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Financial Distress as an Agency Problem: Evidence on Non-Monotonic and Substitute Discipline Effects of Leverage and Competition

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Abstract

This paper addresses two issues encountered in the empirical financial distress literature: *a-theoretical* treatment of leverage and product-market competition as predictors of financial distress hazard; and lack of attention to frailty as a potential source of bias in reported estimates. We address the first issue by postulating that financial distress is essentially a managerial effort problem, mitigated by leverage and product-market competition as substitute disciplining devices with non-monotonic effects. To address the second issue, we utilize a multi-level financial distress hazard model with frailty. Drawing on an unbalanced panel of 13,986 listed firms from 1992 - 2014, we report three novel findings: (i) the effect of leverage on financial distress hazard is inverted-U-shaped; (ii) the effect of the competition is U-shaped; and (iii) leverage and competition are substitute disciplining devices that mitigate each other's adverse effects on financial distress hazard. The predictive power of the proposed model is high, and the results remain strongly or moderately robust to various sensitivity checks.

Keywords: Financial distress; competition; leverage; hazard modelling

JEL Codes: C23; C25; C41; G30; G33.

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1 Introduction

The empirical work on financial distress hazard is rich with a wide range of modelling and estimation contributions (e.g., Altman, 1968; Taffler, 1984; Shumway, 2001; Bauer and Agarwal, 2014; Altman et al., 2017). Nevertheless, model specifications and covariate selection have remained largely *a-theoretical* (Gupta et al., 2018). The disconnect between theory and financial distress modeling implies a risk of model misspecification and makes causal inference difficult, if not impossible. We aim to address this issue by drawing on agency theory, which suggests that financial distress results from the sub-optimal managerial effort, with potential for leverage and competition to have substitute disciplining under certain conditions(Jensen, 1986; Schmidt, 1997; Aghion et al., 1999a,b).

Another issue that remains overlooked is shared frailty and whether the latter is correlated with the regressors in the financial distress hazard model. Indeed, only Gupta et al. (2018) have recently addressed this issue by taking account of frailty as a multiplicative random effect in an extended Cox model with time-varying covariates. This is a welcome step but does not address the issue of endogeneity that may arise from the correlation between frailty and predictors of the financial distress hazard. We address this issue by utilising a multi-level hazard model that allows for shared frailty and takes account of the endogeneity that may arise from the correlation between frailty and predictors of financial distress hazard.

Utilizing an unbalanced panel of 13,986 firms listed in 12 countries and observed from 1992 - 2014, we report three sets of novel evidence. First, we demonstrate that the frequency of financial distress events short of bankruptcy is inversely related to the managerial effort (positively related to managerial slack). We interpret this as *prima facie* evidence that the risk of financial distress is a by-product of the agency problem. Secondly, we establish that leverage and competition have non-monotonic discipline effects on financial distress hazard. Whereas the effect of leverage has an inverted-U shape, that of competition is U-shaped. Third, we find that leverage and competition are substitute disciplining devices in that the adverse effect of one device on the financial distress hazard is mitigated by an increase in the level of the other. We verify the robustness of these findings through a series of sensitivity checks, using different *ex-ante* financial distress event indicators, stepwise model specifications, and different firm cohorts.

The rest of the paper is organised as follows. In section 2, we provide a brief review of the empirical literature on leverage and competition as predictors of financial distress hazard. Here we identify two issues that escape scrutiny in the extant literature: (i) inadequate theoretical justification for the reported effects of leverage or competition on financial distress hazard; and (ii) inadequate attention to frailty (unobserved heterogeneity), and how the latter should be handled in hazard models. In section 3, we draw on agency theory to demonstrate why leverage and product-market competition are likely to have non-monotonic and substitute effects on financial distress hazard; and why the non-monotonic effects of financial distress hazard reflect the effects on managerial effort (or managerial slack).

In section 4, we first introduce our dataset, obtained from Thompson Reuters' Worldscope database. The estimation sample consists of 13,986 firms listed in 12 developed and emerging markets. Then, we discuss how the dynamic hazard model (proposed by Shumway (2001) and evaluated by Bauer and Agarwal (2014)) can be extended to: (i) take account of recurrent events and shared frailty at the firm level; (ii) use Mundlak (1978) corrections to take account of potential correlation between frailty and firm-level predictors of the financial distress hazard.

Our findings, summarised above, are presented in section 5 and the Appendix. We conclude in section 6 by discussing the implications of our findings for future research on financial distress events short of bankruptcy and other repeated events in the firm's life cycle, e.g., default risk or credit downgrades.

2 Issues in Empirical Work and Implications for Modelling

Empirical work on bankruptcy prediction began in the 1960s with Altman (1968)'s discriminant analysis based on the Z-score. This was followed by Taffler (1984) and Zmijewski (1984), who utilised accounting variables such as profitability (net income to total assets), leverage (total debt to total assets) and liquidity (current assets to current liquidity) as bankruptcy predictors. Findings in this early work indicates that the risk of bankruptcy increases with leverage but decreases with liquidity and profitability. The discriminant analysis has informed a large volume of empirical work evaluated in Altman et al. (2017). However, Shumway (2001) questioned its static setup, which may lead to biased estimates due to missing duration (time-

to-failure-event) in the model. Using hazard models with duration and data for US firms from 1962-1992, Shumway (2001) demonstrates that dynamic hazard models outperform the static models; and that models with both accounting and market variables are better than those based on accounting variables only (see also Campbell et al., 2008; Bauer and Agarwal, 2014).

Most of the early work focuses on bankruptcy rather than financial distress events short of bankruptcy[1]. In later work, it has been argued that predictions of financial distress events short of bankruptcy may provide useful early warning information about bankruptcy, which usually occurs after a period of repeated financial distress events (Keasey and Watson, 1991; Platt and Platt, 2006). Our work follows this line of research but complements it by addressing two overlooked issues.

One issue is the absence of a theoretical underpinning that establishes a causal link between accounting and/or market variables as the predictors and the financial distress hazard as the outcome in the empirical models (Bauer and Agarwal, 2014; Gupta et al., 2018). True, the contingent claims model provides a theoretical explanation as to why market variables are more relevant predictors of financial distress hazard (Bauer and Agarwal, 2014). However, the latter also falls short of providing an explanation as to whether the causal effect runs from market information to financial distress hazard or vice versa. In this paper, we undertake a step in that direction by developing a theoretical underpinning for two financial distress predictors investigated widely in the empirical literature: leverage and product-market competition. Drawing on agency theory, we demonstrate that financial distress hazard is essentially a managerial effort problem that can be mitigated through leverage and competition as substitute disciplining devices with non-monotonic effects.

The absence of a theoretical underpinning for the relationship between leverage and financial distress hazard is evident in 30 empirical studies that report estimates for the effects of leverage on financial distress hazard. In 29 studies, leverage enters the model as a linear term. A non-monotonic specification is adopted in only one study (Lee et al., 2011), which controls for interaction between leverage and the firm's capital intensity in the restaurant industry. In two-thirds of the reviewed studies, an increase in leverage is associated with higher hazard rates

[1]In these studies, the financial distress event is defined as a legally visible event such as liquidation or bankruptcy. The advantage of the legal definition is that the distress event can be dated objectively. In contrast, the date of an ex-ante financial distress indicator may be less precise, but its prediction provides more useful information for the parties with interest in the firm's survival.

(e.g., Platt and Platt, 2006; Campbell et al., 2008; Tinoco and Wilson, 2013; Keasey et al., 2015; Gupta et al., 2018). The hazard-increasing effect of leverage is usually explained ex post, invoking higher debt servicing costs and financial risks associated with higher levels of debt (e.g., Tinoco and Wilson, 2013). In none of these studies is there a discussion as to whether leverage may also have a hazard-reducing effect by imposing discipline on managers. Nor is there any consideration as to whether the leverage's effect on financial distress hazard may be non-monotonic, depending on the initial level leverage. The oversight here becomes evident in the light of evidence reported by the remaining one-third of the reviewed studies, where the effect is negative and significant (e.g. Altman and Sabato, 2007). In these works, the focus remains on model performance with little or no discussion as to why leverage should reduce financial distress hazard or whether the findings may be related to the agency theory of debt (Jensen and Meckling, 1976; Grossman and Hart, 1982; Jensen, 1986) [2].

We argue that the conflicting findings summarised above are symptoms of inadequate attention to the agency theory of leverage, which relates financial distress to managerial effort and evaluates the ways in which leverage may affect managerial effort and financial distress hazard at the same time. In the agency-theoretic work, the effect of leverage on financial distress hazard is non-monotonic and depends on: (i) the relative agency costs of debt and equity (Jensen and Meckling, 1976); (ii) the severity of the agency problem (Grossman and Hart, 1982; Jensen, 1986); and (iii) the initial level of leverage (Aghion et al., 1999a,b). The implication for hazard modelling is clear: the effect of leverage on financial distress hazard is inherently heterogeneous. One way in which heterogeneity can be modeled is to allow for variation in the financial distress hazard at different levels of leverage.

A similar trend is observed in the empirical work on how product-market competition affects bank fragility (e.g., Beck et al., 2013) or the distressed shareholder value in banks (e.g., Cipollini and Fiordelisi, 2012). In either line of work, competition enters the model as a linear term, without discussion as to how/whether the effect of competition may differ at different levels of competition or the latter may interact with leverage. Some of the findings indicate that market concentration (and market power) are associated with better bank solvency or stability. Most common explanations include: (i) higher market power may lead to higher

[2] Existing reviews are also silent about conflicting results and whether the latter may be due to model misspecification. See, Platt and Platt (2006); Campbell et al. (2008); Bauer and Agarwal (2014).

profits that can be used to build capital buffers and reduce failure risk; (ii) higher charter values in larger banks may deter excessive risk-taking; (iii) larger banks are better equipped to exercise better credit monitoring and rationing; and (iv) larger banks may be better able to diversify their loan-portfolio risks (Berger et al., 2009; Cipollini and Fiordelisi, 2012).

In contrast, some studies report a positive relationship between market concentration/power and insolvency (e.g., Nicoló et al., 2004; Uhde and Heimeshoff, 2009). These findings are in line with predictions of the competition-stability models(Allen and Gale, 2004), where information asymmetry is an important factor. One explanation for the competition-stability findings is that moral hazard is more severe among large bank managers who take higher risks under government safety nets. Another explanation draws attention to higher interest rates in oligopolistic markets. The argument here is that higher interest rates charged by banks with market power induce borrowers to select higher-return projects with higher risks.

Although the focus on competition as a predictor of bank fragility or distress is a welcome step, it is necessary to investigate its effect on financial distress among both banking and non-banking firms. It is also necessary to investigate whether competition, like leverage, is related to financial distress risk in a non-monotonic way. Finally, it is necessary to verify how competition interacts with alternative disciplining devices such as leverage. To address these questions, we draw on agency theoretical models, which predict that competition may mitigate or exacerbate the agency conflicts (and the financial distress risk) depending on: (i) the extent to which the manager is risk-averse (Hart, 1983; Scharfstein, 1988); (ii) whether the income effect of competition dominates its risk-adjustment effect on the manager (Hermalin, 1992); and (iii) whether the disciplining effect of competition dominates its profit-diluting effect (Schmidt, 1997).

3 Leverage, Competition, and Financial Distress: An Agency-theoretic Approach

In this section, we draw on agency theory, where the severity of the agency conflicts affects firm performance in general and the risk of financial distress in particular (Jensen and Meckling, 1976). In this perspective, financial distress risk is essentially an agency problem. The more severe the agency problem is, the lower is the managerial effort and firm performance, and the

higher is the financial distress risk. Nevertheless, neither the severity of the agency problem nor managerial effort is directly observable. Therefore, the utility of the agency theory for financial distress modeling depends on whether some observable variables provide sufficient information about managerial effort to allow for theory-based inference about their effects on financial distress hazard. Two potential candidates that satisfy this property are leverage and product-market competition.

According to the control hypothesis of debt creation (Jensen, 1986), leverage can act as a commitment device that mitigates the agency problem and reduce the risk of bankruptcy at the same time. Here, the agency problem arises when the firm generates substantial free cash flows, which induce the manager to consume perks or invest in projects with returns lower than the cost of capital. Among such firms, leverage can act as a disciplining device that corrects for weak product-market competition or corporate-market control, or both. An increase in leverage induces the manager to increase effort, improve organizational efficiency, and reduce the risk of bankruptcy. The implication for capital structure theory is that the more severe the agency problem is, the higher is the optimal level of leverage.

Nevertheless, higher levels of leverage may also increase the risk of financial distress due to increased cost of debt servicing, a lower future investment that reduces firm value, exacerbation of the agency problem between bondholders and shareholders (Jensen and Meckling, 1976; Myers, 1977). Hence, the overall effect of leverage on financial distress depends on the balance between the hazard-reducing effect due to mitigation of the agency problem and the hazard-increasing effect due to higher agency costs of debt. A similar result is derived in Grossman and Hart (1982) where the agency problem is due to dispersed ownership in an equity-financed firm rather than the availability of free cash. If the agency problem is severe due to dispersed ownership, leverage acts as a disciplining device that mitigates the agency problem and reduces the risk of financial distress. In contrast, when the firm's ownership structure is concentrated and the agency problem is less severe, an increase in leverage is less likely to act as a disciplining device on the manager. The overall effect depends on the balance between the profitability of the investment projects (i.e., the increase in managerial effort) and the cost of debt

Ambiguity about the leverage's effect on managerial effort and financial distress hazard can be resolved by considering the initial level of leverage, as demonstrated by Aghion et al.

(1999a,b). In the presence of an agency problem, a leveraged firm can be either in a 'binding' or 'shirking' regime, depending on the initial level of debt. The firm is in a shirking regime when it increases debt from a low initial level. This is because, in this state, the capacity for securing external finance is less of a concern and the scope for managerial slack is relatively high[3]. In contrast, the firm would be in a bonding regime when the initial level of outside finance is high, and the manager is under pressure to work harder to repay creditors and secure external finance when required. This work also demonstrates that the two regimes would hold when the firm is considered on its own or when it interacts with other firms in an oligopolistic environment.

The insights from Aghion et al. (1999a,b) indicate that the effect of leverage on financial distress is non-monotonic. The variation in (heterogeneity of) the effect on financial distress hazard is driven by between-firm variation in the initial level of leverage. Whilst a given increase in leverage has a hazard-increasing effect among firms with a low initial level of leverage, the same level of change in leverage has a hazard-reducing effect among forms with high levels of initial leverage. Hence, the first hypothesis (**H1**) that formalises this relationship can be stated as follows:

> *The effect of leverage on financial distress is inverted-U-shaped: the hazard rate increases with leverage when leverage increases from a low initial level but decreases with leverage when leverage increases from a high initial level.*

The inverted-U relationship in **H1** is driven by heterogeneity in the firm's initial level of leverage. Given this heterogeneity, the effect of debt creation on financial distress hazard faced by each firm depends on the gap between the firm's actual level of leverage and the optimal level that is necessary to place the firm in a bonding regime where the manager must work harder to reduce the risk of bankruptcy. Financial distress hazard would be increasing with leverage when the latter increases from a low initial level where the gap is wider. In contrast, financial distress hazard would be decreasing with leverage when the latter increases from a high initial level where the gap is *narrower*.

To the best of our knowledge, this is the first attempt at investigating whether leverage has a non-monotonic discipline effect on financial distress hazard. Although the proposed approach is novel in the context of hazard modelling, it is indeed congruent with empirical findings

[3]This is similar to findings in earlier work, where managerial slack is higher at low levels of debt finance (Myers, 1977).

indicating that: (i) survival time is longer (shorter) among new firms entering the market with higher (lower) levels of debt (Cole and Sokolyk, 2018); and (b) debt has a disciplining effect on managers and is associated with higher innovation efforts among firms with more severe agency problems (Czarnitzki and Kraft, 2009).

The second hypothesis we develop relates to the non-monotonic discipline effects of product-market competition. In Holmstrom (1982) and Nalebuff and Stiglitz (1983), the disciplining effect is due to additional information that competition makes available about relative managerial performance. An increase in competition is associated with higher effort if it increases the cost of shirking more than the cost of higher effort. On the other hand, managers may spend less effort if an increase in competition reduces the returns on higher effort more than it increases the cost of shirking. Overall, the effect is uncertain as it depends on the balance between the incentives for shirking and higher effort.

Hart (1983) proposes a hidden information model where firms are faced with a common shock transmitted via the market price and the manager's compensation depends on the firm's own profits rather than relative profits. Assuming that managers are infinitely risk-averse, Hart (1983) demonstrates that increased competition would not eliminate managerial slack altogether but would induce higher effort; and the effort will be higher as both product-market and input-market competition increases. Stated differently, managerial effort increases (hence financial distress risk decreases) as the firm faces a higher level of competition in the input and output markets. However, results in Hart (1983) hinge on the assumption of infinite risk aversion. Scharfstein (1988) relaxes this assumption and demonstrates that competition would reduce effort when the manager is risk-neutral i.e. when their marginal utility from income is strictly positive.

Conflicting results in Hart (1983) and Scharfstein (1988) raise the question of whether the conflict can be resolved when the initial level of competition is considered, and one remains agnostic about the degree of risk aversion on the manager's part. One answer is due to Hermalin (1992), who distinguishes between three effects of competition on managerial effort: an income effect, a risk-adjustment effect, and a relative-value-of-actions effect. The income effect is similar to Hart (1983): increased competition induces the manager to implement a higher level of effort in order to maintain profits and his/her own income. The risk-adjustment effect is similar to

Holmstrom (1982) and Nalebuff and Stiglitz (1983) as it depends on the relative risks associated with shirking and higher effort. Finally, the relative-value-of-actions effect reflects the increased competition's effect on the expected utility of the manager. This effect can be either positive and augment the positive income effect, or it can be negative and dampen or reverse the positive income effect.

Hermalin (1992, p. 356-357) demonstrates that the relative-value-of-actions effect complements the income effect and managerial effort increases when the manager is faced with increasing returns to effort. This is more likely to be the case when the initial level of competition is low. An increase in competition from a low initial level is associated with higher returns to effort because the competition-induced firm efficiency, the accompanying increase in firm value, and the improvement in the performance-related managerial wage are all obtained at lower costs in terms of reduced market power. When the initial level of competition is high; however, the returns to cost reduction are diminishing with higher competition and the relative-value-of-actions effect is negative. Hence, the relationship between competition and managerial effort is non-monotonic: an increase in competition from a low initial level is associated with higher managerial effort whereas an increase in competition from a high initial level is associated with lower managerial effort.

In a similar vein,Schmidt (1997)) also demonstrates that the effect of competition on managerial effort and financial distress risk depends on the balance between two opposing effects: (i) a disciplining effect that induces managers to exercise higher effort to avoid bankruptcy; and (ii) a profit-diluting effect that reduces the value of cost reduction for the principal, who would be less willing to incentivize the manager though a compensation level above the latter's reservation utility. The disciplining effect of competition is maximised at an intermediate level, up to which managerial effort increases and financial distress risk falls with competition and beyond which managerial effort decreases and financial distress risk increases with the competition[4]. Given the theoretical insights from Hermalin (1992) and Schmidt (1997), we state our second hypothesis (**H2**) as follows:

[4]As stated in Schmidt (1997, p. 194),"...starting from a monopoly, managerial effort increases when we move to a duopoly, but will eventually decrease as additional competitors enter the market."

The effect of competition on financial distress hazard is U-shaped: the hazard rate decreases with competition at low initial levels where the disciplining effect of competition dominates but decreases with competition at high initial levels where the profit-diluting effect dominates.

Naturally, and perhaps inevitably, the analysis above raises the question of whether the discipline effects of leverage and competition are complementary or substitutes. This question is discussed in Aghion et al. (1999b), who incorporate agency considerations into a Schumpeterian growth model with the competition, innovation, and debt accumulation. In that work and in Aghion et al. (2002), product-market competition, leverage, and corporate governance quality are substitute incentive mechanisms if an agency problem exists. In the presence of agency conflicts, either leverage or product-market competition can be used as a discipline/commitment device when the other is not available or ineffective.

If, for example, leverage is ineffective in inducing the manager to act as a profit maximiser due to uncertainty of the returns on effort and/or innovation, then product-market competition can act as a substitute disciplining device that reduces managerial slack, speed up innovation and growth, and hence reduce the risk of financial distress. However, when the leverage-induced discipline is fully effective, i.e., when the manager is already a profit-maximiser and managerial slack does not exist, an increase in competition may increase financial distress hazard as the profit-diluting effect of competition dominates its effort-inducing effect.

The combination of the Schumpeterian perspective with insights from the agency theory indicates that product-market competition and debt accumulation are substitute discipline devices if agency costs exist i.e. if the manager is a 'satisficer' rather than profit maximiser. Hence, we state our third research hypothesis (**H3**) as follows:

The effects of competition and leverage on financial distress hazard can be either complementary or substitutes, depending on the degree of managerial slack. The effects are substitutes if the agency problem is important, but they are complements if the agency problem is mild or non-existent.

Given the central role that the agency problem plays in the analysis above, we use two proxies of the unobservable managerial effort to verify if agency costs exist and are correlated with financial distress risk: the ratio of operating expenses to net sales and the ratio of net sales to total assets. Whilst the first proxy measures the management's effectiveness in keeping the

firm's operating costs low, the second measures the management's effectiveness in deploying the firm's assets to generate sales revenue (Ang et al., 2000; Garanina and Kaikova, 2016). Both measures are in line with the conceptual construct in Jensen and Meckling (1976); and have been used in empirical work by Ang et al. (2000), Garanina and Kaikova (2016), and others.

4 Data and methodology

Our data is from Thompson Reuters' *Worldscope* database, which provides financial statement and profile data. Worldscope data collection templates take account of variation in accounting conventions and are designed to facilitate comparisons between firms within and across countries (Worldscope, 2013). The variables are defined in Table A1 in the Appendix. Recent work drawing on Worldscope data include Guedhami et al. (2014) and Vasilescu and Millo (2016). Nevertheless, it must be stated that the use of commercial databases, including Worldscope and Compustat, remains subject to caveats highlighted in previous evaluation studies [5].

As indicated above, we use ex-ante measures of financial distress events that provide early warning information about eventual bankruptcy. This contrasts with earlier empirical work, which relied on a legally-defined financial distress event (FDE) indicators such as occurrence of bankruptcy or filing for bankruptcy. The advantage of the legal FDE indicators is certainty. However, more recent work argues in favour of ex-ante FDE indicators of financial performance for three reasons. First, often a significant time gap exists between 'economic' and 'legal' default dates, which can be up to three years depending on the legal regime. Secondly, bankruptcy law provisions differ between countries and this raises comparability issues. Third, focusing on economic/financial indicators of distress instead of the latter's legal consequences allows for obtaining early warning information concerning the risk and predictors of financial distress (Pindado et al., 2008; Tinoco and Wilson, 2013; Keasey et al., 2015; Gupta et al., 2018).

Therefore, in this study, we rely on binary ex-ante FDE indicators based on economic/financial performance criteria. Because such indicators are approximations to true bankruptcy in the population (Platt and Platt, 2006), we provide estimations based on three different FDE indicators used in the empirical literature, as defined below:

[5] See, for example, Ulbricht and Weiner (2005); Lara et al. (2006).

- FDE1 = 1 if the interest coverage ratio (EBIT/interest expense on debt) is less than 0.8 for 2 consecutive years and market value growth is negative for two consecutive years; and 0 otherwise. This FDE indicator is similar to Platt and Platt (2006), Pindado et al. (2008), Tinoco and Wilson (2013), Inekwe et al. (2018), Fernández-Gámez et al. (2020), and Li et al. (2020) among others.
- FDE2 = 1 if EBITDA is less than interest payment, EBIT is negative and Net Income is negative for 2 consecutive years; and 0 otherwise. This indicator is similar to Platt and Platt (2006), Pindado et al. (2008), and Keasey et al. (2015).
- FDE3 = 1 if EBITDA is less than financial expenses, the net worth/total debt is less than one, and the net worth growth is negative for two consecutive years; and 0 otherwise. This indicator is similar to Keasey et al. (2015) and Gupta et al. (2018).

Our preferred indicator is the one-year-forward value of $FDE2$, based on the predictive power of the baseline model estimated with three alternative measures. The estimation sample based on FDE2 consists of 13,986 publicly listed firms in 73 two-digit SIC industries (including finance) observed over 23 years (1992-2014). It excludes observations in the top and bottom percentiles of the total asset distribution as potential outliers. It also excludes firm-year observations where leverage (defined as the ratio of total debt to total assets) is greater than one. The annual distribution of the distressed and distress-free firms in the estimation sample is presented in Table 1.

Over the estimation period, 11.66% of the firms experience one or more financial distress events. The percentage of financial distress events was above average around the dot-com bubble crisis (2000-2004), and during the global financial crisis (2007-2010). This pattern provides *prima facie* evidence that the informational content of our FDE indicator is pertinent as the financial distress risk is higher in the run up to and during downturns in the business cycle.

The distribution of distressed and distress-free firms by country is reported in Table A2 in the Appendix, where we observe that the percentage of financially distressed firms is the highest among two English-Law-Origin countries: The United Kingdom (13.13%) and United States (17.80%). These are followed by continental European countries such as France and Germany (around 6-7 %) and emerging markets (Brazil and Turkey) around 4-5 %. The lowest frequency of financially distressed firms (1.8%) is observed in Austria.

The main hazard predictors we study here are leverage and its square, product-market competition and its square, the interaction between leverage and competition, and duration

Table 1: **Distribution of Distressed and Distress-Free Firms by Year**

Year	Total observations in year	Not Financially Distressed	Financially Distressed	Percentage of Financially Distressed
1992	1390	1331	59	4.24 %
1993	1508	1448	60	3.98 %
1994	1623	1571	52	3.20 %
1995	1781	1740	41	2.30 %
1996	2261	2161	100	4.42 %
1997	2702	2568	134	4.96 %
1998	3008	2812	196	6.52 %
1999	3395	3076	319	9.40 %
2000	4032	3528	504	12.50 %
2001	4520	3862	658	14.56 %
2002	4806	4050	756	15.73 %
2003	5147	4348	799	15.52 %
2004	5487	4771	716	13.05 %
2005	5840	5117	723	12.38 %
2006	6327	5583	744	11.76 %
2007	6660	5854	806	12.10 %
2008	7955	6984	971	12.21 %
2009	8257	7106	1151	13.94 %
2010	8518	7463	1055	12.39 %
2011	8859	7849	1010	11.40 %
2012	9250	8155	1095	11.84 %
2013	9704	8568	1136	11.71 %
2014	10897	9535	1362	12.50 %
Total	123927	109480	14447	11.66 %

Notes: Based on the estimation sample estimated with the preferred financial distress event indicator, FDE2. FDE2 = 1 if EBITDA is less than interest payment, EBIT is negative and Net Income is negative for 2 consecutive years; and 0 otherwise. FDE2 is preferred on the basis of area under the ROC curve statistic. Summary statistics for samples based on two other FDE indicators are not reported here to save space but can be provided on request.

(time to event) and it's square. $LEVERAGE$ is the ratio of total debt to total assets of firm j in year t ($TDTA_jt$). We limit the maximum leverage ratio to 1, but we conduct sensitivity checks with higher ratios of up to 2. Our competition measure, $COMPETITION_{jt}$, is a firm-level measure defined as one minus the Lerner index of the firm j in year t. In turn, the Lerner index is the ratio of earnings before interest and taxes ($EBIT$) to net sales. $COMPETITION_{jt}$ indicates the lowest level of competition (full market power) when it is 0, perfect competition when it is 1, and imperfect competition in between. Formally:

$$COMPETITION_{jt} = 1 - \frac{EBIT_{jt}}{NET.SALES_{jt}} \tag{1}$$

There is a long-standing debate on how to measure product-market competition (see,

Boone, 2008; Elzinga and Mills, 2011). Concentration measures such as the Herfindahl-Hirschman index (HHI) or market share of the top m firms are popular measures used by competition policy authorities, but they lack theoretical underpinnings that relate concentration to market power; and require correct definition of the market in question. On the other hand, competition measures based on the Lerner index (the price-cost margin) are based on microeconomic theory but have been criticized for failing to distinguish between deviations of the price from the marginal cost due to price setting from the deviations that may be due to efficiency.

Boone (2008) correct for the possible conflation of the two sources of deviation by developing a competition measure based on relative profit differences. However, the evidence on its performance relative to the Lerner index is mixed. Whilst van Leuvensteijn (2014) report evidence of better performance by the Boone index, Schiersch and Schmidt-Ehmcke (2010) report that the traditional Lerner index performs better. Furthermore, the Boone index does not have a benchmark. This is in contrast to the Lerner index, which allows for identifying perfect competition, absolute monopoly and some intermediate levels of market power in between. Therefore, we prefer the product-market competition indicator in (1).

DURATION is constructed to reflect the length of the episode that elapses until a firm experiences financial distress. For firms that experience a single financial distress event (FDE) over the time dimension of the data (1990-2014), duration begins with the first year in which the firm is observed and ends in the year before the firm becomes financially distressed. If the firm experiences more than one FDEs, we construct episode-specific durations: one for each episode that begins with a non-FDE status and lasts until the firm enters financial distress. We take account of the dependence between the firm-specific durations through multi-level hazard models, where duration dependence is modeled as shared frailty (Steele, 2011).

Although the main interest in this paper is non-monotonic effects of leverage and competition on financial distress hazard, we verify the stability of the hazard estimates to the inclusion of market-based and accounting variables as well as industry/macro level indicators such as growth volatility, lending rates, and business cycles. Following Shumway (2001) and Bauer and Agarwal (2014), we control for two market-based performance indicators, relative to industry and country averages. The relative book-to-market ratio ($REL.BMR_{jt}$) measures the firm's book-to-market ratio relative to the country/industry average in year t. The other

market-based covariate, $REL.BETA_{jt}$, measures the firm's stock price volatility relative to market volatility in each country. This measure is based on the firm's market beta reported in *Worldscope*.

The accounting-based variables also reflect common practice in the literature and include relative returns on assets ($REL.ROA_{jt}$) and relative current ratio ($REL.CURR_{jt}$), both of which are constructed relative to the country/industry average in year t. $REL.ROA_{jt}$ is a measure of profitability whereas $REL.CURR_{jt}$ is the measure of liquidity that reflects the firm's ability to pay short-term obligations.

In the financial distress literature, only few studies have investigated the impact of industry and macroeconomic factors on financial distress hazard (e.g. Koopman and Lucas, 2005). Industry and macroeconomic factors are usually overlooked on the grounds that firm performance indicators already reflect the changes in the industry and macroeconomic conditions. Yet, there is a rich literature that investigates the relationship between macroeconomic conditions and corporate default risk (see, Carling et al., 2007). Findings in this literature indicate that industry and macroeconomic factors are significant predictors of credit risk and/or corporate default risk. In other words, firm-level performance indicators may not provide the full set of information that is necessary to estimate hazard rates correctly. Furthermore, if industry and macro-economic factors do provide additional information, one would expect the firm-level indicators to be less precise predictors of financial distress hazard.

Therefore, in this paper, we control for industry and macroeconomic factors that are likely to affect financial distress risk independently of (or in addition to) the agency problem. These include: (i) the standard deviation of the firm growth rates by country, industry and year ($GROWTH.SD.IND_{ckt}$); (ii) the growth rates of real GDP by country and year($GROWTH.GDP_{ct}$); (iii) country- and year-specific lending rates to business ($BUS.LEND.RATE_{ct}$); and (iv) a binary indicator that captures two crisis episodes: the bursting of the dot.com bubble from 2001-2002 and the global financial crisis from 2008-2010. The macroeconomic variables ($GROWTH.GDP_{ct}$ and $BUS.LEND.RATE_{ct}$) are from the World Bank's Open Data site[6]. Further information about the variables is provided in Table A1 in the Appendix.

Finally, we use two proxy measures for agency costs to verify the severity of the agency

[6]https://data.worldbank.org/, accessed several times in 2019.

problem and whether it is correlated with financial distress risk. The first ($AGENCY.COST1$) is the ratio of operating expenses to net sales revenue. It measures the management's effectiveness in minimizing the firm's operating costs, which include excessive perquisite consumption and other agency costs such as administrative and overhead costs (Ang et al., 2000). The higher is the ratio, the more severe is the agency problem. The second measure ($AGENCY.COST2$) is the ratio of net sales to total assets, which measures the management's effectiveness in deploying the firm's assets to generate sales revenue (Ang et al., 2000; Garanina and Kaikova, 2016). The higher is the ratio, the less severe is the agency problem. We proceed to estimate the effects of leverage and competition on financial distress hazard only after we verify if higher levels of agency costs are associated with higher frequency of financial distress events.

Our hazard modelling strategy builds on Shumway (2001), who demonstrates that dynamic hazard models that take account of duration (time to event) are more appropriate than discriminant analysis or static models of financial distress (see also, Chava and Jarrow, 2004; Campbell et al., 2008; Bauer and Agarwal, 2014; Gupta et al., 2018). We extend the dynamic hazard model by taking account of firm-specific frailty that may be due to duration dependence and/or unobserved firm characteristics; and by correcting for potential correlation between unobserved frailty and the firm-level regressors in the hazard model.

Unlike Gupta et al. (2018), who control for frailty as a multiplicative term, we take account of frailty through a multi-level modelling approach in which shared frailty is an additive random-effect term. Our modelling framework is informed by Steele (2011), who demonstrates how multi-level models (MLMs) can be used to take account of within-firm dependence. MLMs accommodate within-firm dependence between recurring financial distress events by nesting the financial distress episodes within the firm instead of treating them as realizations of independent events. Steele (2011) demonstrates that the likelihood function for a single-level discrete-time hazard model can be generalized to clustered (i.e., multi-level) data. In other words, binary outcome variables that indicate whether an event is observed or not can be used to estimate hazard rates even if the events are recurrent. This is ensured by taking account of within-firm dependence when the firms experience recurrent financial distress events.

Hence, in a two-level hazard model where firm j can be either in a distress-free or financial distress episode ($i = 1, 2$), the probability that a financial distress event occurs in interval t can

be stated as follows

$$P_{tij} = P(y_{tij} = 1 | y_{t'ij} = 0 \text{ for } t' < t) \tag{2}$$

where P_{tij} is the probability that a financial distress event (FDE) occurs. The observed outcome variable, y_{tij}, is a binary indicator that is 1 if the firm is in financial distress (i.e., if it satisfies the conditions for one of the financial distress events defined above); and 0 otherwise. The episode (state) indicator $i = [1, 2]$ indicates whether the firm is distress-free (1) or it is in a financial-distress state (2). Finally, t is the year in episode i.

If the firm is in a distress-free state to start with (i.e., if $i = 1$), the observed outcome, y_{tij}, can be considered as a 'trial', where the probability of 'success' (the probability that the financial distress event occurs) is P_{tij} and the probability of 'failure' (no event) is $1-P_{tij}$ (Steele, 2011). On the other hand, if the firm is in a financial-distress state to start with (i.e., if $i = 2$), P_{tij} is the probability that the firm recovers from financial distress.

We are interested in the probability of the firm lapsing into financial distress, taking into account the possibility that different firms may have different histories financial distress events (FDEs) with different patterns of recurrence. To estimate the probability of financial distress among firms with a different histories of recurring financial distress events, we propose a two-level hazard model where within-firm frailty is modeled as firm-specific intercepts (u_{0j}) and slopes (u_{1j}). In this two-level setup, the firm/year observations of the distress event indicator (level 1) are nested within the firm (level 2). Hence, the probability of financial distress hazard (P_{tij}) with shared frailty at the firm level can be stated as a function of a baseline hazard $[D_{tij} = 1, t, t^2]$, a vector of firm-level explanatory variables (X_{tij}), and two random-effect terms that capture intercept heterogeneity (u_{0j}) and slope heterogeneity (u_{1j}):

$$g(P_{tij}) = \alpha D_{tij} + \beta X_{tij} + u_{0j} + u_{1j} \tag{3}$$

In (4), g(.) is a link function that can be a probit, logit or complementary loglogistic (*cloglog*) link[7]. On the other hand, $D_{tij} = [1, t, t^2]$ is the baseline line hazard that is a quadratic function of the time-to-event (i.e., duration). Finally, shared frailty (u_{0j} and u_{1j}) captures

[7] A probit link function can also be chosen if one assumes that the underlying distribution of the financial distress event is normal; or if it reflects a proportion of the population but not a binary outcome (Gupta et al., 2018). We do not use probit as a link function, but trials with a probit link function yield similar results. The latter are not reported here to save space, but they are available on request.

unobserved firm characteristics that determine the firm's frailty - i.e., its proneness to experience financial distress and hence the dependence between the financial-distress events it experiences. In (4), frailty is modeled as firm-specific random intercepts and slopes, with the implication that the baseline hazard rates are firm-specific. Combining Shumway (2001) with Steele (2011), the survival function of a multi-level hazard model with a logit link function can be stated as follows:

$$\mathcal{S}(t_{ij}, X_{tij}, u_{0j}, u_{1j}; \beta) = 1 - \sum_{\tau<t} f(t_{ij}, X_{tij}, u_{0j}, u_{1j}; \beta) = 1 - F(t_{ij}, X_{tij}, u_{0j}, u_{1j}; \beta) \tag{4}$$

Conversely, the hazard function ($\mathcal{H}$) indicates the probability of failure (financial distress) given that the firm has survived until t and can be stated as follows:

$$\mathcal{H}(t_{ij}, X_{tij}, u_{0j}, u_{1j}; \beta) = \frac{f(t_{ij}, X_{tij}, u_{0j}, u_{1j}; \beta)}{\mathcal{S}(t_{ij}, X_{tij}, u_{0j}, u_{1j}; \beta)} \tag{5}$$

Assuming a logit link function as Shumway (2001) does, parameter estimates (β) can be obtained by maximizing a multi-period likelihood function of the following form:

$$\mathcal{L} = \prod_{j=1}^{N} [\mathcal{H}(t_{ij}, X_{tij}, u_{0j}, u_{1j}; \beta)^{y_{tij}} \prod_{\tau<t_{ij}} (1 - \mathcal{H}(t_{ij}, X_{tij}, u_{0j}, u_{1j}; \beta))] \tag{6}$$

As indicated above, the existing work on financial distress hazard tends to overlook the issue of shared frailty, with the notable exception of Gupta et al. (2018) who control for shared frailty through a multiplicative scaling factor with Gamma distribution. In agreement with Gupta et al. (2018), we model shared frailty explicitly. Nevertheless, we adopt an additive frailty term, distributed normally with a mean of zero and a fixed variance. We model frailty as study-specific random intercepts (u_{0j}) and random slopes (u_{1j}). Stated differently, the effect of leverage and competition on financial distress hazard differs across studies and the variation is due to two sources. The first is the deviation of the study-specific effect from the average effect and modelled as a random intercept distributed normally with zero mean and constant variance - i.e. $u_{0j} \sim N(0, \sigma_0^2)$. The second is modelled as a random slope where the effect of leverage and/or competition on financial distress differs between studies as the level of the regressor increases. This random-slope effect is also distributed normally with a constant variance that

capture the between-study variation - i.e., $u_{1j} \sim N(0, \sigma_1^2)$.

Our second extension to the dynamic hazard model is to take account of potential endogeneity that may arise due to correlation between frailty, u_{0j} or u_{1j}, and the firm-level predictors of the financial distress hazard, X_{tij}. To address this issue, we follow Mundlak (1978) to test if frailty is correlated with the regressors. If correlation exists, we augment the multi-level hazard model with within-firm averages of the firm-level regressors (i.e., Mundlak corrections) to ensure mean independence between frailty and the regressors (Wooldridge, 2010; Greene, 2003). Although Mundlak corrections require time averages in the population, simulation studies report that estimates based on within-firm averages in the sample yield unbiased coefficient estimates (Grilli and Rampichini, 2011).

We estimate the baseline model in (7) below with 7 covariates: leverage and its square to test for **H1**, competition and its square to test for **H2**, an interaction term between leverage and competition to test for **H3**, and duration and its square to take account of the time to event. In all estimations, we include a full set of year dummies (δ_t) as recommended by (Wooldridge, 2010, p 332). Finally, we use one-year-forward FDE indicators to reduce the risk of simultaneity and allow for early-warning information from the hazard model. The baseline model and the stepwise augmentations of the latter with market, accounting and industry/macro variables can be stated as follows:

$$\begin{aligned} FDE_{t+1,j} =& \beta_0 + \beta_1 LEVERAGE_{tj} + \beta_2 LEVERAGE_{tj}^2 + \beta_3 COMPETITION_{tj} + \beta_4 COMPETITION_{tj}^2 \\ &+ \beta_5 (LEVERAGE \times COMPETITION)_{tj} + \beta_6 DURATION_{tj} + \beta_7 DURATION_{tj}^2 \\ &+ \sum_i \beta_{8i} MRKT.PERF + \sum_i \beta_{9i} ACCT.PERF + \sum_i \beta_{10i} IND.MACRO \\ &+ \delta_t + u_{0j} + u_{1j} + w_{tj} \end{aligned} \tag{7}$$

Here, $LEVERAGE$, $COMPETITION$ and $DURATION$ are leverage, competition and duration respectively. $MRKT.PERF$, $ACCT.PERF$ and $IND.MACRO$ include the market, accounting and industry/country covariates, as described above. The frailty terms specified as firm-specific random intercepts (u_{0j}) and slopes (u_{1j}); and an idiosyncratic error term (w_{tj}). The augmented model is estimated in a stepwise manner, adding one set of regressors at a time.

We conduct likelihood ratio ($\mathcal{LR}$) tests after each estimation to verify the correct spec-

Table 2: **Hypotheses and expected coefficient signs**

Hypothesis	Expected coefficient sign
H1: Nonmonotonic leverage effect (inverted-U)	$\beta_1 > 0$; $\beta_2 < 0$
H2: Nonmonotonic competition effect (U-shaped)	$\beta_3 < 0$; $\beta_4 > 0$
H3: Substitutability of leverage and competition	$\beta_5 < 0$

ification of the frailty as a random-effect component. First, we establish whether inclusion of frailty as a random intercept is preferable to so-called fixed-effect-only (restricted) specifications. Then we also test whether frailty should be modelled as random-intercepts only or as random-intercepts and random-slope specification. The test results indicate that the inclusion of frailty (i.e., multi-level modelling) is preferable; and that frailty should be modelled study-specific random-intercepts at the firm level combined with study-specific random slopes for $LEVERAGE$ within each firm. Finally, we compare the multi-level model estimations with alternative link functions (logit, probit and complementary log logistic) to verify the link function that yields better log-likelihood (LL) and information criteria values. These checks indicate that the multi-level model with a logit link ensures better fit than those with probit or clog-log links.

Coefficient estimates in the baseline model (β_1 through β_7) indicate whether a unit increase in the covariates is conducive to higher or lower probability of financial distress. Because the effect of duration (time to event) is controlled for, the probabilities can be interpreted as hazard rates. Furthermore, the coefficient estimates for leverage, competition and duration (β_1 through β_5 in Table 2) can be interpreted as causal effect sizes as they are purged of confounding effects of frailty through Mundlak (1978) corrections.

We also conduct U-tests to verify if the turning points for the hazard effects are significant and occur within the data range in the sample. For this, we draw on Lind and Mehlum (2010), who identify the necessary and sufficient conditions for the validity of the extremum points in quadratic models. The procedure not only tests for correct sign of the linear and quadratic terms, it also calculates a Fieller interval for the extremum point to verify if the interval lies within the data range.

To verify the robustness of the hazard estimates to different FDE definitions, we estimated the baseline model with three different FDE indicators and choose the indicator that yields the best diagnostic values in terms of $\mathcal{LL}$, area under the receiver operating characteris-

tic curve (AUC) values,. The results indicate that the *one-year-forward financial distress event 2* ($FDE2_{t+1}$) is preferable. The second set of sensitivity checks involves stepwise estimations, where we augment the baseline model with accounting, market and industry/macro-level covariates. The results indicate that the hypothesized non-monotonic and substitution effects remain robust, and the predictive capacity of the augmented models is only marginally better than the parsimonious baseline model. As a third set of sensitivity checks, we have estimated the baseline model with different firm cohorts, using samples of non-financial and non-utility firms, firms in countries with English Law origin, US and non-US firms, and samples that include highly leveraged firms with leverage ratios greater than 1. The results indicate that the non-monotonic effects of competition and the effects of leverage and competition as substitute discipline devices remain robust in all samples, but the non-monotonic effect of leverage disappears when the number of highly-leveraged firms increases in the sample.

5 Results

We first report descriptive evidence indicating that the frequency of financially distressed firm/year observations are positively correlated with the severity of the agency problem (Table 3). As we move up the deciles of $AGENCY.COST1$ (proxied by operating expenses / net sales), managerial slack increases and so does the frequency of the financial distress events. In contrast, as we move up the deciles of $AGENCY.COST2$ (proxied by net sales /total assets), managerial effort increases, and the frequency of the financial distress events falls. These correlations indicate prima facie evidence that firms are heterogeneous in terms of managerial effort (agency costs), and the proxies of the latter are correlated with financial distress event frequency as predicted by agency theory. This finding also indicates that the postulate that financial distress hazard is essentially a managerial effort problem is compatible with the evidence in the sample.

We now turn to the effects of leverage and competition on financial distress hazard reported in Table 4. The preferred FDE indicator is $FDE2$ in the second column. The preference for $FDE2$ is based on the area under the receiver operating characteristics curve (AUC) value of 94.4% when prediction is based on full information from the multi-level model; and an AUC of 87.1% when prediction is based on fixed-effect components only. The full-information AUC value from our baseline model is better than AUC values in Gupta et al. (2018), who estimate

Table 3: Frequency of Financial Distress Events by Deciles of Managerial Effort Proxies

Agency cost deciles	Mean $AGENCY.COST1$ in decile	Frequency of financial distress events (%)	Mean $AGENCY.COST2$ in decile	Frequency of financial distress events (%)
1	0.649	1.9	0.102	34.1
2	0.817	1.6	0.318	17.2
3	0.870	1.6	0.504	12.1
4	0.902	1.9	0.668	9.2
5	0.926	2.0	0.825	7.8
6	0.948	3.0	0.985	6.5
7	0.969	4.3	1.162	5.9
8	0.998	9.2	1.386	6.8
9	1.102	26.2	1.735	7.1
10	40.222	65.0	3.341	1.0

Notes: The financial distress event indicator is FDE2 as defined in section 4 above. The agency problem is more severe as $AGENCY.COST1$ (Operating expenses over net sales) increases; but it is less severe as $AGENCY.COST2$ (net sales over total assets) increases. The patterns of association between the mean value of the agency cost in the decile and the frequency of financial distress events also holds for $FDE1$ and $FDE3$. The latter are not reported here to save space, but they are available on request.

several hazard models using a large set of market- and accounting-based variables. Furthermore, both the full-information and fixed-effect-only AUC statistics for our baseline model are higher than those reported in Bauer and Agarwal (2014), whose models also include market- and accounting-based regressors.

Continuing with the bottom half of Table 4, we observe that the intercept for the baseline hazard function (captured by the 'average' estimate for the constant term) is firm specific. The variance of the intercepts for the firm-specific baseline hazard functions is 0.0886 for $FDE1$, 3.507 for $FDE2$ and 2.445 for $FDE3$. These findings indicate that firms are heterogenous with respect to baseline hazard they face after controlling for managerial effort, accounting/market variables and industry/macroeconomic environment. Similarly, the conditional effect of leverage on financial distress hazard is even more heterogenous, as indicated by variances of 7.786 for $FDE1$, 11.835 for $FDE2$ and 9.783 for $FDE3$. These findings indicate that the 'average' estimates reported in the top half of Table 4 are only part of the picture. The other part of the picture is that firms are inherently heterogenous with respect to: (a) the baseline hazard they face; and (b) the effects of leverage on financial distress hazard

Secondly, the likelihood ratio ($\mathcal{LR}$) tests indicate that the multi-level model with random intercepts for the baseline hazard and random slopes for leverage is preferable to restricted alternatives that overlook the nested nature of the data. The evidence of heterogeneity and the $\mathcal{LR}$ tests results indicate the multi-level hazard model provides more reliable average (fixed-effect)

Table 4: Non-Monotonic and Substitute Discipline Effects of Leverage and Competition: Baseline Results with Alternative Financial Distress Events (FDEs)

Dependent variable:	$FDE1_{t+1}$	$FDE1_{t+2}$	$FDE1_{t+3}$
LEVERAGE (TDTA)	3.049***	1.075*	11.24***
	(0.597)	(0.615)	(0.865)
LEVERAGE.SQ	-2.770***	-1.185***	-8.035***
	(0.466)	(0.398)	(0.632)
COMPETITION: (1 - firm Lerner index)	-3.357***	-8.239***	-1.125*
	(0.552)	(0.546)	(0.661)
COMPETITION.SQ	3.752***	7.823***	1.662***
	(0.456)	(0.471)	(0.457)
LEVERAGE×COMPETITION	-2.039***	-1.091*	-1.643**
	(0.515)	(0.565)	(0.640)
DURATION	0.222***	0.230***	0.373***
	(0.013)	(0.014)	(0.017)
DURATION.SQ	0.006***	0.004***	0.003
	(0.000)	(0.001)	(0.001)
CONSTANT	1.279***	3.037***	-1.676***
	(0.324)	(0.490)	(0.414)
Extremum point for leverage	0.550***	0.454*	0.699***
Extremum point for competition	0.447***	0.527***	0.338**
Between-firm variance of	0.886***	3.507***	2.445***
the random intercepts	(0.932)	(0.177)	(0.261)
Between-firm variance of	7.786***	11.835***	9.783***
the random slopes	(0907)	(1.217)	(1.195)
Firm/year observations	140080	123927	155085
Firms	14554	13986	16088
Log-likelihood: Multi-level model	-21429.1	-24029.2	-17084.0
LR test (chi2):	6195.2	6173.6	4236.9
H_0: Restricted model is nested within multi-level model			
p>chi2	0	0	0
Intra-firm correlation	0.212	0.516	0.426
AUC Incl. random effects	0. 857	0.944	0.901
AUC Fixed effects only	0. 809	0.871	0.840

Notes: The dependent variable is one-year-forward financial distress event (FDE) indicator, as defined in section 4 above. Log likelihood values for the restricted model are from a random-effect logit link. The null hypothesis in the likelihood ratio ($\mathcal{LR}$) test is that the restricted model is nested within the multi-level model, and this is rejected in all columns. Intra-firm correlation indicates the correlation of the financial distress episodes within the firm. All estimations include a full set of year dummies and Mundlak corrections, which are not reported here to save space. $DURATION$ is time-to-event in years and is episode-specific. It is the number of years in a single episode that precedes a non-recurrent FDE or in each of the episodes that precede recurrent FDEs. Robust standard errors in parentheses.*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

estimates for leverage and all other regressors by taking account of between-firm heterogeneity and the nested nature of the data at hand. It also provides information that goes beyond 'average' hazard estimates for a 'representative firm' that may or may not exist and allows for comparing each firm with rest of its peers in the sample. Finally, the within-firm correlation of the financial distress event observations is positive (around 0.5) and highly significant. This finding indicates that firms tend to *sui generis* financial distress histories, which require the use of a multi-level modeling framework that takes account of within-firm correlation of financial distress events as shared frailty.

Returning to coefficient estimates in the top half of Table 4, we observe that the results are fully consistent with hypotheses sets of **H1**, **H2** and **H3**. Consistency is observed with respect to linear, quadratic and interaction terms for leverage and competition. Furthermore, the results indicate that financial distress hazard increases exponentially with duration i.e., the time that the firm spends in a distress-free state.

Focusing on the preferred financial distress event indicator ($FDE2$), we observe that the effect of leverage on financial distress hazard is inverted-U-shaped; and that of competition is U-shaped. Furthermore, the interaction effect indicates substitution. In line with the agency-theoretic prediction, the hazard-increasing effect of leverage is observed when the initial level of leverage is low, the firm is in a 'shirking' regime, and the disciplining effect on managerial effort is weak. Conversely, the hazard-reducing effect is observed when the initial level of leverage is high, the firm is in a 'bonding' regime, and the disciplining effect is strong. These results are consistent with Aghion et al. (1999a,b), where leverage does not mitigate the agency problem if it increases from a low initial level but does mitigate the agency problem if it increases from a high initial level.

In the case of competition, the disciplining effect is strong when the initial level of competition is low and the returns to cost reduction through increased managerial effort are high; but the effect is weak when the initial level of competition is high and the returns to cost reduction through higher managerial effort are low. The findings are consistent with the theoretical perspective in Schmidt (1997), where the discipline effect of competition outweighs the profit-diluting effect when competition increases from a relatively low level.

The negative and significant coefficient on the interaction term (LEVERAGE $\times$ COM-

Table 5: **Average Marginal Effects as Elasticities: Margins Based on FDE2**

	Elasticity	SE	Z	P>z	Confidence interval	
LEVERAGE (TDTA)	0.056	0.029	1.87	0.061	-0.003	0.115
LEVERAGE. SQ	-0.059	0.020	-2.98	0.003	-0.098	-0.020
COMPETITION	-0.409	0.028	-14.86	0.000	-0.464	-0.356
COMPETITION.SQ	0.389	0.024	16.24	0.000	0.342	0.436
LEVERAGE×COMPETITION	-0.054	0.028	-1.93	0.054	-0.109	0.001
DURATION	0.011	0.001	16.85	0.000	0.010	0.013
DURATION.SQ	0.0002	0.0000	4.95	0.000	0.0001	0.0003

Notes: The Average Marginal Effect (AME) indicates the percentage change in the hazard rate in response to 1% change in the covariate. For other notes, see Table 4. AMEs based on other FDE definitions are similar. They are not reported here but are available on request.

PETITION) indicates that leverage and competition are substitute disciplining devices and as such they confirm the existence of an agency problem in the sampled firms. It lends support to **H3** and is consistent with Aghion et al. (2002), where product-market competition and financial-market discipline are substitutes in the presence of an agency problem among older firms in Central and Eastern European countries. Our findings indicate that an increase in leverage strengthens (or prolongs) the hazard-reducing effect of competition when the latter is kept constant. Similarly, an increase in competition mitigates (or curtails) the hazard-increasing effect of leverage when the latter is kept constant.

In Table 5, we report average marginal effects (AMEs) of the covariates, using the preferred FDE2 indicator. The AMEs are obtained as elasticities to indicate the percentage change in the hazard rate in response to a one-percent change in the covariates. The AMEs confirm that the effect of leverage on distress hazard is inverted-U shaped whereas that of competition is U-shaped. Furthermore, the effect of the interaction term is negative, indicating that leverage and competition have substitute disciplining effects on financial distress hazard.

In Table 6, we provide further post-estimation evidence that confirms and elucidates the substitute discipline effects of leverage and competition. Using the preferred FDE2 indicator and the baseline model in 8, we present tuning points for the effects of leverage and competition on estimated hazard. The turning points are obtained by fixing one of the disciplining devices at the sample mean and varying the substitute device by one decile at a time. The decile values for competition and leverage are presented in columns 2 and 4 respectively, followed in column 3 and 5 by the conditional turning points for the relationship between leverage and competition as predictors and financial distress hazard as the outcome.

Table 6: **Leverage and Competition as Substitute Disciplining Devices**

Decile	Competition at decile	Turning point for leverage	Leverage at decile	Turning point for competition
1	0.778	0.636	0.008	0.406
2	0.850	0.561	0.055	0.419
3	0.887	0.522	0.110	0.435
4	0.913	0.495	0.166	0.451
5	0.935	0.472	0.219	0.466
6	0.955	0.452	0.272	0.481
7	0.976	0.429	0.330	0.497
8	1.000	0.404	0.397	0.516
9	1.000	0.404	0.502	0.546

Focusing on columns 2 and 3, we observe that the turning point for leverage occurs at lower levels of leverage as competition increases. Recalling that the effect of leverage on financial distress hazard is inverted-U-shaped, the lower levels of leverage at which the turning point occurs indicates that the hazard-increasing effect of leverage disappears (the upward-sloping segment of the concave curve ends) at lower levels of leverage as competition increases and leverage is kept constant at the sample mean. This is due to the substitution effect of competition, which exerts additional pressure on the manager to increase effort. Stated differently, the firm enters a binding regime and managerial effort increases sooner, and the leverage's hazard-reducing effect kicks in at lower levels of leverage when competition increases while leverage is kept constant.

The evidence in columns 4 and 5 indicates a leverage substitution effect too. Recalling that the effect of competition and financial distress hazard is U-shaped, the higher levels of competition at which the turning points occur to indicate that the hazard-reducing effect of the competition is prolonged as leverage increases. This is because leverage acts as a substitute discipline mechanism, which mitigates the agency problem and delays the start of the hazard-increasing effects of competition. Stated differently, the effort-increasing effect of competition dominates the profit-diluting effect on managerial effort for longer when leverage increases and competition is kept constant at sample mean.

Stepwise estimation results reported in Table 7 confirm that the non-monotonic and substitution effects of leverage and competition on financial distress hazard remain stable to augmenting the baseline model with market, accounting and industry/macroeconomic variables [8]. Moreover, the predictive power of the model as measured by AUC increases only marginally

[8]Results in Table 6 are based on the preferred financial distress indicator, $FDE2$. We have estimated the

(from 93.7% to 94.9%) when it is augmented with accounting and market variables. This is to be expected because both distress risk and firm performance in general are essentially managerial effort problems. Once one controls for managerial effort through leverage and competition as disciplining devices, market and accounting indicators add only little new information as they are more likely to be correlated with managerial effort. A slightly better improvement in the predictive power (from 94.9% to 97.4%) is obtained when industry and macroeconomic variables and a crisis indicator are added. This is also to be expected because industry and macroeconomic conditions are less correlated with managerial effort and as such may provide new information relevant to financial distress hazard. It must be noted that the predictive power (the AUC) of the model augmented with industry and macroeconomic variables is higher than the within-sample and out-of-sample performance of all models estimated in Gupta et al. (2018).

As indicated above, the accounting/market variables are defined relative to industry average in the country of listing, as proposed by Platt and Platt (2006). As such, the accounting/market variables take account of industry/country effects and reveals the extent to which a firm deviates from its industry norm in the country of listing. We find that the ratio of current assets to current liabilities relative to industry average ($REL.CURR$) is associated with an increase in financial distress hazard. This finding is in line with agency-theoretic predictions and indicates that firms with larger current ratios relative to the industry average are less efficient in deploying their assets. In contrast, a larger return on assets ratios relative to industry average ($REL.ROA$) is associated with lower hazard rates. This finding is also in line with predictions from the agency theory. It indicates that managerial slack and the risk of financial distress are lower when the firm's performance relative to its industry norm improves. Of the market variables, only the book-to-market ratio relative industry average ($REL.BMR$) is significant and associated with an increase in financial distress hazard. According to Campbell et al. (2008), the book-to-market ratio should be considered as a correction factor that reflects the extent of misalignment between market and own valuation of the firm's value. Viewed from this perspective, our finding indicates that the firms in our sample tend to overestimate their book values compared to valuations by the market, which takes account of both current and

augmented model with other FDE indicators too and obtained consistent results. The latter are not reported here to save space but can be provided on request.

Table 7: **Non-Monotonic and Substitute Discipline Effects of Leverage and Competition: Stability to Stepwise Estimations**

	(1)	(2)	(3)	(4)
Dependent variable:	$FDE2_{t+1}$	$FDE2_{t+1}$	$FDE2_{t+1}$	$FDE2_{t+1}$
LEVERAGE (TDTA)	1.075*	3.372***	2.522***	2.619***
	(0.615)	(0.872)	(0.938)	(0.971)
LEVERAGE.SQ	-1.185***	-1.832***	-1.378***	-1.301***
	(0.398)	(0.421)	(0.490)	(0.487)
COMPETITION: (1 - firm Lerner index)	-8.239***	-8.240***	-7.611***	-7.137***
	(0.546)	(0.684)	(0.745)	(0.728)
COMPETITION.SQ	7.823***	8.332***	7.657***	7.273***
	(0.471)	(0.547)	(0.595)	(0.592)
LEVERAGE×COMPETITION	-1.091*	-2.749***	-2.256**	-2.415**
	(0.565)	(0.849)	(0.905)	(0.943)
DURATION	0.230***	0.228***	0.202***	0.195***
	(0.014)	(0.0141)	(0.0153)	(0.0154)
DURATION.SQ	0.0044***	0.0037***	0.0049***	0.0053***
	(0.000)	(0.0009)	(0.0010)	(0.0010)
REL.CURR		0.0723***	0.0728***	0.0740***
		(0.0077)	(0.0086)	(0.0086)
REL.ROA		-0.0996***	-0.111***	-0.113***
		(0.0355)	(0.0405)	(0.0408)
REL.BMR			0.214***	0.223***
			(0.0277)	(0.0276)
REL.BETA			0.0796	0.0214
			(0.391)	(0.400)
GROWTH.SD.IND				0.664***
				(0.0634)
GROWTH.GDP				-0.235
				(0.277)
BUS.LEND.RATE				-0.644
				(0.521)
CRISIS.EPISODES				0.110
				(0.0772)
CONSTANT	3.037***	3.873***	4.166***	0.742
	(0.490)	(0.754)	(0.847)	(0.830)
Between-firm variance of the random intercepts	3.507***	3.219***	3.024***	2.738***
	(0.177)	(0.176)	(0.188)	(0.180)
Between-firm variance of the random slopes	11.835***	11.606***	12.991***	12.376***
	(1.217)	(1.222)	(1.492)	(1.464)
Firm/year observations	123927	116707	99604	96103
Firms	13986	13196	10962	10875
Log-likelihood	-24029.2	-22387.9	-18578.9	-18164.8
LR test (chi2):	6173.6	6257.5	5470.4	5494.8
p>chi2	0	0	0	0
Intra-firm correlation	0.516	0.495	0.479	0.454
AUC Incl. random effects	0.944	0.946	0.949	0.967
AUC Fixed effects only	0.871	0.882	0.890	0.921

Notes: The dependent variable is preferred one-year-forward financial distress event (FDE2) indicator, as defined in section 4 above. For details see Table 4. Column (1) is baseline model; Column (2) is baseline model augmented with market variables; Column (3) is baseline model augmented with market and accounting variables; Column (4) is baseline model augmented with market, accounting and industry/macroeconomic variables. Standard errors in parentheses. *p < 0.10, **p < 0.05, ***p < 0.01.

future earnings and losses.

The final set of covariates in the augmented model relate to industry and macroeconomic variables. The existing work tends to overlook the effects of industry and macroeconomic factors on the grounds that their informational content is already captured by the firm's market- and accounting-based performance indicators. Nevertheless, this assumption overlooks a wide range of evidence indicating that industry and macroeconomic conditions are significant predictors of corporate defaults and rating downgrades after controlling for firm-level performance indicators (e.g., Koopman and Lucas, 2005; Carling et al., 2007). We address this inconsistency in column 4 of Table 7, where we augment the model with industry and macroeconomic variables with potential to affect the financial distress hazard. We find that only the volatility of net sales growth in the industry ($GROWTH.SD.IND$) is significant and associated with an increase in financial distress hazard. Nevertheless, the inclusion of industry/macro-economic variables improves the predictive power of the model more than accounting/market variables.

We have conducted two further sets of sensitivity checks to verify the robustness of the non-monotonic and substitution effects discussed above. Table A4 in the Appendix reports the results from sensitivity checks based on five different firm cohorts: (i) firms excluding financials; (ii) firms excluding financials and utilities; (iii) US-listed firms only; (iv) non-US firms; and (v) firms listed in countries with English Law origin. The results indicate that the non-monotonic effects of competition and the substitute discipline effects are robust across all firm cohorts, but the non-monotonic effects of leverage are robust in three out of five sub-samples (non-financials, firms excluding financials and utilities, and non-US firms). In the remaining two sub-samples, the coefficients have the expected signs but only the quadratic term for leverage is negative and significant. In Table A5 we estimate the baseline model by increasing the cut-off point for leverage (total debt / total assets ratio) to 1.5, 1.75 and 2. Again, the non-monotonic effects of competition and the substitute discipline effects are robust with all cut-off points, but only the quadratic term for leverage is negative and significant.

We interpret the results from the sensitivity checks as evidence of strong empirical support for the agency-theoretic predictions of: (i) non-monotonic competition effects on financial distress hazard (H2); and (ii) substitute discipline effects when competition and leverage interact (H3). Nevertheless, we find only moderate empirical support for the agency-theoretic

prediction of non-monotonic leverage effects on financial distress hazard (H1). The latter is not supported when the sample consists of US-listed and English-origin firms; or when the sample includes highly leveraged firms with leverage ratios at 1.5 or higher. We observe that the distribution of leverage in these samples is more skewed, with longer tails to the right. Therefore, we conclude that H1 is less likely to hold when leverage is skewed and some of the observations in the tail may be outliers.

6 Conclusions

In this paper, we have hypothesized that, in the presence of agency conflicts, leverage and product-market competition act as disciplining devices with non-monotonic and substitution effects on financial distress hazard. Our hypotheses are informed by agency theories of debt accumulation and product-market competition, which analyse the role of leverage and competition in mitigating the agency problem and reducing the risk of financial distress.

Drawing on a sample of 13,986 listed firms observed from 1992 2014 and utilising a multi-level hazard model with shared frailty, we have reported two novel findings. First, leverage and product-market competition have non-monotonic effects on financial distress hazard. To be specific, the effect of leverage is inverted-U-shaped whereas that of competition is U-shaped. Secondly, we find that leverage and competition are substitute disciplining devices in that an increase in leverage (competition), *ceteris paribus*, reinforces the hazard-reducing effect of competition (leverage). These findings indicate that monotonic specifications for leverage and competition and lack of control for interactive effects between the two are potential sources of model misspecification bias in financial distress models. They also indicate that there is scope for augmenting the financial distress hazard models with other disciplining devices such as corporate governance rules or creditor control indicators which are commonly used in corporate default or rating downgrade models.

We have also argued in favour of a multi-level hazard model that takes account of: (i) shared frailty that reflects within-firm dependence between financial distress episodes; and (ii) potential endogeneity that arises from correlation between unobserved frailty and predictors of financial distress hazard. We have taken account of endogeneity by augmenting the hazard model with Mundlak corrections, which consist of within-firm averages of the regressors. The

multi-level hazard model yields better log-likelihood values and have higher predictive power than restricted equivalents such as pooled or random-effect logit. The findings from the multi-level hazard model remain highly robust to different financial distress event definitions and to augmenting the baseline hazard model with accounting, market, and industry/macroeconomic variables. The non-monotonic effects of leverage, however, are only moderately robust to variations in the sample. Particularly, we find that the linear leverage term is insignificant in samples consisting of US firms only, firms listed in countries with English Law origin, and in samples including highly leveraged firms. A common characteristic of the samples where the non-monotonic effect of leverage fails to hold is higher skewness of the leverage.

Our work can contribute to future research along four paths. First, we have demonstrated how agency theory can be deployed to bridge the gap between theory and empirics in the financial distress literature. An agency-theoretic perspective is necessary not only for correct model specification but also for enabling causal inference about the effects of financial distress predictors. Secondly, our work can be extended to investigate the effects on financial distress hazard of other disciplining devices such as corporate governance rules or incentive mechanisms, including whether such disciplining devices have complementary or substitute effects on managerial effort and financial distress hazard. Third, our work can be extended to take account of different levels of nesting in the data. For example, it is possible to test whether financial distress episodes are also correlated at higher levels such as industries or countries; and whether the frailty should be modeled as random intercepts only or as random intercepts and slopes at different levels of nesting. Finally, the multi-level modelling framework we propose can be extended to model other repeated events in the firm's life cycle, such as credit downgrades or default risks.

With respect to policy and practice, one implication from our findings is that risk assessment models based on a 'representative firm' may be inadequate for evidence-based decision making. Our findings indicate that the effect of leverage or competition on the firms' financial distress risk is inherently heterogenous. This is also the case with respect to the baseline hazard that is conditional on observed firm, industry, or market information. Specifically, we find that the effect of leverage or competition on financial distress risk depends on three factors: (i) the severity of the agency conflicts; (ii) the gap between the actual level of debt that firm holds

and the optimal level of debt required to place the firm in a binding regime where the manager must increase effort to avoid bankruptcy; and (iii) the extent to which the effort-inducing effect of product-market competition dominates its profit-diluting effect. The multi-level modeling framework supports evidence-based decision making in this environment of contingencies and non-linearities by providing not only 'average' estimates for the effects of the financial distress predictors but also firm-specific deviations from the norm. The latter property of multi-level models enables both shareholders and lenders to make better informed decisions about the firm's optimal capital structure, taking into account: (a) the level of product-market competition in the market; (a) the information about the firm's own history; and (c) the relative position of the firm compared to its peers in the industry or the market.

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Appendix

This is the Appendix to manuscript titled:

Financial Distress as an Agency Problem: Evidence on Non-Monotonic and Substitute Discipline Effects of Leverage and Competition

All tables are cited in the manuscript; and numbered consequentially.

Table A1: **Variables and definitions**

Financial Distress	Financial distress is a binary variable that indicates whether the company is likely to fail in meeting its financial obligations to its creditors. It takes the value of 1 if the firm is under financial distress and 0 otherwise. We use five different financial distress indicators: • FDE1 = 1 if the interest coverage ratio (EBIT/interest expense on debt) is less than 0.8 for 2 consecutive years and market value growth is negative for two consecutive years; and 0 otherwise. This FDE indicator is similar to Platt and Platt (2006), Pindado et al. (2008), Tinoco and Wilson (2013), Inekwe et al. (2018), Fernández-Gámez et al. (2020), and Li et al. (2020) among others. • FDE2 = 1 if EBITDA is less than interest payment, EBIT is negative and Net Income is negative for 2 consecutive years; and 0 otherwise. This indicator is similar to Platt and Platt (2006), Pindado et al. (2008), and Keasey et al. (2015). • FDE3 = 1 if EBITDA is less than financial expenses, the net worth/total debt is less than one, and the net worth growth is negative for two consecutive years; and 0 otherwise. This indicator is similar to Keasey et al. (2015) and Gupta et al. (2018). In estimation, we use one-year-forward value of the financial distress indicator to obtain early warning information and avoid simultaneity. Our preferred financial distress event is FDE2, based on area under the ROC curve and correct classification statistics.
Hazard model variables::	
Main variables of interest:	
LEVERAGE (TDTA)	Total debt/Total assets [= (Short Term Debt & Current Portion of Long Term Debt + Long Term Debt) / Total Assets].
LEVERAGE (TDTC)	Total debt / (total debt + common equity).
LEVERAGE.SQ	Square of leverage measures.
COMPETITION	Product-market competition measured as 1-firm Lerner index.
COMPETITION.SQ	Square of the competition measures.
LEVERAGE×COMP.	Interaction of leverage and competition measures.
Market-based covariates:	
REL.BMR	Firm's book-to-market, relative to industry and country average in year t.
REL.BETA	Measure of stock price volatility relative to market volatility. It is based on between 23 and 35 consecutive month-end price percent changes and their relativity to a local market index.
Accounting-based covariates:	
REL.CURR	Ratio of current assets to current liabilities, relative to industry and country average.
REL.ROA	Earnings before interest and taxes (EBIT) / Total assets, relative to industry and country average.
Industry/Macro covariates:	
GROWTH.SD.IND	Standard deviation of sales growth in the industry.
GROWTH.GDP	Real GDP growth in the country.
BUS.LEND.RATE	Business lending rate by country and year.
CRISIS.EPISODES	Dot.com and global financial crises.
Duration:	
DURATION	Years until financial distress occurs.
DURATION.SQ	Years until financial distress occurs squared.
Agency cost variables:	
AGENCY.COST 1	Ratio of operating expenses to net sales.
AGENCY.COST 2	Ratio of operating income to net sales.
PROFIT.MARGIN	Ratio of net sales to total assets.
log(TOTAL.ASSETS)	Firms size measured with the logarithm of total assets
TANGIBILITY	Fixed-to-Total Asset ratio

Table A2: **Distribution of Financially Distressed and Distress-Free Firms by Country**

Country	Number of firms	Observation	Distress-free	Financially distressed	Percent
Austria	65	846	831	15	1.77%
Brazil	284	2542	2429	113	4.45%
France	571	6025	5686	339	5.63%
Germany	654	6497	6053	444	6.83%
India	2159	16380	15642	738	4.51%
Netherlands	110	1563	1517	46	2.94%
South Korea	1553	10846	10116	730	6.73%
South Africa	242	2211	2160	51	2.31%
Taiwan	1199	6475	6101	373	5.76%
Turkey	260	2478	2349	129	5.21%
United Kingdom	1274	13872	12051	1821	13.13%
United States	5615	54192	44544	9648	17.80%
Total	13986	123927	109479	14447	11.66%

Notes: The financial distress event is FDE2, as defined in Table A1 above.

Table A3: **Summary Statistics for Distressed and Distress-fee Firms in the Samples**

	Non-distressed Observation = 109480				Financially-distressed Observation = 14447			
	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.
Covariates of main interest:								
LEVERAGE	0.246	0.201	0	1	0.211	0.240	0	1
LEVERAGE.SQ	0.101	0.137	0	1	0.102	0.178	0	1
COMPETITION	0.871	0.157	0	1	0.967	0.129	0	1
COMPETITION.SQ	0.783	0.210	0	1	0.951	0.156	0	1
LEVERAGE×COMP.	0.214	0.180	0	1	0.204	0.236	0	1
Duration:								
DURATION	7.070	5.497	0	23	5.046	3.830	0	23
DURATION.SQ	80.199	110.196	0	529	40.127	62.936	0	529
Accounting-based covariates:								
REL.CURR	-0.206	2.072	-14.827	29.206	0.375	4.127	-9.405	29.647
REL.ROA	0.097	0.312	-12.336	3.471	-0.297	1.083	-12.778	2.412
Market-based covariates:								
REL.BMR	0.001	0.754	-8.221	5.923	-0.049	0.998	-7.928	5.737
REL.BETA	1.063	0.413	0.002	4.128	0.889	0.431	0.002	3.100
Industry/Macro covariates:								
GROWTH.SD.IND	0.456	0.322	0.000	5.801	0.629	0.304	0.000	4.381
GROWTH.GDP	0.115	0.640	-0.713	28.946	0.087	0.543	-0.295	28.946
BUS.LEND.RATE	0.094	0.083	0.026	0.755	0.072	0.053	0.026	0.7
CRISIS.EPISODES	0.467	0.499	0	1	0.536	0.499	0	1

Notes: The variables are as defined in Table A1 above.

Table A4: **Robustness Checks by Firm Cohorts**

	(1)	(2)	(3)	(4)	(5)
Dependent variable:	$FDE2_{t+1}$	$FDE2_{t+1}$	$FDE2_{t+1}$	$FDE2_{t+1}$	$FDE2_{t+1}$
LEVERAGE (TDTA)	1.411**	1.652**	0.848	1.134*	-0.011
	(0.714)	(0.787)	(2.020)	(0.639)	(0.743)
LEVERAGE.SQ	-1.103***	-1.134***	-2.725*	-1.098***	-0.793*
	(0.410)	(0.432)	(1.480)	(0.415)	(0.420)
COMPETITION: (1 Lerner index)	-9.075***	-9.188***	-8.314***	-8.193***	-8.869***
	(0.581)	(0.620)	(1.467)	(0.585)	(0.623)
COMPETITION.SQ	8.569***	8.646***	7.969***	7.747***	8.207***
	(0.500)	(0.528)	(1.302)	(0.502)	(0.537)
LEVERAGE×COMPETITION	-1.508**	-1.720**	-0.718	-1.135*	-0.469
	(0.671)	(0.748)	(1.942)	(0.581)	(0.703)
DURATION	0.232***	0.227***	0.134***	0.246***	0.216***
	(0.0143)	(0.0146)	(0.0370)	(0.0151)	(0.0152)
DURATION.SQ	0.004***	0.004***	0.011***	0.003***	0.004***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
CONSTANT	4.770***	4.666***	3.732***	2.690***	3.058***
	(0.695)	(0.737)	(1.322)	(0.527)	(0.617)
Between-firm variance of the random	3.545***	3.582***	2.834***	3.617***	3.275***
intercepts	(0.182)	(0.190)	(0.433)	(0.193)	(0.184)
Between-firm variance of the random	12.188***	12.567***	21.248***	11.238***	10.850***
slopes	(1.274)	(1.342)	(6.313)	(1.222)	(1.299)
Firm/year observations	116586	106013	13872	110055	86655
Firms	12912	11874	1274	12712	9290
Log-likelihood	-22562.6	-21092.8	-2813.6	-21147.2	-18496.2
LR test (chi2)	5937.6	5548.1	708.1	5516.0	4999.5
p>chi2	0	0	0	0	0
Intra-firm correlation	0.519	0.521	0.463	0.524	0.499

Notes: Multilevel mixed effects logistic estimations with Mundlak corrections and full set of year dummies. The latter are not reported to save space. Leverage is total debt over total assets; Competition is measured as 1 - firm Lerner index. The dependent variable is one-year-forward financial distress event indicator FDE2, as defined in table A1 above. Column (1) excludes firms in the financial sector; Column (2) excludes firms in the financial, utility and transport sectors; Column (3) includes US firms only; Column (4) includes non-US firms only; Column (5) includes firms only in countries of English legal origin. Robust standard errors are in parentheses. *p < 0.10, **p < 0.05, ***p < 0.01.

Table A5: **Robustness Checks at Higher Leverage Ratio Cut-offs**

Dependent variable: FDE2t+1	Max. Leverage ratio cut-off at 1.5	Max. Leverage ratio cut-off at 1.75	Max. Leverage ratio cut-off at 2.0
LEVERAGE (TDTA)	0.579	0.733	0.563
	(0.516)	(0.485)	(0.460)
LEVERAGE.SQ	-0.393*	-0.321*	-0.0670
	(0.231)	(0.190)	(0.159)
COMPETITION (1 - Lerner index)	-8.231***	-8.242***	-8.227***
	(0.537)	(0.536)	(0.535)
COMPETITION.SQ	7.817***	7.861***	7.860***
	(0.462)	(0.461)	(0.460)
LEVERAGE×COMPETITION	-0.988**	-1.189***	-1.220***
	(0.465)	(0.441)	(0.420)
DURATION	0.223***	0.221***	0.220***
	(0.014)	(0.014)	(0.014)
DURATION.SQ	0.004***	0.004***	0.005***
	(0.001)	(0.001)	(0.001)
CONSTANT	2.704***	2.707***	2.777***
	(0.480)	(0.480)	(0.480)
Between-firm variance of the random intercepts	3.349*** (0.164)	3.300*** (0.161)	3.328*** (0. 160)
Between-firm variance of the random slopes	8.890*** (1.011)	7.623*** (0.925)	7.328*** (0.858)
Firm/year observations	125227	125568	125804
Firms	14071	14092	14110
Log-likelihood	-24622.6	-24795.7	-24958.8
LR test (chi2): Restricted model is nested within multi-level model	6360.2	6364.1	6379.0
p>chi2	0	0	0
Intra-firm correlation	0.504***	0.501***	0.503***

Notes: Dependent variable is FDE2, as defined in Table A1 above. Multilevel mixed effects logistic estimations with Mundlak corrections and full set of year dummies. The latter are not reported to save space. Robust standard errors are in parentheses. *p < 0.10, **p < 0.05, ***p < 0.01.