Can managerial (over)confidence lead firms to bankruptcy? Evidence from the UK

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Abstract

This paper empirically investigates the relationship between CEO confidence levels and the probability of bankruptcy. We postulate that the relationship depends on the range of the managerial confidence. Specifically, we argue that there exists a range of CEO confidence, which associated with lower likelihood of bankruptcy, as well as a range, which is associated with a greater probability of bankruptcy. In our analysis, we employ a discrete time hazard model to analyse the survival of UK non-financial firms during the period 2000-2015. We measure CEO confidence by incorporating the ownership and share dealings of CEOs in their own firms. In the analysis, we consider three distinct levels of confidence (low, moderate and high) and investigate the effect that they exert in the bankruptcy probability. We find that firms that are managed by overconfident (moderate) CEOs are more (less) likely to go bankrupt. Overall, the analysis suggests incorporating the measures of managerial confidence improves the predictive power of bankruptcy prediction models.

Keywords: managerial bias; managerial overconfidence; probability of bankruptcy;

JEL Classification: G02, G14, G30, G33

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1 Introduction

Overconfidence is observed when individuals overestimate their own abilities and think that they are better than they really are. This behavioural bias is more frequently found among experts, including the Chief Executive Officers (CEOs) of firms (Graham et al. 2013). Among the CEOs the bias reveals itself via the overestimation of the probability of success and the ability to impact average returns (Hirshleifer et al. 2012). Prior research provides theoretical and empirical evidence that managerial overconfidence results in suboptimal corporate decisions and hence reduces firm value. It is argued that biased managers tend to use more debt financing as they perceive that the firm is less risky and hence less likely to enter financial distress, than it actually is (Hackbarth 2008). Similarly, Malmendier et al. (2011) find that overconfident managers are more likely to issue debt as they believe that the firm's equity is undervalued. Huang et al. (2016) add that the overconfidence leads to a view that the overall external financing is mispriced, since it does not incorporate the better long-term performance, which is inaccurately envisiged by overconfident managers. Because the mispricing affects more severely the long-term financing then short-term one, managers are inclined to shorter-debt maturity structure with a hope that they will refinance at a cheaper cost when the external financing is priced in accordance to their perception. Rationally, however, the overconfidence results in more expensive, riskier, and hence value destroying choice of financing. Malmendier & Tate (2008) show that this managerial bias could explain the usage of relatively too low discount rates when making investment appraisal, which further explains why

overconfident managers tend to engage in value-destroying acquisitions.

Despite ample research on the consequences of managerial overconfidence for corporate decisions and value, how managerial overconfidence impacts the likelihood of bankruptcy remains unaddressed.[1] This study provides the first attempt to fill this gap by examining the relation between CEO confidence levels and the likelihood of bankruptcy. This analysis is important to further our understanding of the role of executives and their personal attributes in delivering returns to investors. Bankruptcy is a special corporate event that has major implications not only for shareholders and debtholders, but also for managers and other stakeholders including employees. The fact that managerial overconfidence generally reduces firm value does not necessarily mean that it will also increase the probability of bankruptcy. It is possible that overconfidence may enhance the firm's chance of survival during financial difficulties if, for example, overconfident managers make riskier investment decisions that would not normally be taken by risk-averse managers. Conversely, such bold decisions would precipitate the failure of distressed firms. In addressing the interactions between managerial confidence and corporate bankruptcies, we attempt to address the following research questions: (1) Is the degree of CEO confidence important for probability of default? If so, then (2) are firms managed by the overly confident CEOs more/less likely to go bankrupt? (3) Can the boards of directors of firms alleviate the risks stemming from the confidence levels of CEOs?

To carry out our analysis, we group each firm's CEO into one of the three

[1] In this paper we use interchangeably terms bankruptcy, default, failure, insolvency, liquidation.

categories: low, moderate, and high level of confidence by estimating the confidence levels of a large number of CEOs in UK firms. We refer to the high level of confidence as overconfidence. In order to measure the confidence levels of CEOs, we use information on their shareholdings and insider trading activities in their own firms. Following closely the measurements developed by Campbell et al. (2011), we classify a firm's CEO as overconfident if she overinvests her personal funds in her own firm. The CEO of a firm is likely to be overconfident if, in a given year, her net stock purchases (NPS) place her in the top quintile among the trading CEOs in the distribution. However, to classify a CEO as overconfident, it is also required that these purchases increase her shareholdings in the firm by at least 10%. Likewise, the level of CEO confidence is classified as low if NPS lies in the bottom quintile of the distribution and the transactions reduce the CEO's ownership by at least 10%. Other CEOs who do not fall into either of the two categories are classified as moderately confident.

In our empirical analysis, we employ data for a large sample of firms with 3,736 firm-year observations during the period 2000-2015, with 940 distinct CEOs and 140 filings for corporate insolvencies to consider. The methodology we use to investigate the relation between CEO confidence and the probability of bankruptcy is a discrete-time hazard model. This methodology is suitable for our empirical analysis as it captures information from previous periods in a dynamic framework. Incorporating information in a dynamic manner is particularly important in overconfidence studies as the bias is time-variant. The degree of confidence can change over time depending on, for example, the success of earlier initiatives, good past performance

of the company, or success in the accuracy of earnings forecast (Hilary & Hsu 2011, Hilary et al. 2016).

Our empirical approach also controls for the firm-level information identified as important in prior bankruptcy prediction studies, as well as board size and independence measures. The estimated results provide strong support for a significant relation between managerial confidence and the likelihood of bankruptcy. Specifically, firms managed by overconfident CEOs are more likely to go bankrupt. In contrast, moderately confident managers help reduce the probability of bankruptcy. Low confidence levels do not exert a meaningful impact. Moreover, we find that larger board of directors mitigate the adverse effects of CEO confidence on the likelihood of bankruptcy. Overall, our findings suggest that the accuracy of bankruptcy prediction models is likely to increase with the inclusion of managerial overconfidence among other firm-level factors.

To the best of our knowledge, this paper is the first to explore the relationship between CEO confidence and the probability of bankruptcy. In doing so, we contribute to the several strands of the literature. Firstly, we add to the literature that explores the probability of bankruptcy (see, for example, Campbell et al. (2008); Chava & Jarrow (2004); Shumway (2001); Reisz & Perlich (2007)). This is achieved by providing clear evidence that the level of CEO confidence plays a significant role in predicting corporate bankruptcies. Secondly, we add to a broader literature on the relevance of managerial behavioural biases in impacting corporate policies and value. This is done not only by showing that overly confident CEOs adversely affect firm survival but also by providing evidence that moderate levels of CEO confidence

lead to a lower probability of bankruptcy.[2] Thirdly, this paper provides further support for the line of recent research that finds that directors of firms approaching insolvency tend to increase their purchase transactions significantly Ozkan et al. (2017). Finally, we contribute to the emerging literature on the effectiveness of corporate governance in restraining managerial biases (see, e.g., Banerjee et al. (2015); Banerjee et al. (2017); Li & Tang (2010)), by showing that larger boards of directors are more effective in restraining the hubris.

The remainder of the paper proceeds as follows. In the next section, we present the review of the relevant literature. In section three we explain the methodology applied in the paper. In section four we discuss the obtained results, which are tested further in the following robustness section. We conclude the paper in section six.

2 Managerial confidence and the probability of bankruptcy

The relation between managerial confidence and the probability of bankruptcy is not clear-cut. One channel through which they can be linked relates to the expected costs associated with managerial overconfidence. The existing theoretical and empirical literature provides compelling arguments and evidence that managerial overconfidence leads to financing and investment decisions that could adversely affect firm value. For example, Malmendier &

[2]Apart from the contribution of Kallunki & Pyykkö (2013), who consider the influence of defaulting on personal loan payments CEOs on the probability of financial distress, there is virtually no prior research on the subject.

Tate (2005) show that overconfident CEOs tend to overinvest when they have excessive internal funds and curtail investment when external financing is required. Harvey et al. (2007) find that overconfident managers underestimate the level of risk in appraising investment opportunities and hence end up incorporating lower discount rates to value future expected cash flows. This leads to too risky investment decisions, or as shown by Kim et al. (2016), misperception of on-going negative net present value projects as value creating.

Moreover, prior work also finds that overconfident managers not only underestimate the risk, but also overestimate profitability, future growth prospects, and expected returns. They also tend to favour higher than optimal leverage (Hackbarth (2008), Malmendier et al. (2011)), as well as shorter debt maturity (Huang et al. 2016), and engage in value-destroying M&As (Malmendier & Tate 2008). These value decreasing distortions are directly related to the probability of bankruptcy as the survival of firms, ceteris paribus, is positively related to value. Therefore, our first hypothesis is as follows:

Hypothesis 1. *The likelihood of bankruptcy is higher in firms that are managed by overly confident CEOs.*

There are also benefits associated with different levels of managerial confidence. Starting with overconfidence, it is argued that the underinvestment problem that arises from the risk-averse characteristic of can be curtailed by relatively overconfident managers who increase investment in risky projects (Hirshleifer et al. 2012). In this respect, CEO overconfidence can be a desirable attribute and hence firms managed by overconfident managers can

generate greater returns and simultaneously enhance firm survival. Risk taking is not the only attribute which the strand of the literature uses to show the positive effects of managerial overconfidence. Galasso & Simcoe (2011) and Hirshleifer et al. (2012) argue that overly confident managers are desired on boards as they promote greater value creation through innovation compared to their rational peers. Furthermore, Bénabou & Tirole (2002) show that overconfidence enhances the motivation of other managers, and Compte & Postlewaite (2004) argue that it improves the overall firm performance.

While top managers, in particular CEOs, are said to be more overconfident than the general population (Graham et al. 2013), it is important to gauge the exact nature of the relation between overconfidence and the likelihood of bankruptcy. This view is in line with the more recent work, which emphasises the varying degrees of confidence and the positive impact that moderately confident managers can exert on firm value (see, e.g., Goel & Thakor (2008); Hackbarth (2008); Puri & Robinson (2007)). It is argued that the moderately confident executives tend to make more prudent financial decisions and hence improve overall firm performance. These studies imply that there is an optimal level of managerial confidence, which maximises firm value. It is argued that the optimal level offsets managerial risk aversion and reduces the potential agency conflicts between managers and shareholders, leading to an improvement in firm value. These arguments lead to the following hypothesis:

Hypothesis 2. *The likelihood of bankruptcy is lower in firms that are managed by moderately confident CEOs.*

Since moderately confident CEOs are more likely to improve firm value,

the corporate governance structure of firms should ensure that such managers are employed and an environment should be created to hinder the implementation of the policies driven by extreme confidence. However, the recognition of the bias and distinguishing between overly and moderately CEOs may not always be straightforward. The recent literature shows that several groups of stakeholders seem to able to recognise the bias. For example, Hilary & Hsu (2011) point that financial markets appear to recognize overconfident CEOs, which is evidenced by the fact that they react less strongly to earnings forecasts made by overconfident managers. Sunder et al. (2010) note that the recognition ability is visible in actions of debt providers who impose stricter debt covenants when providing financing to firms led by the overconfident CEOs. More importantly, Campbell et al. (2011) suggest that overconfidence may be recognised by good boards of directors who, acting in the best interest of shareholders, should replace the overconfident manager. Effective boards would be expected to have corporate governance practices that are likely to restrict the undesirable consequences of managerial overconfidence and make the most of the desirable (optimal) levels of confidence.

On the basis of their aggregate analysis of the implementation of the Sarbanes-Oxley Act, Banerjee et al. (2015) point out that the hubris can be restricted by the improved corporate governance structure. Indeed, recent previous work shows that the risky managerial decisions can be restrained by larger Nakano & Nguyen (2012)and independent boards of directors Li & Tang (2010). On the basis of the arguments above, in our analysis we also test the following hypothesis.

Hypothesis 2. *The unfavourable (favourable) impact of CEO overconfi-*

dence on the probability of bankruptcy are lower (higher) in firms with larger and more independent boards of directors.

3 Research sample and design

3.1 Sample selection and data sources

The data used in our study is derived as follows. First, we begin with a list of all live and dead UK firms listed on the London Stock Exchange listed at any time between 2000 and 2015. Second, we exclude all financial firms using the Industry Classification Benchmark (ICB) code 8000. Using ISIN codes, we confirm the solvency status using FAME[3] database and obtain the insolvency dates for firms which failed during the sample period. Third, we obtain the accounting and market data needed for the bankruptcy model from using Thomson Reuters Datastream. This yields 11,741 firm-year observations. We then merge this sample with that containing the measures of the overconfidence for all trading directors. The data on directors trading and holdings is obtained from Thomson Reuters EIKON. Finally, we incorporate the data on board characteristics from BoardEx.

To measure the different levels of managerial confidence, we use trading and shareholdings information for 15,506 directors, of which 1,304 are CEOs. The final sample contains 3,736 yearly observations of 1,304 CEOs that in total manage 940 firms. We analyse 140 cases of insolvency fillings in the period 2000-2015. Table 1 reports the distribution of insolvencies over the

[3]FAME, Financial Analysis Made Easy, is a database of public and private companies, administred by Bureau Van Dijk

sample period.

Over the sample period the average failure rate is 3.43%. Not surprisingly, the highest failure rates are observed during the crisis years of 2007 and 2008, which are 12.72% and 6.77% respectively. The percentage of firms that filed for insolvency is also high in 2009 at 5.96%. At managerial level, this failure rate corresponds to 41.43% of overconfident CEOs, 53.57% of moderately confident CEOs, and 9.93% of CEO's with a low level of confidence filed for insolvency.

[INSERT TABLE 1 ABOUT HERE]

Our sample is constructed as the time-to-event data (otherwise known as duration data), where the event is a corporate failure. The patterns for each firm are described by time spent in solvency, registered by the listing age, which begins with the initial public offering (IPO), and ends with the filing for insolvency. The duration of the firm is right-truncated in case of firms where the CEO stopped trading the firm's shares before the final accounts were published. Similarly to Shumway (2001), we consider all firms that filed for any type of insolvency within five years of final records on our dataset (driven by the delisting, or the final open-market transaction by the CEO, whichever comes first). By doing so, we ensure that the available during the listing accounts are considered as the last, and also represent a state of imminent insolvency. To ensure that the observations are consecutive, we removed all the firm-year observations if they were followed by any time gaps before the next available observation. Hence, the observation of survival may

be delayed.[4]

Finally, to ensure that outliers do not bias our results, we winsorise our variables at 1% level of their pooled distribution across all firm-years. That is, we replace all firm-year observations higher (smaller) than the 99th (1st) percentile of each variable to the value of the 99th (1st) percentile.[5]

3.2 Model

Predicting corporate bankruptcies has been of great interest for decades in corporate finance research. This is mainly because corporate failures have significant implications for managers, shareholders, creditors and other stakeholders of the firm including the government. Since the seminal paper of Beaver (1966), the literature on bankruptcy prediction has been dominated by three distinct approaches, namely (i) the traditional approach based on the static accounting information Altman (1968); (ii) the contingent claims approach based on the option pricing theory Vassalou & Xing (2004); Charitou et al. (2013); (iii) and the hazard approach that captures the dynamic information from previous periods and enables the determination of bankruptcy

[4]An additional source of the left truncation it the beginning of the dataset recorded for the year 2000. If the firm operated before the year 2000, we observe the accounts only from year 200 onwards.

[5]The treatment of outliers in bankruptcy prediction and related studies is of particular importance, and in our view truncation (as in Verwijmeren & Derwall (2010) or Davies et al. (2005)), i.e. the removal of the extreme values, is not appropriate in the context of bankruptcies. The distribution of accounting figures related to firms that file for insolvency is significantly different, and removing the outliers can lead not only to selection bias but also to the omission of important information regarding bankruptcy prediction irregularity. For example, the 1st percentile of the distribution of total assets across all firm-years equals £1,558,000, while the 1st percentile of the distribution across firms which filed for insolvency equals to £626,000. Deleting the extreme values at the left tail would lead to removal of 14 insolvencies, while the smaller values of total assets in highly distressed firms is justifiable.

risk at any point in time (Shumway 2001). While some of the models are argued to be superior due to their theoretical construction, latest empirical research by Bauer & Agarwal (2014) shows that the hazard models have the greatest predictive power, and therefore we employ this methodology.

The most general form of the discrete-time hazard model with time-varying covariates is the following

$$ln(\frac{h_j(t)}{1-h_j(t)}) = \alpha(t) + BX_j(t) \tag{1}$$

In this model $h_j(t)$ represents the hazard (probability of bankruptcy) at duration time t for company j, which is conditional on survival up to time t; $\alpha(t)$ is the baseline hazard, B is the vector of coefficients, and X_jt is a matrix of bankruptcy predictors. As shown by Shumway (2001), the likelihood function of the hazard model is identical to the function of the multiple logit model. Hence, we estimate the hazard model using logistic regression function, and specify the probability of bankruptcy at time t in the following way

$$P_{j,t}(Y_{j,t+1} = 1) = \frac{1}{1 + e^{-\alpha(t)-BX_{j,t}}} \tag{2}$$

where $Y_{j,t}$ is an insolvency indicator.

3.3 Variables

3.3.1 Bankruptcy indicator

The dependent variable in our hazard model is insolvency indicator, i.e. a binary outcome variable equal one, if a firm enters insolvency procedures in

a particular year, and zero otherwise.[6]. For example, if a firm is listed for five years it adds five observations to our database. If it ends in insolvency, we code the dependent variable to one only in the final (fifth) year of the duration. Following Ozkan et al. (2017) we define corporate failure by observing one of the following events in the data: administration, dissolution, liquidation, or receivership.

3.3.2 Measures of overconfidence

The main explanatory variables of interest in our analysis relate to managerial confidence levels. We construct them in accordance with Campbell et al. (2011), who extend the well-known measures of Malmendier & Tate (2005). The employed measures are developed on the basis of insider trading data, which is more available in the context of the United Kingdom as well as the bankruptcy prediction than the traditional option-based measures of Malmendier & Tate (2005, 2008).

We concentrate on the levels of confidence of the Chief Executive Officer (CEO) who is the person within a firm with the greatest influence on the way in which the business is conducted. To construct the measures, we first observe the CEO's ownership in the firm as well as his insider trading activity[7] [8]. Following Campbell et al. (2011), we classify CEOs into three

[6]Similarly to Campbell et al. (2008) use the variable also for censoring the last observation of firms which left the sample for reasons other than insolvency, for example merger or delisting. We censor the data by coding the insolvency indicator to zero in the final year of duration.

[7]We consider four categories of insider transactions available on Thomson Reuters EIKON that relate to the open market transactions, i.e. sold, bought, increase, and decrease. All the remaining categories, including the transactions related to exercises of options, or vesting of the awards are excluded from our analysis.

[8]Our overconfidence measures are based on insider dealings which regulated by Compa-

categories regarding using the degree of their confidence, namely high, moderate, and low.[9] We further interpret the high confidence as overconfidence. A CEO is classified as overconfident (HIGH) if in a given year his ownership increased by at least 10% and his net purchases of shares during the same year are significant. To assess that we first establish the distribution of net stock purchases (NSP)[10] of all CEOs in our sample, and select executives in the top quintile of the distribution as potentially highly confident. We then additionally require that their share ownership increased by at least 10% during the same year. Similarly, the level of managerial overconfidence is classified as low (LOW) if the value of NSP lies in the bottom quantile of the distribution and trading reduces their stock holdings in the firm at least by 10%. The overconfidence measures are semi-permanent, i.e. the executives carry their extreme classifications at both ends until they exhibit ownership and trading activity that would put them in a category from the opposite end. The remaining firm-year observations with available trading and holdings data, which do not fall in either of the above two categories, are classified as moderately confident (MODERATE).

3.3.3 Control variables

In specifying our empirical model we closely follow Shumway (2001), Campbell et al. (2008), and Charitou et al. (2004). Specifically, we define our

nies Act 2006, and Model Code on directors' dealings, set out in Chapter 9 of the Listing Rules (LR9 Annex 1). For a discussion on regulatory framework of the insider trading activity see Ozkan et al. (2017).

[9]While we perceive all CEOs to be overconfident, we aim to distinguish the degree of the bias. To avoid erroneous terms, like moderately overconfident, we distinguish between highly-confident, moderately-confident, and low-confidence executives.

[10]Net stock purchases (NSP) equal purchases minus sales, both in units of shares.

baseline hazard rate using firm's survival time, proxied by the logarithm of age. We also include a number of control variables that are identified in prior research as relevant in forecasting corporate failure. In this regard, we use firms' profitability, leverage, size, market-to-book ratio (MTB) and cash holdings proxy (CASH). Moreover, we incorporate two market-driven variables that are also used in Shumway (2001), namely past stock returns (EXC. RET), and their risk (SIGMA). To control for industry-related factors that impact the likelihood of default we include individual industry effects as defined by the Industry Classification Benchmark (ICB).

Finally, to test if the board of directors restrain the influence of the CEO's behavioural bias on the probability of insolvency, we include two corporate governance dummies. Specifically, we incorporate a control for the efficient size of the board (EFFICIENT BOARD) and a control for its independence (INDEPENDENT BOARD). The definitions of all the variables used in the analysis are given in Table 2.

[INSERT TABLE 2 ABOUT HERE]

4 Empirical Results

In this section, we discuss the results of our empirical analysis of the probability of insolvency. We begin by presenting the descriptive statistics of the variables used in the analysis, followed up by a discussion on the relationship between the probability of insolvency and the degree of managerial overconfidence.

4.1 Descriptive Statistics

Table 3 presents the descriptive statistics and the comparison of means of the variables used in the hazard model for the period 2000-2015. The reported statistics for accounting and market variables are in line with the previous UK studies (Agarwal & Taffler 2008, Bauer & Agarwal 2014, Chava & Jarrow 2004). In line with expectations, firms that file for insolvency are smaller (9.858, vs. 11.643), have higher leverage (0.261 vs. 0.194), and less profitable (-0.216 vs. -0.009) than the average firm.

Similarly, the market variables reveal poor performance and greater risk for the insolvent firms, as evidenced by excess returns of -24.903 (in comparison to 2.970 for the average firm in the sample), and sigma equal to 0.207 (in comparison to 0.119 for the average firm). The average company in our sample is managed by 7 directors. 96% of the boards are efficient in size and about 53% are independent. The results reveal that insolvent firms have smaller and more independent boards[11]. Finally, the table reports the summary statistics for our measure of CEO confidence. The average ratio of overconfident managers equals 0.324, which is similar to the reported by Campbell et al. (2011). The average ratio of managers with low confidence is, however, lower than the one reported by Campbell et al. (2011). Since the confidence measures are binary variables, the mean values represent the proportion of executives classified in a particular category. That is, 41.4% of failed firms in their final year are managed by overconfident CEOs, 53.6% of the CEOs in these firms exhibit moderate confidence, while only

[11]We note that the boards of the insolvent firms may get smaller as the directors depart from the insolvency becomes more likely

5% shows low confidence characteristics. Overall, the initial analysis reveals that the CEOs of the firms approaching insolvency (at $t_{(0)}$ are more likely to be overconfident in comparison to the average degree of executive confidence exposed during the lifetime of failed firms. Put differently, overconfidence is more likely to be observed as the insolvency approaches.

We next investigate the impact of the different degrees of CEO confidence on the probability of bankruptcy by estimating and plotting the Kaplan Meier's hazard curves. The plots simply show the proportions of failed firms after each distinct failure time. The analysis time in the graph represents firm age, i.e. the number of years since the firm's IPO. In line with the statistics discussed above, we consistently observe higher hazard rates for firms managed by overconfident CEOs in comparison to the ones managed by those CEOs with moderate levels of confidence.

[INSERT TABLE 3 ABOUT HERE]

[INSERT FIGURE 1 ABOUT HERE]

4.2 Hazard models

Table 5 reports the results from various specifications of hazard models. In the first column, we estimate our baseline model with only the accounting and market variables. The estimated coefficients of the majority of the variables are significant and have the expected signs. Specifically, smaller firms and firms with higher leverage, lower profitability and past returns, and higher return volatility are associated with a greater risk of bankruptcy. These findings hold across the remaining specifications in the table.

In the second column, we extend the baseline model by adding two board characteristics, which are widely used in the extant literature on bankruptcy prediction (see, e.g., Fich & Slezak (2008), Lajili & Zéghal (2010)). In line with Kolasinski & Li (2013), and Malmendier & Tate (2008), the reported estimated coefficients suggest that efficient and independent boards are effective in protecting shareholder's interest, which in the context of this analysis would be reducing the probability of insolvency.

[INSERT TABLE 5 ABOUT HERE]

In the third and fourth columns, we test the impact of overconfident and moderately-confident CEOs. We find that the estimated coefficients of the two degrees of confidence are significant at the 1 percent level, with the expected signs. However, the low-confidence indicator is insignificant. The reported coefficients suggest that firms managed by overconfident CEOs are associated with a greater risk of bankruptcy than the remaining firms that are managed by CEOs with low or moderate levels of confidence. Also importantly, the findings show that the firms managed by moderately confident CEOs are less likely to go bankrupt.

We next move on to test if the relation between the probability of bankruptcy and the levels of CEO overconfidence is conditional on the corporate governance characteristics used in the analysis. In particular, we interact each confidence indicator separately with board size and board independence. In doing so, we are interested in testing if either of the two mechanisms is effective in restraining the adverse impact that is exerted by the overconfident managers exerts in the likelihood of bankruptcy. Table 6 reports the key re-

sults of these estimations. In models 1, 2, and 3 we present the results of the interactions of managerial confidence dummies with EFFICIENT BOARD, which is a dummy variable. We extend the analysis in models 4, 5, and 6, where the confidence variables are interacted with BOARD SIZE, being a natural logarithm of the number of directors sitting on the board. The latter group of models allows for more indepth analysis, due to the character of the interacted variable. The reported estimated coefficients imply that larger boards are effective in reducing the influence of overconfident CEOs on the probability of insolvency. The results in Model 5 reveal that the board size is also significantly associated with moderate confidence. This may imply that larger boards outnumber the CEO, and therefore the impact of individual managerial biases is less significant in influencing the probability of corporate failure.[12]

[INSERT TABLE 6 ABOUT HERE]

5 Robustness

To assure the robustness of our results we carry out further additional tests. Firstly, we examine if the inclusion of CEO overconfidence in the probability of bankruptcy specification increases the prediction accuracy. To do so, we divide our sample into two periods, i.e. 2000-2007, and 2008-2015. We then estimate the hazard models in the first period and using the estimated coefficients we predict the bankruptcies that occurred in the out-of-sample

[12]We also consider the effectiveness of the independence of the board in reducting the impact of managerial overconfidence, however we find no significant influence on the probability of bankruptcy. The results are available from the authors on request.

sub-period 2008-2015. In Table 7, we present the comparisons of the out-of-sample accuracy of the models that contain various sets of predictors. Similarly to the approach taken for the earlier hazard models in the study, we begin with the model which contains only the market and accounting variables and then proceed by adding the corporate governance variables, confidence measures , and interaction terms. The results reveal that the most accurate model is the final specification given in Table 7, where all the variables and the relevant interaction terms are incorporated in the model. This model classifies 43.66% of bankrupt firms accurately in the highest bankruptcy decile, which shows an improvement from the first model, which includes only the market and accounting data. Therefore, we confirm that introducing the managerial bias into the bankruptcy prediction model increases the predictive accuracy.

[INSERT TABLE 7 ABOUT HERE]

Secondly, in order to test our hypotheses in a larger sample, we relax the definition of managerial overconfidence. Instead of investigating the bias for the CEOs only, we explore the confidence levels of the top executive in a particular year. We classify an executive as the top one, if he is involved in trading the firm's shares and if his holdings are the largest among the executives in a year. This classification may include but is not limited by the position of the CEO. By so doing, we are able to increase the number of observations and the number of insolvencies to 9,850 and 216 respectively. Indeed, it can be argued that CEOs have a greater influence on corporate decisions, hence the expected impact on the risk of bankruptcy will be then

greater in comparison to other executives. However, we assume that the significant shareholding of the top-director makes him important in the corporate hierarchy, as well as on the board of directors. Hence, he is able to impact the policies and decisions more. As it is presented in Table 8, the results are robust to the selection of the executive. The reported coefficients confirm the earlier results that managerial overconfidence (top dir high) has a positive effect on hazard, while the moderate level of overconfidence tends to have a negative impact.

In models 4 and 5 we conduct the analysis with alternative measures of confidence as proposed by Kolasinski & Li (2013). The measure is also based on the insider dealings activity of investors. However, it is not semi-parametric and hence allows the classification of directors only in the periods when they trade. As a result, we conduct the research on a limited sample of 2,171 observations for 682 firms, out of which 55 firms defaulted during the period of analysis. Kolasinski & Li (2013) classify CEO as highly confident when they purchase their own stock and ex-post earn a negative abnormal return (over the period of the next 180 calendar days). The measure reveals that the CEO mistakenly perceived their own stock as undervalued, and hence is overconfident. The confident manager would earn a positive abnormal return. The reported results confirm our earlier findings showing that the degree of confidence is important for the bankruptcy prediction models. Further, model 4 provides supporting evidence that CEOs overconfidence is associated with greater probability of insolvency, while model 5 shows that CEOs confidence is associated with lower probability of default.

[INSERT TABLE 8 ABOUT HERE]

Finally, we consider an alternative methodology in establishing the relation between overconfidence and the probability of bankruptcy. Specifically, using the specification based only on the accounting and market predictors (as presented in model 1 of Table 5) and the sample containing 9,850 observations and 216 insolvencies, we estimate a hazard model from which we extract residuals. Next, we view the residuals as a measure of unexplained insolvency and regress the managerial overconfidence and corporate governance variables on the unexplained insolvency. Table 9 reports the obtained coefficients, which are generally in line with our previous findings.

6 Summary and conclusions

This study investigates the interaction between managerial overconfidence and the likelihood of insolvency. The main hypothesis of the study is that managerial overconfidence is an informative predictor of insolvency, where three degrees of the bias, namely low, moderate and high overconfidence, are incorporated in the empirical analysis. In so doing, the study focuses on CEOs as they are the most effective directors within firms. Additionally, we incorporate the main board characteristics to test if the board of directors moderates the adverse impact of managerial overconfidence bias on the likelihood of insolvency.

The results from the analysis support the main hypothesis that CEO overconfidence increases the risk of bankruptcy while moderate levels of overconfidence reduce it. We also find that the size of the board and its independence

reduce the degree of the adverse effects of managerial biases, irrespective of its degree. Furthermore, it seems that larger boards are more effective in reducing the detrimental impact of managerial overconfidence in comparison to the more independent ones.

In performing the empirical analysis we faced limitations created by the availability of data. Still, the incremental increase to the forecast accuracy is significant and has practical implications. The analysis of this paper shows that if CEOs are not restricted by the board of directors, their level of confidence significantly affects the probability of bankruptcy. Hence, the level of CEO's confidence should be included in the bankruptcy prediction models. The literature on the impact of managerial irrationality and personal characteristics on bankruptcy prediction is very limited. Apart from the contribution of Kallunki & Pyykkö (2013) and this study, there is virtually no evidence on the role of managerial biases in relation to the probability of bankruptcy, hence should be of interest for future research.

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7 Tables

Table 1: Insolvency Distribution

Year	No. of observations	No. of failures	Failure rate(%)
2000	87	1	1.15
2001	123	2	1.63
2002	171	3	1.75
2003	220	3	1.36
2004	239	9	3.77
2005	267	5	1.87
2006	287	10	3.48
2007	283	36	12.72
2008	251	17	6.77
2009	235	14	5.96
2010	286	6	2.10
2011	288	14	4.86
2012	289	10	3.46
2013	297	5	1.68
2014	311	4	1.29
2015	102	1	0.98
Total	3,736	140	3.43

This table reports annual distribution of insolvencies during the period of analysis. The total number of firms in the study is 940.

Table 2: Definitions of Variables

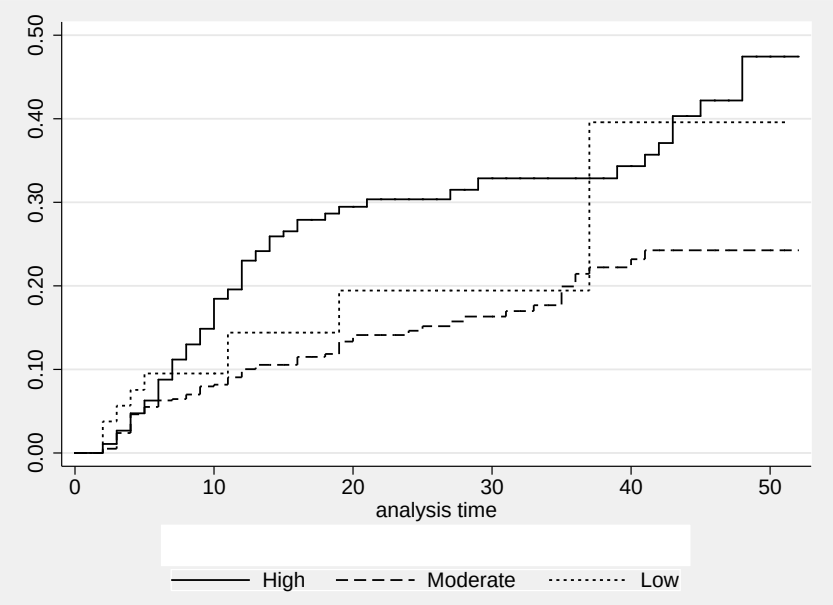
Variable name	Definition
Accounting and market variables	
PROFIT	the ratio of net income to total assets
LEV	the ratio of total debt to total assets
SIZE	the logarithm of total assets in constant prices
MTB	the ratio of total assets minus book value of equity then plus market value of equity to total assets
CASH	the ratio of cash and equivalent to total assets
EXC.RET	the return of the firm in year t minus the value-weighted FTSE index return in year t
SIGMA	the standard deviation of residuals obtained by regressing each stock's monthly returns in previous year on the FTSE ALL SHARE index return for the same year
Corporate governance proxies	
BOARD SIZE	natural logarithm of number of directors on the board
EFFICIENT BOARD	binary variable equal 1 if board size consists of more than 4 and less than 12 directors
INDEPENDENT BOARD	binary variable equal 1 if the ratio of non-executive directors to the total number of directors on the board is greater than 50%
Confidence measures	
HIGH	binary variable equal 1 if the degree of the CEO's confidence is high, and hence he may be viewed as overconfident, and zero otherwise (for more details see chapter 3.2.2)
MODRATE	binary variable equal 1 if the degree of the CEO's confidence is justifiable, and zero otherwise (for more details see chapter 3.2.2)
LOW	binary variable equal 1 if the degree of the CEO's confidence is low, and zero otherwise (for more details see chapter 3.2.2)

Table 3: Descriptive Statistics

	Panel A. Full sample			Panel B. Insolvent firms		
	Mean	*Median*	*Std. Dev.*	t_{-2}	t_{-1}	t_0
Accounting and market variables						
CASH	0.104	0.068	0.115	0.089	0.082	0.096
SIZE	11.643	11.564	1.952	10.347	10.191	9.858
LEV	0.194	0.167	0.158	0.243	0.257	0.261
MTB	1.606	1.307	1.122	1.728	1.456	1.664
PROFIT	-0.009	0.035	0.174	-0.110	-0.152	-0.216
EXC. RET	2.970	4.800	46.042	-17.188	-28.718	-24.903
SIGMA	0.119	0.098	0.080	0.191	0.171	0.207
Corporate governance proxies						
BOARD SIZE	6.910	7.000	2.104	5.829	5.574	5.393
EFFICIENT BOARD	0.965	1.000	0.184	0.329	0.383	0.336
INDEPENDENT BOARD	0.526	1.000	0.499	0.957	0.915	0.879
Confidence measures						
HIGH	0.324	0.000	0.468	0.400	0.404	0.414
MODERATE	0.577	1.000	0.494	0.514	0.543	0.536
LOW	0.099	0.000	0.299	0.086	0.053	0.050

This table reports the descriptive statistics of variables used in the hazard models. The statistics presented in panel A relate to the full sample used in the analysis from the year 2000 until 2015, containing 940 firms, out of which 140 filed for insolvency. The mean values presented in panel B relate only to 140 firms that file for insolvency during our observation. Means at t_{-2}relate to the observations two years prior to the insolvency event at t_0, and t_{-1} relate to observations of a year before the filing.

Figure 1: Hazard Curves



The graph presents Kaplan-Meier hazard curves for each of the three groups of managerial confidence, i.e. high, moderate, low. The plot shows the proportion of failed firms after each distinct failure time.

Table 4: Hazard Models

	(1)	(2)	(3)	(4)	(5)
CASH	-1.251	-0.971	-0.897	-0.907	-0.974
	(0.863)	(0.860)	(0.865)	(0.866)	(0.859)
SIZE	-0.449***	-0.399***	-0.412***	-0.419***	-0.393***
	(0.076)	(0.075)	(0.076)	(0.076)	(0.075)
LEV	2.040***	2.084***	1.966***	1.993***	2.084***
	(0.534)	(0.539)	(0.548)	(0.544)	(0.541)
MTB	-0.202***	-0.205***	-0.185***	-0.196***	-0.201***
	(0.069)	(0.065)	(0.065)	(0.065)	(0.065)
PROFIT	-1.329***	-1.292***	-1.259***	-1.287***	-1.280***
	(0.397)	(0.400)	(0.403)	(0.402)	(0.400)
EXC. RET	-0.009***	-0.009***	-0.009***	-0.009***	-0.009***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
SIGMA	5.740***	5.537***	5.363***	5.476***	5.493***
	(0.829)	(0.833)	(0.834)	(0.838)	(0.829)
EFFICIENT BOARD		-1.069***	-1.132***	-1.108***	-1.079***
		(0.331)	(0.329)	(0.331)	(0.330)
INDEPENDENT BOARD		-0.390*	-0.473**	-0.454**	-0.391*
		(0.202)	(0.205)	(0.205)	(0.202)
HIGH			0.687***		
			(0.199)		
MODERATE				-0.553***	
				(0.196)	
LOW					-0.408
					(0.443)
Constant	-0.879	-0.067	0.061	0.614	-0.081
	(0.817)	(0.841)	(0.839)	(0.873)	(0.840)
Model fit	257.801	270.598	282.236	278.532	271.529
Pseudo R^2	0.216	0.227	0.236	0.233	0.227

This table reports the results from discrete-time hazard models. The dependent variable is insolvency indicator, equal 1(0) if the firm failed (survived) during the year. The baseline hazard rate is set using the natural logarithm of firm's age. All models include industry controls in accordance to the industry classification benchmark. The models are estimated on a sample of 3,736 firm-year observations. The definitions of all variables are provided in Table 2. Model fit is the chi-square of the likelihood ratio. Standard errors are reported in parentheses. ***, **, * indicate that the estimated coefficient is significant at the 1%, 5%, and 10% levels respectively.

Table 5: Hazard Models

	(1)	(2)	(3)		(4)	(5)	(6)
EFFICIENT BOARD	-0.833**	-1.581***	-1.071***	BOARD SIZE	-0.910**	-1.985***	-1.268***
	(0.414)	(0.503)	(0.341)		(0.408)	(0.524)	(0.358)
HIGH	1.485**			EXTREME	2.520**		
	(0.649)				(1.106)		
EFFICIENT BOARD*HIGH	-0.872			BOARD SIZE*EXTREME	-1.131*		
	(0.678)				(0.656)		
MODERATE		-1.268**		MODERATE		-2.446**	
		(0.637)				(1.063)	
EFFICIENT BOARD*MODERATE		0.784		BOARD SIZE*MODERATE		1.161*	
		(0.666)				(0.629)	
LOW			-0.298	LOW			0.399
			(1.240)				(2.167)
EFFICIENT BOARD*LOW			-0.126	BOARD SIZE*LOW			-0.454
			(1.327)				(1.274)
Constatnt	-0.210	1.044	-0.088	Constatnt	-0.117	2.193**	0.425
	(0.872)	(0.939)	(0.843)		(0.972)	(1.093)	(0.894)
Age controls	Yes	Yes	Yes	Age controls	Yes	Yes	Yes
Industry control	Yes	Yes	Yes	Industry control	Yes	Yes	Yes
Model fit	283.847	279.898	271.538	Model fit	288.171	285.486	276.100
Pseudo R^2	0.238	0.234	0.227	Pseudo R^2	0.241	0.239	0.231
# firm-year obs.	3736	3736	3736	# firm-year obs.	3736	3736	3736
# insolvencies	140	140	140	# insolvencies	140	140	140

This table reports the results from discrete-time hazard models. The dependent variable is insolvency indicator, equal 1(0) if the firm failed (survived) during the year. The baseline hazard rate is set using the natural logarithm of age. All models include accounting, market, and industry controls, which are not reported for brevity. The models are estimated on a sample of 3,736 firm-year observations. The definitions of all variables are provided in Table 2. Model fit is the chi-square of the likelihood ratio. Standard errors are reported in parentheses. ***, **, * indicate that the estimated coefficient is significant at the 1%, 5%, and 10% levels respectively.

Table 6: Out-of-sample Forecast Accuracy

	(1)	(2)	(3)	(4)
Decile				
1	40.845	40.845	42.254	43.662
2	16.901	18.310	18.310	22.540
3	16.901	15.490	16.901	11.268
4	7.042	7.042	5.634	5.634
5	4.225	4.225	7.042	7.042
6-10	14.086	14.088	9.859	9.854

This table reports a comparison of the out-of-sample forecast accuracy of various hazard models. Specifically forecast 1 is of hazard model 1 in Table 5, forecast 2 is of hazard model 2 in Table 5, forecast 3 is of hazard model 3 in Table 5, forecast 4 is of hazard model 1 in Table 6. The parameters for the forecast are estimated with 2000-2007 data, and the forecasts are made for insolvencies occurring between 2008-2015.

Table 7: Additional tests

	(1)	(2)	(3)	(4)	(5)
CASH	-0.646	-0.649	-0.638	-1.337	-1.319
	(0.520)	(0.518)	(0.520)	(1.352)	(1.351)
SIZE	-0.399***	-0.388***	-0.405***	-0.445***	-0.444***
	(0.055)	(0.056)	(0.056)	(0.118)	(0.118)
LEV	1.784***	1.755***	1.814***	1.439	1.443
	(0.365)	(0.364)	(0.365)	(0.917)	(0.918)
MTB	-0.107***	-0.107***	-0.114***	-0.191**	-0.191**
	(0.041)	(0.041)	(0.041)	(0.095)	(0.095)
PROFIT	-0.768***	-0.749***	-0.787***	-1.347**	-1.331**
	(0.221)	(0.220)	(0.220)	(0.642)	(0.641)
EXC. RET	-0.009***	-0.009***	-0.009***	-0.009***	-0.009***
	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)
SIGMA	3.725***	3.763***	3.761***	4.201***	4.210***
	(0.498)	(0.496)	(0.499)	(1.266)	(1.266)
EFFICIENT BOARD	-0.316	-0.302	-0.318	-1.297**	-1.298**
	(0.253)	(0.254)	(0.254)	(0.549)	(0.549)
INDEPENDENT BOARD	-0.197	-0.172	-0.192	-0.749**	-0.755**
	(0.157)	(0.157)	(0.157)	(0.322)	(0.321)
HIGH*	0.312*			0.765**	
	(0.165)			(0.306)	
MODERATE*		-0.480***			-0.754**
		(0.158)			(0.306)
LOW*			-0.030		
			(0.248)		
Constant	-1.872***	-1.741***	-1.725***	-12.446	-10.575
	(0.664)	(0.660)	(0.660)	(1013.425)	(534.540)
Model fit	353.244	359.410	349.821	125.148	124.966
Pseudo R^2	0.176	0.179	0.174	0.244	0.244

This table reports the results from discrete-time hazard models. The dependent variable is insolvency indicator, equal 1(0) if the firm failed (survived) during the year. The baseline hazard rate is set using the natural logarithm of age. HIGH*, MODERATE*, and LOW* are measures of confidence established using alternative methodologies, which are explained in the robustness section of the paper. Model fit is the chi-square of the likelihood ratio. Standard errors are reported in parentheses. ***, **, * indicate that the estimated coefficient is significant at the 1%, 5%, and 10% levels respectively.

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