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Financial distress and bankruptcy prediction among listed companies using accounting, market and macroeconomic variables

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ABSTRACT

Using a sample of 23,218 company-year observations of listed companies during the period 1980–2011, the paper investigates empirically the utility of combining accounting, market-based and macro-economic data to explain corporate credit risk. The paper develops risk models for listed companies that predict financial distress and bankruptcy. The estimated models use a combination of accounting data, stock market information and proxies for changes in the macro-economic environment. The purpose is to produce models with predictive accuracy, practical value and macro dependent dynamics that have relevance for stress testing. The results show the utility of combining accounting, market and macro-economic data in financial distress prediction models for listed companies. The performance of the estimated models is benchmarked against models built using a neural network (MLP) and against Altman's (1968) original Z-score specification.

1. Introduction

The financial crisis of 2008 highlighted the shortcomings of risk management practices within the lending environment and risk assessment at the micro level (PD estimation). Lenders and other investors in the corporate sector along with regulators require timely information on the default risk probability of corporates within lending and derivative portfolios. For banks, developing effective 'Internal Rating Systems' (IRB) for corporate risk management requires building probability of default (PD) models geared to the specific characteristics of corporate sub-populations (e.g. SME's, private companies, listed companies, sector specific models), tuned to changes in the macro environment, and, of course, tailored to the availability and timeliness of data. The use of credit risk models has been well documented since Altman (1968). There is now an extensive literature on the modelling of corporate financial distress and bankruptcy but often, it reports work that is either based on using publically available historical accounting data (Altman, 1968) or relies on securities market information (Merton, 1974) to predict insolvencies. Recent papers argue for a combined approach, Trujillo-Ponce, Samaniego_Medina, and Cardone-Riportella (in press) test both accounting and market data (Credit Default Swaps, CDS) and suggest that "accounting and market data complement one another and thus a comprehensive model that includes both types of variables appears to be the best option." (p. 2). The outcome definition, bankruptcy, is taken from formal (legal) insolvency notices, debt servicing (Mella-Barral & Perraudin, 1997) and bond (Geske, 1977) or loan defaults, default swaps[1] (Ericsson, Jacobs, & Oviedo, 2009) or stock market suspensions. These modelling approaches have been applied extensively to listed companies using statistical procedures such as MDA, logistic regression or hazard models. Recent work has extended the definition of bankruptcy to include wider measures of 'financial distress' based on financial statements. Further, attempts have been made to incorporate some dynamics by the inclusion of data reflecting changes in the macroeconomic environment, non-financial data and other time variant predictors. The present study contributes to the academic literature by, first, presenting distress prediction model for quoted companies in the United Kingdom that employ a 'finance-based' definition of distress, to detect early stages of financial distress, alongside the more formal approach using event data provided by the London Share Price Database. Timely prediction of financial distress could, in practice, help creditors avert some of the costs associated with a bankruptcy filing. Second, using a multi-level theoretical and empirical procedure, this study offers a financial distress prediction model that, with a rather small number of variables, exhibits a considerably high classification and prediction accuracy relative to previous research works. Third, and perhaps most importantly, the study tests, for the first time in financial distress prediction models for public companies in the United Kingdom, the relative contributions (individual as well as collective) of three types of variables: financial ratios, macroeconomic indicators, and market variables.

The paper is structured as follows. In the next section we discuss the literature that is relevant to our modelling approach. We describe

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[1] The issuance of (rated) bonds and the related CDS market is relatively small among UK listed companies and therefore not considered in this study.

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our database and measures of the outcome variable and set of explanatory variables. The estimation methodology is discussed along with analysis, results and conclusions.

2. Review of the literature

Most of prior default prediction models for quoted companies employ a definition of the criterion event that is contingent upon its ultimate legal consequence: either bankruptcy in the United States and creditors' compulsory and/or voluntary liquidation in the United Kingdom. These are highly visible legal events that can be objectively and accurately dated for use as an outcome variable. The likelihood of bankruptcy can be modelled using binary choice models that require that the populations of failing and non-failing firms be well defined and clearly separated from each other.[2] However, this legal definition of default is not without issues. For instance insolvency can be a lengthy legal process and the 'legal' date of failure may not represent the 'economic' or the 'real' event of failure. Analysis of UK companies demonstrates a considerable time gap (up to three years or 1.17 years in average) between the period that a firm enters a state of financial distress (that caused the firm to default) and the date of legal default/bankruptcy. This evidence is consistent with the finding by Theodossiou (1993) that firms in the United States stop providing accounts approximately two years before the bankruptcy filing. The implication is that a firm in this situation is already in serious financial distress at some point two years before the legal bankruptcy event. Moreover, it is possible that a firm in a state of financial distress does not change the legal status that a bankruptcy filing would entail (Balcaen & Ooghe, 2004). Additionally, changes in insolvency legislation, (e.g. the Enterprise Act 2004 in the UK or Chapter 11 in the US) which have attempted to create a 'rescue culture', have changed the nature and timing of the legal bankruptcy process. Wruck (1990) states that there are several stages that a firm can go through before it is defined as dead: financial distress, insolvency, filing of bankruptcy, and administrative receivership (in order to avoid filing for bankruptcy), for instance. Moreover decline can be managed by the sale of assets (pre-packs) and eventual dissolution rather than formal bankruptcy.

The present study introduces for the first time, for quoted companies in the United Kingdom, a definition based on 'financial distress'. This development has been highlighted as important in the academic literature (Barnes, 1987, 1990; Pindado, Rodrigues, & De la Torre, 2008) and is justified by the fact that the failure of a firm to meet its financial obligations does not inevitably lead to a filing of bankruptcy. The study recognises that financial distress can be costly for creditors and that they would wish to take timely actions to minimise/avert these costs. It is therefore essential that a reliable financial distress prediction model be developed that not only uses the event of bankruptcy as the primary outcome, but also includes the time when a company fails to meet its financial obligations. Wruck (1990) defines financial distress as the situation where the cash flow of a firm is not enough to cover its current financial obligations.[3] Asquith, Gertner, and Scharfstein (1994) analyse the options that junk bond issuers face in order to prevent bankruptcy and define financial distress in a similar way. Their definition of financial distress is based on interest coverage ratios. In practical terms, a firm is classified as financially distressed if its earnings before interest, taxes, depreciation and amortisation (EBITDA) are less than its reported financial expenses (interest expense on debt) for two consecutive year beginning in the year following its junk bond issue, or, if in any other year, EBITDA is less than 80% of its interest expense. Similarly, Andrade and Kaplan (1998) define financial distress as the first year that a firm's EBITDA is less than financial expenses. However, the authors classify firms in this category (in addition to the first condition) whenever a firm attempts to restructure its debt, or defaults. The fulfilment of any of these conditions classifies a firm as financially distressed. Whitaker (1999) analyses the early stages of financial distress and points out that its effects are not limited to those firms that are unable to meet contractual debt obligations as they come due, but also to those firms whose likelihood of default increases. He states that, in fact, the effects of financial distress can be detected before the firm defaults, as a proportion of the loss in firm value occurs before default or bankruptcy. Whitaker (1999) defines financial distress as the first year in which a firm's cash flow[4] is less than current maturities of long-term debt. Moreover, market value is used in order to confirm financial distress i.e. whether the distressed firms in the sample had either a negative rate of growth in market value or a negative rate of growth in industry-adjusted market value.

Previous research has tested the utility of market variables in predicting bankruptcy by employing methodologies such as the Black and Scholes (1973) and Merton (1974) contingent claims or option based approach. Bharath and Shumway (2008), Hillegeist, Keating, Cram, and Lundstedt (2004), Reisz and Perlich (2007), and Vassalou and Xing (2004) have employed the contingent claims approach to estimate the likelihood of corporate failure. More recently data on Credit Default Swaps (prices and spreads) have been used to proxy credit risk (Alexander & Kaeck, 2008). Many empirical papers have attempted to demonstrate the superiority of market-based models over accounting-based models and vice versa. However, the results obtained from these models (that entail numerous restrictive assumptions[5]) and the subsequent performance comparisons with accounting-based models have been controversial. In a recent paper, Agarwal and Taffler (2008) perform a comparison of market-based and accounting-based bankruptcy prediction models, and find that traditional models based on financial ratios are not inferior to KMV-type, option-based models for credit risk assessment purposes. They conclude that, 'in terms of predictive accuracy, there is little difference between the market-based and accounting models.[6]' Hillegeist et al. (2004) provide contrasting results indicating that the Black–Scholes–Merton option-pricing model provides significantly more information about the probability of bankruptcy that do either the Altman's Z-score or the Ohlson O-score. As surmised earlier the default prediction literature can be characterised by a competing approach, where there is a clear division between market and accounting variables. Hillegeist et al. (2004),[7] for instance, recommend that researchers use the Black–Scholes–Merton methodology instead of the traditional accounting-based measures as a proxy for the probability of bankruptcy.

More recent work suggests that both approaches yield similar results implying that both contain useful information about firms' likelihood of default/financial distress. Furthermore, the individual characteristics (e.g. timeliness) of each type of variable (market and accounting) give promise to the development of a model that is superior in performance than ones that rely on *either* accounting *or* market variables. Balcaen and Ooghe (2004)[8] argue that 'if researchers only include financial ratios into their failure prediction model, they implicitly assume that all relevant failure or success indicators – both internal and external – are reflected in the annual accounts.[9]' It is clear

[2] Balcaen and Ooghe (2004, p. 21).

[3] Such as debts to suppliers and employees, and principal or interest payments in arrears.

[4] Defined as net income plus non-cash charges.

[5] The underlying assumptions of the theoretical Merton–Black–Scholes option-pricing model are, according to Saunders and Allen (2002) and Agarwal and Taffler (2008): normality of stock returns, and the existence of a single zero coupon loan (it does not distinguish between different types of loans), for instance.

[6] p. 1550.

[7] p. 28.

[8] Argenti (1976), Zavgren (1985), Keasey and Watson (1987), and more recently Maltz, Shenhar, and Reilly (2003) offer support for the inclusion of non-financial variables to default prediction models.

[9] Balcaen and Ooghe (2004, p. 35).

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