Table 8: Cumulative speed of adjustment: One-step approach

Time horizons	Default firms	Non-default firms
Panel A: Book leverage (in years)		
One	0.55	0.34
Two	0.80	0.60
Three	0.92	0.75
Four	1.01#	0.84
Five	1.04	0.91
Six	1.02	1.00#
Seven	0.99	1.01
Panel B: Market leverage (in years)		
One	0.60	0.40
Two	0.81	0.70
Three	0.93	0.83
Four	1.08#	0.93
Five	1.09	0.97
Six	1.05	1.01#
Seven	1.04	1.02

Notes: This table presents the cumulative SOA estimate over various time horizons via a one-step approach. The equation for estimation is presented in Section 4.7. The # denotes the SOA researching 100% (i.e., the value of one) for the first time.

Table 9: Marginal speed of adjustment: One step approach

Given period (BEG to END)	Default firms	Non-default firms
Panel A: Book leverage		
Year 1	0.09	0.09
Year 2	0.12	0.07
Year 3	0.35	0.09
Year 4	0.55	0.15
Year 5	NA	0.26
Year 6	NA	0.34
Year 7	NA	NA
Panel B: Market leverage		
Year 1	0.15	0.03
Year 2	0.12	0.04
Year 3	0.21	0.10
Year 4	0.60	0.13
Year 5	NA	0.30
Year 6	NA	0.40
Year 7	NA	NA

leverage lagged by two periods as the instrumental variables suggested by Anderson-Hsiao as a solution to the endogeneity problem.

Notes: This table presents the speed of adjustment for a given period, i.e., marginal SOA. The marginal SOA is calculated by taking the difference in the cumulative SOA and it represents the degree of leverage adjustment in a given period. Figure 1 (panel B) illustrates an example. We define the time of completion when the degree of cumulative SOA reaches 100% for the first time under the cumulative SOA. The marginal SOA is therefore not available after completion and is denoted as NA.

5. Summary and conclusions

Using 45,769 firm-year observations in the United States from 1975 to 2015, we re-examine the issue of heterogeneity in capital structure adjustment by addressing the comparison between the two types of firms (default versus non-default firms) and the two measures of speed of adjustment (cumulative versus marginal). Our empirical findings are consistent with the following notions. First, we find default firms are associated with a higher speed of adjustment than non-default firms. Second, a short (long) time horizon is associated with a low (high) degree of leverage adjustment. Third, firms take multiple periods to complete the adjustment on leverage, and the speed of adjustment is slower (faster) at the beginning (ending) period of adjustment. Overall, the empirical results support our hypothesis that the speed of adjustment is non-uniform across firms and over time.

This study makes several contributions to the literature. Unlike most of the previous studies, we estimate the SOA over a long time horizon focusing on important characteristics of firms' leverage adjustment behaviour. In contrast to the fixed proportion of adjustment speed suggested by Flannery and Rangan (2006), we find that firms have different degrees of adjustments over a long time horizon and throughout an adjustment period due to market imperfection or other constraints. Thus, our results stress that transaction cost and other constraints have a strong influence on leverage adjustment being varied across time periods. Also, we contribute by extending the literature on dynamic capital structure to focus on the firms' leverage adjustment with different time intervals. However, since our study is primarily designed to test the heterogeneity of SOA over the long-time horizon under the assumption of constant target, the results should be interpreted with these limitations in mind.

In sum, we argue that financial institutions should consider the leverage dynamics of firms more precisely due to the heterogeneity of their leverage adjustments. Further, ignoring the leverage adjustment across firms and time is

likely to have led to misleading the conclusions of dynamic capital structure literature.

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Appendix

Table A: Determinants of target leverage

Variable	Measurement	Expected sign
Leverage variables		
Book leverage	Book value of debt divided by total assets	
Market leverage	Book value of debt divided by market value of total assets	
Target leverage determinants		
Size	Natural logarithm of Total assets	+
Tangibility	Fixed assets divided by total assets	+
Growth opportunity	Market value of total assets divided by book value of total assets	-/+
Profitability	Earnings before interest and taxes divided by total assets	-/+
Depreciation Shields	Depreciation expenses divided by total assets	+/-
R&D_Dummy	Dummy variable equal 1 if R&D expenses are missing, 0 otherwise 1 if R&D expenses missing	+
Industry median debt	Median market industry debt ratio using first two digits of SIC	+
GDP	Annual GDP growth rate	-
Commercial paper spread	Annualized 3-month commercial paper rate over 3-month Treasury bill rate	+

Notes: This table presents the leverage ratios, determinants of target leverage. Below we show the codes used in Compustat database for financial information. Book leverage: [(Long term debt (DLTT) + Debt in current liabilities (DLC)/ Total assets (AT)]; Market leverage: [Long term debt (DLTT) + Debt in current liabilities (DLC)/ Price fiscal year close (PRCC)* Common shares outstanding (CSHO)]; Size: [Natural logarithm of total assets (ln (AT))]; Tangibility: [Property, plant and equipment (PPENT)/ Total assets (AT)]; Growth opportunity: [Price fiscal year close (PRCC)* Common shares outstanding (CSHO)/ Total assets (AT)]; Profitability: [Earnings before interest and tax (EBIT) / Total assets (TA)]; Depreciation shield:[Depreciation expenses (DP) /Total assets (AT)]; R&D_Dummy: equals 1 for missing Research and Development expenses (XRD).

Do leverage dynamics strengthen bankruptcy prediction? A comprehensive test

Declaration about the role and the contributions of authors

I (Ruwani Fernando) confirm that I am the principal author of the following paper. As the principal author, I developed the conceptual framework, collected the data, conducted the data analysis, interpreted the results, and wrote the research paper. Leon Li provided conceptual advice, commented on and edited all versions of the paper. Greg Hou also commented on and edited all the versions of the paper.

Please see the Co-authorship form attached in Appendix 5.

This paper has been submitted and is under review by *Applied Economic Letters*.

- Fernando, J.M.R., Li. L., & Hou. G. (2019). Do leverage dynamics strengthen bankruptcy prediction? A comprehensive test.

Do leverage dynamics strengthen bankruptcy prediction? A comprehensive test*

Abstract

This paper comprehensively examines the effect of leverage deviation on measuring firms' default risk. A logistic model is employed to estimate the explanatory power of leverage deviation together with information on accounting, market and corporate governance for default prediction over several horizons. Our in-sample and out-of-sample tests suggest that taking into account leverage deviation enhances the capacity of measuring corporate borrowers' default risk. Additionally, such benefit is persistent over various time horizons.

JEL classification: G32; G33
Keywords: Leverage deviation, default risk, capital structure, z-score
Data Availability: Data analyzed in the study are collected from public sources

* Please note, this paper presents an additional test conducted additionally to those reported in chapter four. However, due to the data unavailability of corporate governance variables to the main sample reported in chapter four of the thesis, this further study is conducted by using a different data set. Thus, this further work has been submitted to Applied Economic Letters and the paper is structured as per the journal's requirements.

1. Introduction

Traditional capital structure theories state that firms have target leverage and the decision on the target debt depends on a trade-off between the tax benefit of borrowing debt and the cost of financial distress and bankruptcy. New dynamic capital structure models show that firms dynamically rebalance their leverage towards the target leverage with varying speeds of adjustment (e.g., Flannery and Rangan, 2006). Thus, the leverage deviation (i.e., the difference between target leverage and actual leverage) provides useful information for financial institutions to recognize whether firms are over- or under-leveraged when they are assessed against the credit risk.

A few studies show the importance of incorporating capital structure dynamics into credit risk modelling theories (see, for example, Collin-Dufresne and Goldstein, 2001; Dangl and Zechner, 2004; Hui et al., 2007; Lo et al., 2008; Löffler and Maurer, 2011). Although these studies have investigated the issue of leverage dynamics and default prediction, to our best knowledge, none has explicitly examined the default prediction considering comprehensive predictor information together with leverage dynamics.[31] To address the gap in the literature, we incorporate leverage dynamics with accounting, market and corporate governance information into default prediction. We also conduct both in-sample and out-of-sample tests and examine the persistence of the leverage dynamics as a predictor variable over various time horizons.

We employ a two-step approach for the study. The target leverage is forecast in the first step. In the second step, the leverage deviation is calculated based on the forecast target leverage in the first step. It is then used as a new variable for the regression analysis. Further evidence is shown on the role of leverage deviation for default prediction. It is found that defaults firms tend to have a higher leverage deviation, i.e., they are highly over-leveraged. Leverage deviation carries extra firm-specific risk information that is not subsumed by other information, thus

[31] González-Aguado and Moral-Benito (2013) examine the issues of using single regression-based model selection.

enhancing the power of prediction. Additionally, prediction performances of leverage deviation are consistent over various time horizons.

2. Methodology

2.1. Target leverage estimation

We follow the standard partial adjustment approach to measure the target leverage. The typical target leverage estimation model can be written as:

$$Lev^*_{it} = \pi X_{it} + u_{it} \quad (1)$$

Where we specify target leverage, Lev^*_{it}, as a function of firm-specific and macroeconomic factors represented by X_{it}. Book leverage is used to measure target leverage.[32] The model allows the target leverage ratio to vary across firms and over time. The leverage deviation is obtained as follows:

$$LDev_{it-1} = Lev^*_{it} - Lev_{it-1.} \quad (2)$$

Leverage deviation ($LDev_{it-1}$) is the difference between the target leverage and lagged actual leverage of the i^{th} firm for the t^{th} period. To measure the leverage deviation over various time horizons, we change the lag number order of the lagged actual leverage in Eq. (4.2) (e.g., $Lev_{it-2,}$ Lev_{it-3} …). Notably, we lock the target leverage of firm *i* at time *t*. accordingly, leverage deviation conveys the information on how far a firm is deviating from its optimal leverage.

2.2. Default prediction

We employ a conventional logistic regression model to predict default probability.[33] The model is presented as follows:

$$y^*_{it+1} = cont. + \beta_1 Z\text{-}score_{it} + \beta_2 DD_{it} + \beta_3 CGS_{it} + \beta_4 LDev_{it} + \varepsilon_{it+1.} \quad (8)$$

y^*_{it+1} is an unobservable latent variable. What we observe is a dummy variable y_{it+1},

[32] We also estimate all the models by using market leverage, and the estimation results are similar. The results are available upon the request.

[33] We also perform the probit regression and the results are similar to the logit model. The results are available upon request.

defined as $y_{it+1} = 1$ if $y_{it+1}^* > 0$ (i.e., company *i* defaults at time *t+1*) and $y_{it+1} = 0$ if otherwise (i.e., company *i* does not default at time *t+1*). *Z-score* is obtained by the original Altman (1968)'s *Z*-score model. DD_{it} denotes distance to default;[34] CGS_{it} denotes corporate governance score;[35] and $LDev_{it}$ denotes leverage deviation for measuring default risk. ε_{it+1} denotes the error term. We also estimate Eq. (4.8) by regressing the dependent variable at time *t+k,* aligning with *k* time horizons, against explanatory variables at time *t*, where *k*=1, 2,..5. Based on Eq. (4.8), we develop two empirical models, Model 1 and Model 2. Model 1 includes $Z\text{-}score_{it}$, DD_{it}, and CGS_{it} as explanatory variables only. Henceforth, Model 1 restricts β_4 in Eq. (4.8) to be 0. Model 2 remains the same as Eq. (4.8) which integrates all four types of information. Note that we estimate Model 1 for comparison purposes (see Table A of Appendix for the variable definitions).

2.3. Data

Firms which were encountering bankruptcy or liquidation events, as defined by the Compustat database over the period 2000–2015, are selected as default firms in this study. For each default firm, we select a firm of similar size (defined by the value of total assets) in the same industry. The default and non-default firms are chosen by referring to the first two digits of the SIC-code for the sampling process. We exclude financial (SIC code: 6000-6999) and utilities (SIC code: 4900-4999) firms and firms with the leverage levels outside the range between 0 and 1. All the other financial variables are winsorized at the 1 percent and 99 percent levels. The variables for *Z-score*, *DD*, and the determinant variables for target leverage are collected from the Compustat/CRSP database as panel data over five years on a quarterly basis.[36] Corporate governance variables are collected through company proxy statements. Depending on the data availability, 73 default firms are taken for

[34] Merton (1974) introduces the distance to default. *DD* is calculated by using average market price of equity divided by the volatility of equity using daily data on quarterly basis.

[35] *CGS* is developed by following the S&P's governance framework (2002), which covers ownership concentration, shareholder rights, financial transparency and board effectiveness.

[36] See Flannery and Rangan (2006) for the definitions of the target leverage variables.

the sample. Then, by matching the sample, 73 companies are selected as non-default ones. Accordingly, we collect 3280 firm-quarter observations for the sample.

3. Empirical results

Table 1 presents the leverage deviation comparison among default versus non-default firms. Accordingly, default firms tend to be over-leveraged given a negative mean of leverage deviation (-0.037). The difference in mean leverage deviation is significant between default and non-default firms.

Table 1: Leverage deviation comparison

	Default	Non-default	Difference (Default – Non-Default)
Leverage deviation	-0.037	0.003	-3.036***

Notes: This table presents the comparison of mean leverage deviation between default and non-default firms by using Eq. (2). The *** represents significance at the 1% level.

Table 2 shows the estimation results of Model 1 and Model 2, based upon Eq. (4.8) for a one-year prediction horizon. We find that all three variables in Model 1 have significantly negative effects on default probability. The results suggest that default firms are characterized by low *Z-score*, distance to default and corporate governance score. The results of Model 2 show that leverage deviation has a significantly positive effect on default probability. It is suggested that leverage deviation increases default risk. The R^2 of Model 1 is 28.25 percent whereas that of Model 2 is 30.34 percent. A lower Akaike Information Criterion (AIC) value of Model 2 is found. T values present in parentheses. The results suggest that taking into account leverage deviation enhances the power of default prediction.

Table 2: Regression results for default prediction

	Model 1	Model 2
Constant	2.419 (11.36)***	2.867 (12.16)***
Z-score	-0.539 (-20.74)***	-0.669 (-20.90)***
DD	-0.030 (-7.54)***	-0.027 (-6.86)***
CGS	-0.236 (-6.84)***	-0.262 (-7.09)***
LDev		2.155 (8.35)***
Pseudo R^2	0.2825	0.3034
AIC	2841.64	2501.41

Notes: This table presents the estimation results of Eq. (3). The model is estimated based on the logit regression. The explanatory variables are *Z-score, DD* (Distance to default), *CGS* (Corporate governance score) and *LDev* (leverage deviation). Figures in parenthesis are *t-values*. Pseudo R^2 denotes the explanatory power of the models. AIC denotes Akaike Information Criterion. *** denotes significance at the 1% level.

Table 3 reports the models' (Model 1 and 2) accuracy measured by using the area under the Receiver Operating Characteristics (ROC) curve (AUC) for multiple prediction horizons ranging from one to five years. AUC measures the correct classification rate of default and non-default firms. Accordingly, Panel A presents the accuracy ratios for the in-sample test: Panel B reports the results for the out-of-sample test. For 1-year prediction for default, Model 2 of Panel A has 84.85 percent accuracy, compared to lower accuracy of 83.88 percent for Model 1. The prediction performances for longer prediction horizons show a rapid decline, which is consistent with the literature (e.g., Campbell et al., 2008). The prediction performances for the five-year horizon are 75.99 percent and 76.68 percent for Models 1 and 2, respectively. For any horizon, the accuracy of Model 2 outperforms that of Model 1. The result is consistent with Löffler and Maurer (2011) who find leverage deviation has an incremental contribution to prediction of performance. The predictive power of leverage deviation, together with three other predictor information types, is persistent in the long run (not tabulated).

Table 3: Accuracy ratio comparison

Prediction horizon	1-Year	2-Year	3-Year	4-Year	5-Year
Panel A: In-sample test					
Model 1	83.88%	81.37%	79.07%	77.09%	75.79%
Model 2	84.85%	82.77%	80.43%	77.36%	76.68%
Panel B: Out-of-sample test					
Model 1	82.59%	76.86%	73.62%	73.62%	72.84%
Model 2	83.00%	78.31%	75.53%	74.81%	75.19%

Notes: This table summarizes the prediction accuracy measured by the area under the Receiver Operating Characteristics (ROC) curve over a five-year prediction horizon for in-sample (Panel A) and out-of-sample analyses (Panel B).

To examine the out-of-sample prediction, we randomly withhold 20 percent of the sample. The data is used for forecasting defaults. The residual sample is used to estimate Models 1 and 2. We then use model estimates to predict the default events for multiple horizons. The results of the out-of-sample accuracy ratios in Panel B are similar to in-sample results in Panel A. Therefore, the advantage of incorporating leverage deviation for default prediction is further confirmed.

4. Concluding remarks

New capital structure models suggest that firms dynamically rebalance their leverage towards the target leverage. Before firms achieve their target leverage, they are either recognized as under-leveraged or over-leveraged. It is posited that leverage dynamics significantly predict the company's default event. In this paper, we address the issue of whether leverage deviation strengthens the default prediction. Our in-sample and out-of-sample tests show that default firms are highly over-leveraged and the default prediction is advantaged by including leverage deviation together with information of accounting, finance, and corporate governance. The leverage deviation provides persistent performance across multiple predicting horizons in default risk assessment. Hence, the importance of capital structure for credit risk modelling cannot be ignored.

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Table A: Definitions for variables

Variable	Measurement
Leverage variables	
Book leverage	Book value of debt divided by total assets
Market leverage	Book value of debt divided by market value of total assets
Target leverage determinants	
Size	Natural logarithm of Total assets
Tangibility	Fixed assets divided by total assets
Growth opportunity	Market value of total assets divided by book value of total assets
Profitability	Earnings before interest and taxes divided by total assets
Depreciation Shields	Depreciation expenses divided by total assets
R&D_Dummy	Dummy variable equal 1 if R&D expenses are missing, 0 otherwise
Industry median debt	Median market industry debt ration using first two digits of SIC
GDP	Annual GDP growth rate
Commercial paper spread	Annualized 3-moth commercial paper rate over 3-month Treasury bill rate
Default predictor information	
ZS	Atman Z-score (1968) is calculated as follows; ZS= 1.2*working capital to total assets+ 1.4* Retained earnings to total assets + 3.3*sales to total assets + 0.6* Market value of equity to book value of total debt + Sales to total assets
DD	Distance to default is calculated by using average market price of equity divided by the volatility of equity using daily data on quarterly basis.
CGS	Corporate governance score is calculated by using four sub-indices of ownership concentration, shareholder rights and relations, financial transparency and board effectiveness.
LDev	Leverage deviation; the difference between the target leverage and actual leverage

This table presents the leverage ratios, determinants of target leverage. We below show the codes used in Compustat database for financial information. Book leverage: [(Long term debt (DLTT) + Debt in current liabilities (DLC)/ Total assets (AT)]; Market leverage: [Long term debt (DLTT) + Debt in current liabilities (DLC)/ Price fiscal year close (PRCC)* Common shares outstanding (CSHO)]; Size: [Natural logarithm of total assets (ln (AT))]; Tangibility: [Property, plant and equipment (PPENT)/ Total assets (AT)]; Growth opportunity: [Price fiscal year close (PRCC)* Common shares outstanding (CSHO)/ Total assets (AT)]; Profitability: [Earnings before interest and tax (EBIT) / Total assets (TA)]; Depreciation shield:[Depreciation expenses (DP) /Total assets (AT)]; R&D_Dummy: 1 equal for missing Research and Development expenses (XRD)

Chapter 5

Summary and Conclusion

The research findings of this PhD thesis contribute to the knowledge of credit risk management and corporate finance. This research investigates the importance of corporate governance in measuring default risk at the individual and portfolio levels. It also examines the heterogeneity of capital structure adjustments between default and non-default firms.

The second chapter of this thesis provides evidence of the advantages of combining different predictor information for improving predictive accuracy. It highlights the importance of comprehensive application of corporate governance information to measure default risk at the individual level, the utility of combining different types of predictor information (accounting, share market and corporate governance information) and the effectiveness of different predictor information in the developed and emerging markets' contexts.

The third chapter reveals the results of one of the first studies to examine the importance of considering firm-specific corporate governance information in recognizing non-uniform default correlations among firms. The fourth chapter finds that capital structure adjustments and leverage dynamics differ between default and non-default firms and those dynamics can be successfully incorporated into default prediction models.

The main findings from this thesis are:

(i) the comprehensive application of corporate governance information is necessary for default prediction;

(ii) the combination of accounting, share market and corporate governance information improves default prediction,

(iii) financial information has higher prediction ability in matured markets whereas non-financial information plays a significant role for predicting corporate defaults in emerging markets,

(iv) firms with weak corporate governance in terms of ownership concentration, low board effectiveness, low financial transparency, and high shareholder rights increases default correlation,

(v) default firms tend to have higher speed of leverage adjustment compared to non-default firms and firms have different degrees of SOA over long horizons, and

(vi) leverage deviation when applied with accounting, share market and corporate governance information further strengthens default prediction and it is persistent in the long run.

The details of these findings are set out in Sections 5.1 to 5.3. Contributions to knowledge and implications of the results of this research contained in Section 5.4. Section 5.5. explains the limitations of this research and suggests future research opportunities.

5.1 Main findings of Chapter 2 (Essay one)

Given the importance and the role played by the predictor information in measuring default risk, Chapter 2 divides the predictor information into three main categories, namely accounting, share market and corporate governance. The chapter consists of two research papers. The first paper, entitled "Corporate governance and default prediction: reality test," investigates corporate governance information comprehensively in a default prediction model. By following Standard and Poor's (2002) governance framework, the corporate governance information is categorized into four dimensions, that is, ownership structure and influence, shareholder rights and relations, financial transparency and disclosures, and board effectiveness. Although Ashbaugh-Skaife et al. (2006) adopt Standard and Poor's (2002) governance framework to test the effect of corporate governance on credit rating, this chapter shows the importance of the comprehensive application of corporate governance information on default prediction for a first time. The importance is attributed to the difference between credit ratings and default probability when identifying credit losses. The chapter also shows that the extant literature, that applies corporate governance within their research scope, is mainly limited to ownership concentration and board characteristics variables. Therefore, the

research for this thesis reported in Chapter 2 is different from the previous studies that employ governance information for default prediction.

Moreover, the novelty of the research in this chapter is that it combines accounting, share market and corporate governance information for the quoted companies in the US to test two types of information, that is financial (accounting and market) and non-financial information which are not mutually exclusive. Previous studies show the limitations of using pure accounting and market information for default prediction and also the advantage of combining accounting and market information in a single predictor model. However, this study presents the argument that both accounting and market information represents financial information and it is important to capture the non-financial information in the default prediction model. Thus, it is of academic interest to use corporate governance as alternative non-financial information for default prediction. It is tested whether non-financial corporate governance information provides an incremental contribution to the financial information-based model.

The binary logistic model is employed to estimate the major results by using 3280 US firm-quarter observations over the period of 2000-2015. The results clearly indicate that the comprehensive application of corporate governance information is necessary for default prediction. In order to test the incremental contribution of the non-financial information, five models are developed, that is, Model 1 (Accounting-based approach), Model 2 (Market-based approach), Model 3 (corporate governance-based approach), Model 4 (accounting and market-based approach) and Model 5 (integrated model, using accounting, market and governance information). The findings are unambiguous that the integrated model with financial and non-financial information yields the highest prediction accuracy compared to all the models. The prediction accuracy is measured through the accuracy ratios under Receiver Operating Characteristic (ROC) and Cumulative Accuracy Profile (CAP) curves. Overall, this research suggests that default firms are characterized by concentrated ownership, lower shareholder rights and relations, lower financial transparency and lower board effectiveness than non-default firms. Moreover, this study stresses the importance of including comprehensive governance information in addition to financial information for improved default prediction.

The second paper presented in Chapter 2, is titled "Financial versus non-financial information for default prediction: Evidence from Sri Lanka and the USA." It explores whether the prediction performances of financial and non-financial information are different between mature and emerging markets. The results of the U.S.(mature market) are compared with Sri Lanka (emerging market) after applying the same methodology with some modifications to match the emerging market context. Sri Lanka is selected as a representative secondary emerging market for the comparison purpose.

The rationale for the comparison is based on the institutional and market differences between mature and emerging markets. This thesis argues that if markets are efficient, the effectiveness of financial information should be high for default prediction, then these markets should highly rely on financial information. On the other hand, this thesis argues that if the market is not efficient, a higher weight should be given to non-financial information. Although it appears that the extant literature has not explicitly examined this issue, this research shows that financial information is more relevant for U.S. firms and non-financial corporate governance information appears to be more relevant for the emerging market. This study uses 730 firm-year observations from Sri Lanka, in the model based estimations. The performance of the five models described earlier is measured by using the ROC curve, CAP curve, Gini rank coefficient, Kolmogorov-Smirnov test, and Pseudo R^2.

Overall, the results suggest that corporate governance information is useful in default prediction in both Sri Lanka and the US. Further, this study finds that ownership variables have less prediction ability in Sri Lanka and the relative prediction performance of accounting, market and governance information differs between the two markets. Accounting information provides higher prediction accuracy for a mature market (U.S.), followed by the market and corporate governance information. However, non-financial corporate governance information has a higher prediction ability than financial information in an emerging market such as Sri Lanka.

5.2. Main findings of Chapter 3 (Essay two)

Chapter three consists of one research paper titled "Corporate governance and default prediction" that explores whether corporate governance affects default correlation among firms. The extant literature establishes three main reasons for default correlations: cyclical, contagion and learning from defaults (Das et al., 2007). This thesis contributes to the literature by extending the reasoning behind these three sources of default correlation by using the firm-specific corporate governance information. Following Lucas (1995), this research uses a standard binomial approach to measure default correlation of 160 and 675 default and non-default firms over the period 2000-2015. The Standard and Poor's governance framework (2002) is again applied to define the governance dimensions: ownership structure and influence, board effectiveness, financial transparency and disclosures, and shareholder rights. The firms are categorized, first, on the basis of credit quality (high, medium and low) by using Altman Z-score (1968). Then good and poor corporate governance are classified using the governance indices based on the four governance dimensions of Standard and Poor's governance framework (2002).

This thesis argues that default correlation varies with firms' corporate governance quality. In particular, different ownership structures, board effectiveness, financial transparency, and shareholder rights affect joint default risk among firms due to contagion and cyclical effects as proposed by Das et al. (2007). With regards to ownership structure and influence, given the mixed findings of the literature, it is argued that different ownership structures affect differently on default correlation. The literature shows that ownership concentration can bring better monitoring and positively affect a firm's value. By contrast, some studies reported in the literature find a negative effect of concentrated ownership, as concentrated shareholders focus on personal benefits at the expense of minority shareholders and debtholders, which in turn may create financial issues and lead to poor credit quality. An effective board is necessary to face the external environmental shocks. Thus, having less effective board increases the default correlation in a situation of external environmental shocks. This thesis argues that low financial transparency increases managerialism, and thus leads to poor credit quality. Therefore, the default correlation is increased due to the effect of contagion among firms with low financial transparency.

The issue of shareholder rights presents additional complexity when interpreting the results. On one hand, this thesis argues that having strong shareholder rights can help to reduce managerial opportunism and to enhance the quality of financial reporting (e.g., Healy and Wahlen, 1999). On the other hand, this thesis also argues that having strong shareholder rights can increase unnecessary influence on management and corporate controls thereby creates risks to bondholders and minority shareholders.

Overall, the results of this research show that concentrated ownership, low financial transparency, low board effectiveness, and higher shareholder rights in a single portfolio increase the joint default risk among firms. Further, the effects of poor corporate governance are more pronounced during a financial crisis period, than during a non-crisis period.

5.3. Main findings of Chapter 4 (Essay three)

Chapter 4 consists of two research papers. One paper entitled, "Heterogeneity in capital structure adjustment revisited: Default versus non-default firms and short versus long time horizon" investigates an important and contemporary issue in the capital structure literature, that is, heterogeneity of speed of adjustment in the contexts of default events and different time horizons. Previous research has examined the heterogeneity of speed of adjustment across financial conditions such as financial constraints (Korajczyk and Levy, 2003), financially distress (Gilson, 1997) and financial deficit (Byoun, 2008). By contrast, this paper selects default firms that have gone through bankruptcy and liquidation and hence employs a realized default sample. This paper is distinguished from the previous research as it chooses samples from firms based on credit losses. It is assumed that default firms are likely to incur permanent losses whereas in the previously tested samples, firms suffer losses due to the downgrading of credit ratings. The novelty of this study is presented below.

Although a few studies consider the speed of adjustments and its long-run behaviour, this thesis examines the degrees of leverage adjustments over various time horizons. Flannery and Rangan (2006) find that firms accomplish the leverage target about one third each year. However, this thesis argues that a firm's leverage

movements come with different speeds across a particular time horizon. To investigate this phenomenon, this research measures two forms of the speed of leverage adjustments - cumulative and marginal.

For the testing, 568 default and 2840 non-default firms from 2000 to 2015 US data are selected. The fixed panel regression model is used to test for 6,203 and 51,371 firm-year observations for default and non-default subsamples, respectively, over the period from 1975 to 2015. It is found that default firms have a higher speed of adjustment than non-default firms. A firm, in general, takes multiple years to complete its target leverage. The adjustment speed is low for the short adjusting horizon and high for the long horizon. Further, the marginal speed of adjustment is smaller at the beginning of a horizon and larger at the end of the time horizon.

The paper titled "Do leverage dynamics strengthen bankruptcy prediction? A comprehensive test" is also included in Chapter 4. While a few studies have investigated the issue of leverage dynamics and default prediction, this research examines the predictor information comprehensively in a single predictor model. In particular, this thesis explores the incremental contribution of leverage deviation when added to the previously tested accounting, market and governance information (see the first paper in Chapter 2) using 3280 US firm-quarter observations over the period 2000-2015. This analysis uses two steps to derive the results. In the first step, the study estimates the target leverage by using panel fixed effect model and finds the leverage deviation over five years before the default events. In the second step, the study adds leverage deviation to the accounting, market and governance variables as predictor information. A binary logistic model is used to estimate the results and the prediction accuracy is measured by the ROC and CAP curves. The findings of this analysis clearly show that leverage dynamics provides significant information about corporate defaults in addition to the information of accounting, market and corporate governance. The performance is persistent in the long run.

5.4. Research contributions and policy implications

This study makes a number of academic and practical contributions. The first essay contributes to the literature in several ways. First, it contributes to the extant

literature on credit risk modelling by incorporating corporate governance information comprehensively in a default prediction model. Following Standard & Poor's (2002) governance framework's dimensions, it applies corporate governance information comprehensively to assess the default risk of corporate borrowers. Second, it contributes to the literature as it incorporates financial and non-financial information in a single default predictor model for better prediction performance. Third, knowledge is expanded through examining the roles of financial and non-financial information between a mature and an emerging market perspective. This comparison reveals ways in which the model's performance differs when applied to a mature market and an emerging market. The analysis in the first essay therefore enrichens the conclusions reached by prior research efforts.

The second essay contributes to the credit risk literature by extending the empirical analysis to default correlation. This essay examines the effect of corporate governance on default correlation. Studies on default correlation provide three reasons for default correlation. Such as cyclical correlation, contagion effect and learning from defaults (Das et al., 2007). Thus, this paper extends the cyclical and contagion reasons by considering corporate governance information for clustering defaults among firms. This is the first study to examine the effect of corporate governance on default correlation, thus generating new insights to add to the knowledge relating to this issue.

The third essay contributes to the literature on corporate finance in several ways. First, it focuses on the speed of capital structure adjustment which is a growing area of interest in the capital structure literature. Second, it links the capital structure literature with the credit risk literature by addressing the importance of a comprehensive application of predictor information together with capital structure dynamics for default risk prediction. In this context, the development of a default prediction model with new dimensions can contribute to the banking sector's ability to proactively predict corporate defaults. The findings of the first part of the third essay invites financial institutions to extend their consideration of factors relating to default firms' behaviour. Moreover, the findings enrich the extant literature on capital structure.

From a policy-making perspective, this thesis guides the banks towards better credit risk modelling. As per the Basel II accord, sophisticated banks have

the freedom to use their internal credit rating systems and credit risk models to determine their capital requirements to cover the credit risk exposures.[37] Therefore, it is assumed that banks have their unique internal rating systems and credit risk models and the application of the predictor information is different among the bankers. This thesis emphasises the importance of paying more attention to corporate governance information comprehensively not only about individual credit risk management but also about portfolio credit management. Moreover, the thesis directs financial institutions and corporate management to consider different time horizons relating to capital structure dynamics, that is, it is beneficial to observe the capital structure dynamics in both short and long runs before granting a loan to corporate customers. In summary, the research supporting this thesis provides different insights into the area of credit risk management. It improves the general understanding of the corporate governance information as effective predictor information. Additionally, corporate governance information is found to be a significant source of default correlation. Also, the inclusion of leverage dynamics provides additional improvements for default prediction models.

5.5. Limitations and directions for future research

Defaults are infrequent, and the default firms have different dynamic characteristics as compared to those of healthy firms. These distinguishing characteristics require financial institutions to carefully use default prediction models in order to avoid credit losses. Thus, the research questions addressed in this thesis help financial institutions to modify their default prediction models in a more efficient way. However, this research is subject to some limitations. This research pays attention only to the predictor information. Therefore, applying different default prediction models that have not been tested in this research would add different dimensions for future studies. Given the importance of financial and non-financial information, it would be enlightening to consider enhanced Altman's Z-score model including

[37] Basel committee on banking supervision (Basel) introduces Basel II (1999) to measure the capital requirements for credit risk exposures. There are two approaches for this purpose. First approach is standardized approach where banks can use the models that are already developed by the Basel committee. The second approach is internal-rating based approach. The large financial institutions can develop their internal rating and credit risk models.

both financial and non-financial types of information. Examining more countries representing mature and emerging markets could be another fruitful direction for comparison studies.

Additionally, in the thesis, the sample selection is based on the firms encountering bankruptcy and liquidation. Therefore, it would be interesting to choose a sample with default firms directly obtained from the databases held by financial institutions to test the models suggested by the study. Further, it is of academic and practical interest to examine whether these models can be extended to the areas of credit derivatives and fixed income securities.

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Chapter 2 : Fernando, J.M.R., Li, L., & Hou, G. (2019). Corporate governance and default prediction : A reality test, Applied Economics, 51. 2669-2686.

Nature of contribution by PhD candidate	Data collection, Literature review, empirical analysis, writing of the initial draft
Extent of contribution by PhD candidate (%)	60%

✓ **CO-AUTHORS**

Name	Nature of Contribution
LEON LI	Editing the paper, interpreting the results, producing the final draft.
GREG HOU	Editing the paper, Interpreting the results, proofreading.

✓ **Certification by Co-Authors**

The undersigned hereby certify that:
- the above statement correctly reflects the nature and extent of the PhD candidate's contribution to this work, and the nature of the contribution of each of the co-authors; and

Name	Signature	Date
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Nature of contribution by PhD candidate: Literature review, data collection, empirical analysis, writing of the initial draft

Extent of contribution by PhD candidate (%): 60%.

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The undersigned hereby certify that:

- the above statement correctly reflects the nature and extent of the PhD candidate's contribution to this work, and the nature of the contribution of each of the co-authors; and

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Nature of contribution by PhD candidate	Data collection, Literature review, Empirical analysis, writing of the initial draft.
Extent of contribution by PhD candidate (%)	60%

CO-AUTHORS

Name	Nature of Contribution
LEON LI	Editing, interpreting, producing the paper
GREG HOU	Editing the paper, interpreting the results and proofreading

Certification by Co-Authors

The undersigned hereby certify that:

- the above statement correctly reflects the nature and extent of the PhD candidate's contribution to this work, and the nature of the contribution of each of the co-authors; and

Name	Signature	Date
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Nature of contribution by PhD candidate	Literature review, Data collection, Empirical analysis, writing of the inital draft
Extent of contribution by PhD candidate (%)	70%

CO-AUTHORS

Name	Nature of Contribution
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GREG HOU	Editing the paper, interpreting the results and proof reading

Certification by Co-Authors

The undersigned hereby certify that:

- the above statement correctly reflects the nature and extent of the PhD candidate's contribution to this work, and the nature of the contribution of each of the co-authors; and

Name	Signature	Date
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Nature of contribution by PhD candidate	Literature review, Data collection, Empirical analysis, writing of the inital draft
Extent of contribution by PhD candidate (%)	70%

CO-AUTHORS

Name	Nature of Contribution
LEON LI	Editing, interpeting, producing the paper
GREG HOU	Editing the paper, interpreting the results and proofreading

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LEON LI	Leon Li	21/05/2019
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Appendix 6: Supplementary information for chapters

1. Chapter two

The following tables relate to the footnotes included in paper one and two. Table A1 relates to the note number 23 of paper one (page 2682 of the first paper in chapter two) and Table A2 relates to note number 18 (page 12 of the second paper in chapter two).

Table A1: Accuracy ratio comparison over a long-time horizon

	1-year		3-year		5 year	
Model Specifications	ROC curve	CAP curve	ROC curve	CAP curve	ROC curve	CAP curve
Model 1	72.97%	73.12%	68.00%	68.13%	60.56%	59.63%
Model 2	54.63%	53.77%	46.08%	46.21%	39.74%	38.84%
Model 3	41.87%	40.18%	39.50%	39.41%	42.22%	41.76%
Model 4	76.13%	75.82%	71.16%	71.01%	66.14%	65.04%
Model 5	**82.05%**	**81.96%**	**79.02%**	**78.76%**	**78.40%**	**77.27%**

Notes: This table summarizes the results of accuracy ratio as performance measure of bankruptcy prediction over one, three and five-year time horizon. The value in bold denotes the maximum in the column.

Table A2: Logistic regression results of the alternative models for Sri Lanka

Governance Variables	Variable	*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Ownership structure and influence	***Intercept***	0.172 (1.54)	6.679***(7.12)	1.711***(3.09)	7.954***(7.31)	10.726*** (7.86)
	INST (%)			0.002 (0.54)		0.007 (1.44)
	DIRECTOR (%)			-0.005 (-1.08)		-0.004 (-0.79)
	NUM_SHARE			-0.32 (-0.54)		-0.100 (-1.420)
	BLOCK			0.302 (0.89)		0.494 (1.17)
Shareholder rights and relations	*REM_MAG*			2.746***(5.42)		3.177***(6.01)
Financial transparency and disclosures	*AUDCOM_QUA*			-0.858***(-2.80)		-0.313 (-0.92)
	AUD_OP			0.046 (0.21)		-0.311 (-1.25)
Board structure and effectiveness	*BOARD SIZE*			0.028 (0.53)		0.185***(2.87)
	CEO DUALITY			0.050 (0.23)		-0.336 (-1.31)
	IND_DIRE			0.062 (0.99)		0.016 (0.22)
	OUT_DIRE			-0.363***(-5.94)		-0.460***(-6.39)
Financial variables	*WCTA*	-0.289***(-3.28)			-0.238***(-2.85)	-1.190 **(-2.10)
	MVEBTD	-0.001 (-0.20)			0.012*(1.86)	0.006 (0.78)
	STA	-0.065 (-1.190)			-0.016 (-0.30)	-0.008 (-0.14)
	RETA	-0.794***(-5.11)			-0.631***(-4.24)	-0.628***(-3.79)
	EBITTA	0.189 (1.59)			0.229**(2.04)	0.104 (0.83)
	CASHMTA	-1.185*(-1.93)			-2.233***(-3.51)	-2.282***(-3.47)
	LTDTA	0.471**(2.65)			0.335*(1.85)	0.404**(2.20)
	TDTA	0.156**(2.11)			0.168**(2.21)	0.141*(1.76)
	CFTA	-1.271**(-2.28)			-1.104**(-1.99)	-1.453**(-2.30)
	CFCL	-0.188**(-2.43)			-0.182**(-2.42)	-0.136*(-1.73)
	CFTD	-0.031(-1.07)			-0.038 (-1.29)	-0.028 (-0.91)
	SHARE PRICE		-0.409***(-3.07)		-0.123 (-0.81)	-0.057 (-0.33)
	STOCK_VOL		0.875(1.40)		0.758 (1.17)	0.884 (1.28)
	RELATIVE SIZE		-0.697***(-6.57)		-0.880***(-7.11)	-1.147***(-7.31)
	EXCESS RETURN		-1.960 (-0.680)		-0.970 (-0.970)	-3.49 (-1.05)

	0.09	0.07	0.14	0.16	0.28
Pseudo R^2					
Likelihood ratio	92.28***	73.38***	133.21***	158.14***	281.41***

Notes: This table presents the results of the logistic regression for five alternative models. 730 firm-year observations. 1= if the company is default and 0 otherwise. The goodness of fit of the models are measured by using Pseudo $R^{2,}$ Likelihood ratio χ^2 and Wald χ^2. 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. ***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.

2. Chapter four

The following tables relate to the footnotes included in chapter four. Table A3 relates to the note number 30 of chapter four (page 131). Table A4 relates to the note number 32 of Chapter four (see page 144). Table A5 relates to note number 33 of chapter four (page 144).

Table A3: Speed of adjustment towards target leverage with alternative models

Dependent variable Leverage(t)	Tobit		System GMM	
	Book leverage	Market leverage	Book leverage	Market leverage
Panel A: Default				
Lev_{it-1}	0.656***	0.582***	0.705***	0.636***
SOA	0.344	0.418	0.295	0.364
T-stat./Z-stat.	30.17	24.38	15.63	13.31
R^2				
Year fixed effect			Yes	Yes
AR(1) test (ρ-value)			0.00	0.00
AR(2) test (ρ-value)			0.87	0.58
Hansen test of over-identification (ρ-value)			1.00	1.00
Diff-in-Hansen tests of exogeneity (ρ-value)			0.07	0.55
Panel A: Non-default				
Lev_{it-1}	0.757***	0.650***	0.714***	0.638***
SOA	0.243	0.350	0.286	0.362
T-stat	86.23	68.96	30.04	27.65
R^2				
Year fixed effect			Yes	Yes
AR(1) test (ρ-value)			0.00	0.00
AR(2) test (ρ-value)			0.86	0.78
Hansen test of over-identification (ρ-value)			0.96	0.96
Diff-in-Hansen tests of exogeneity (ρ-value)			0.12	0.75

Notes: This table presents the regression results for the dynamic partial adjustment model of leverage adjustment given by Eq. (6) using tobit and system GMM models. For system GMM model, we used leverage lagged by two periods as the instrumental variables suggested by Anderson-Hsiao. GMM model is tested by using two step estimator. AR (1) and AR (2) are tests for first and second-order correlation in the first differenced residuals under the null hypothesis that no serial correlation. Hansen test of over-identification test the null hypothesis that all instruments are valid. The Diff-in-Hansen tests of exogeneity (ρ-value) test the null hypothesis that instruments used in the model are exogenous. The model explanatory power (R^2), t-statistics are also given in the table. *** indicates

coefficient is significant at 1% level. The SOA value is calculated by using the estimation results for the lagged leverage, i.e., subtracting the coefficient by 1. The coefficient of the firm specific and macroeconomic variables are not reported for brevity.

Table A4: In-sample accuracy ratio comparison using market leverage deviation

Prediction horizon	1-Year	2-Year	3-Year	4-Year	5-Year
Model 1	83.88%	81.37%	79.07%	77.09%	75.79%
Model 2	85.36%	82.99%	80.81%	78.64%	77.15%

Notes: This table summarizes the prediction accuracy measured by the area under the Receiver Operating Characteristics (ROC) curve over a five-year prediction horizon for in-sample (Panel A) and out-of-sample analyses (Panel B). ***Model 1***: Default risk= *f* (Z-score, Distance to default, corporate governance score). ***Model 2***: Default risk= *f* (Z-score, Distance to default, corporate governance score, market leverage deviation).

Table A5: Model estimation using probit regression over five-year time horizon

Predictor information	Prediction horizon 1	2	3	4	5
Panel A: Book leverage					
Constant	1.667***	1.555***	1.473***	1.442***	1.663***
	(-7.17)	(10.50)	(8.58)	(6.57)	(5.15)
ZS	-0.388***	-0.367***	-0.342***	-0.291***	-0.265***
	(-22.53)	(-19.45)	(-15.76)	(-11.06)	(-7.17)
DD	-0.15***	-0.013***	-0.012***	-0.10***	-0.007***
	(-7.00)	(-5.74)	(-4.90)	(-3.78)	(-2.00)
CGS	-0.153***	-0.142***	-0.136***	-0.155***	-0.209***
	(-7.17)	(-5.94)	(-4.86)	(-4.27)	(-3.97)
LDev	1.276***	1.287***	1.288***	0.898***	0.736***
	(8.50)	(8.01)	(7.01)	(4.24)	(2.54)
LR Chi	1109.55	744.63	460.66	230.68	97.71
Pseudo R^2	0.281	0.263	0.222	0.176	0.156
AUC	0.845	0.827	0.804	0.773	0.766
Panel B: Market leverage					
Constant	1.758***	1.703***	1.590***	1.666***	1.651***
	(13.54)	(11.86)	(9.73)	(8.18)	(5.73)
ZS	-0.366***	-0.332***	-0.298***	-0.267***	-0.236***
	(-23.42)	(-19.74)	(-15.76)	(-11.64)	(-7.51)
DD	-0.019***	-0.018***	-0.016***	-0.014***	-0.013***
	(-8.58)	(-7.46)	(-6.63)	(-5.15)	(-3.48)
CGS	-0.175***	-0.174***	-0.161***	-0.185***	-0.194***
	(-8.43)	(-7.49)	(-6.00)	(-5.52)	(-4.13)
LDev	0.993***	0.959***	0.903***	0.734***	0.639***
	(10.27)	(9.46)	(7.97)	(5.44)	(3.37)
LR Chi	1220.89	841.75	532.84	296.32	120.81
Pseudo R^2	0.309	0.267	0.228	0.195	0.165
AUC	0.853	0.829	0.808	0.786	0.771

Notes: This table presents the results estimated by using equation 4. The model estimated is based on probit regression to predict the default probability by using two explanatory variables. Such as leverage deviation (LevDev) defined as the difference between the target leverage estimated from equation 2 (chapter four) and the actual leverage and Altman Z-score values. The table provides the coefficient estimates and t-values in parenthesis with *** indicating significant level at 1%. The explanatory power of the models and the prediction performances of the models by using area under the Receiver Operating Curve (ROC) values are also given.