Corporate Diversification and Debt Maturity

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Abstract

We are the first to study the interplay between corporate diversification and debt maturity, both theoretically and empirically. Our models predict that diversification mitigates the debt-overhang problem, making long-term debt more attractive in the presence of rollover costs. Using data on 30,135 firms from 1978 to 2022, we find that multi-division firms have debt maturities at least one year longer than stand-alone firms, especially when facing debt overhang. Consistent with our predictions, the excess value of Berger and Ofek (1995) and Mansi and Reeb (2002) increases with debt maturity, suggesting that traditional measures of the diversification discount could be misleading.

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I. Introduction

Corporate diversification, with its potential impact on firm value and risk, has attracted the interest of academics and management practitioners alike.[1] A key strand of the corporate diversification literature investigates its impact on debt capacity. In particular, Galai and Masulis (1976); Lewellen (1971) claim that diversified firms can exploit the coinsurance effect across their divisions to increase their leverage, but empirical evidence in this respect is mixed (Berger and Ofek, 1995; Mansi and Reeb, 2002). However, leverage is only one of the channels through which corporate diversification might affect firm value via the coinsurance effect.

In this paper, we are the first to investigate both theoretically and empirically the interplay between corporate diversification and debt maturity choices and their effect on firm value. Recent contributions have studied the role of debt maturity choices for investment incentives, rollover risk, and the debt overhang problem (see, e.g., Myers, 1977; Diamond, 1991; Barclay and Smith, 1995; Cheng and Milbradt, 2012; Chen, Xu, and Yang, 2012; Diamond and He, 2014; Gopalan, Song, and Yerramilli, 2014; Dangl and Zechner, 2021).[2] However, the literature has insofar neglected the role of corporate diversification in shaping debt maturity choices. We argue that corporate diversification allows companies to

[1]The literature on corporate diversification has provided important insights on market behavior, internal capital allocation, investment opportunities, risk management, and the effects of debt on firm performance (see, e.g., Lang and Stulz, 1994; Berger and Ofek, 1995; Campa and Kedia, 2002; Mansi and Reeb, 2002; Duchin, 2010; Hann, Ogneva, and Ozbas, 2013; Onali and Mascia, 2022; Boguth, Duchin, and Simutin, 2022).

[2]For example, Diamond (1991) finds that borrowers with higher credit ratings prefer short-term debt, while those with lower ratings prefer long-term debt due to the trade-off between a credit rating improvement and liquidity risk. Barclay and Smith (1995) documents that long-term debt tends to be issued by large and regulated firms with poor growth options, consistent with the view that short-term debt is more useful in the presence of high information asymmetries. Sorge, Zhang, and Koufopoulos (2017) examine the role of information asymmetries and creditor protection and find a negative (positive) correlation between the degree of asymmetric information (the strength of creditor rights) and debt maturity.

have a longer average debt maturity than stand-alone firms by alleviating the debt-overhang problem.

Our theoretical contribution consists of a simple three-period discrete-time model and a continuous-time model based on a basket option pricing approach. The three-period model extends Diamond and He (2014)'s numerical example of how debt maturity can affect debt overhang to a multi-division setting.[3] Although corporate diversification reduces the conditional variance of the multi-division firm's future payoffs (i.e., the *coinsurance* effect), it does not affect the value of an all-equity firm because it does not alter the expected payoffs, consistent with Mansi and Reeb (2002)'s findings. When we introduce the possibility for firms to raise debt, the coinsurance effect allows a multi-division firm to have a lower book value of debt than a comparable stand-alone firm. The lower book leverage reduces the default risk of the multi-division firm and, therefore, mitigates debt overhang in both short and long terms. Once we allow for higher non-interest debt expenses for short-term debt (see, e.g., Acharya, Gale, and Yorulmazer, 2011),[4] our model predicts that multi-division (stand-alone) firms are more likely to issue long-term (short-term) debt.

The idea that short-term debt improves investment incentives (Myers, 1977) originates from the Black-Scholes-Merton model, in which equity is analogous to a European call option with a strike price equal to the face value of the debt due at maturity (Diamond

[3]Debt overhang is a type of agency problem which leads to under-investment in levered firms because the return on the new projects would partly be transferred to existing debt-holders (Chen and Manso, 2017). We use the term "multi-division" firm to indicate a firm diversifying its activities by business segment. We do not consider geographical diversification because it might leverage factors unrelated to the coinsurance effect, such as acquiring resources inaccessible in the country of origin.

[4]In this study, we focus on non-interest related debt expenses including expenses related to the issuance of debt (i.e., underwriting fees, brokerage costs, advertising costs, etc.); financing charges; credit rating fees; etc. These non-interest debt expenses are higher for short-term debt as they need to be rolled over at a higher frequency relative to long-term debt.

and He, 2014). To further study the corporate diversification's effect on debt maturity, we generalize our three-period model using a Black-Scholes-Merton approach, considering the multi-division firm's equity value as a European basket call option. We use Ju (2002)'s approach as an efficient closed-form approximation of the basket call option to price the equity value of the multi-division firm. This model allows us to conduct more flexible counterfactual analyses. The basket-option framework leads to the same conclusion as the three-period model: the optimal debt maturity – i.e., the one that maximizes investment incentives – is shorter for stand-alone firms than for multi-division firms. This theoretical prediction, for which we find strong empirical support, has important implications for the diversification discount/premium measure: the presence of the coinsurance effect might lead multi-division firms to have longer debt maturity compared to stand-alone firms.[5] Longer-term debt makes the market value of equity of multi-division firms higher than that of comparable stand-alone firms. Conventional measures of excess value could be misleading because they neglect the endogenous nature of debt maturity preferences. Our model predicts that the excess value measure introduced by Berger and Ofek (1995); Mansi and Reeb (2002), which is not adjusted for debt maturity, increases with debt maturity.[6]

We test the empirical predictions of our models and their assumptions on a sample of

[5] Lang and Stulz (1994) document that multi-division firms generally exhibit lower Tobin's q compared to stand-alone firms, a phenomenon referred to as diversification discount. These findings are confirmed by Berger and Ofek (1995), who ascribe the diversification discount to over-investment and cross-subsidization of business segments with poor investment opportunities by those with good ones.

[6] Matching multi-division firms to stand-alone firms so that they have similar debt maturity–for example, using parametric methods such as propensity score matching or non-parametric methods such as scoring Coarsened Exact Matching used by Hund, Monk, and Tice (2024)–would lead to an even larger diversification discount, according to our model. This happens because the value of equity increases with debt maturity, and the optimal debt maturity for stand-alone firms is shorter than that for multi-division firms (as shown in Figure 5). Thus, stand-alone firms with longer maturity are likely to have, all else equal, a higher Tobin's q than their diversified counterparts.

stand-alone and multi-division firms. Our main findings are as follows. First, our regression results confirm a positive association between corporate diversification and debt maturity. Multi-division firms have a debt maturity at least one year longer than stand-alone firms, with a median stand-alone firm increasing debt maturity by 25% through diversification. Compared with other determinants of debt maturity, corporate diversification has a larger incremental explanatory power than the debt-to-equity ratio, net income, and capital expenditures. The only variable with a larger incremental explanatory power than corporate diversification is size (market value of equity), but the positive effect of corporate diversification on debt maturity remains positive across three size-based sub-samples. Thus, the positive impact of corporate diversification on debt maturity is distinct from the effect of firm size. However, the magnitude of the impact becomes smaller and less statistically significant for larger firms, plausibly because smaller firms have better growth options.

Second, we provide evidence that the positive effect of corporate diversification on debt maturity is stronger for firms with debt overhang. This finding is important because it supports the view that corporate diversification leads to longer debt maturities by mitigating the debt overhang problem, which is consistent with our model. These results are robust to using different proxies for debt overhang, including the one introduced by Alanis et al. (2018), which uses a model introduced by Chava and Jarrow (2004) to estimate the probability of default.

Third, we find a positive and statistically significant relationship between the excess value (Berger and Ofek, 1995; Mansi and Reeb, 2002) and debt maturity, consistent with the predictions of our basket-option model: a one standard deviation increase in the natural logarithm of debt maturity leads to a 1.6% increase in the excess value.[7]

In our empirical exercise, we also provide evidence supporting our models' assumptions. Specifically, we find that a one standard deviation decrease in the log of debt maturity results in a 0.23 standard deviation increase in the cost of debt, equivalent to a 4% increase. This finding supports the assumption of a negative correlation between debt maturity and the cost of debt in our theoretical models. Moreover, we provide evidence of an economically negligible difference in the leverage of the stand-alone and multi-division firms (only 40 basis points or 0.4%). This result is consistent with the setup of our basket-option model, where we require that the face value of debt of the stand-alone and multi-division firm be the same.

The central contribution of our paper lies in bridging a gap between two strands of literature: the one on the determinants of debt maturity and the one on corporate diversification. Debt maturity affects shareholders' investment incentives (Myers, 1977) and short-term debt mitigates debt overhang. Diamond and He (2014)'s theory offers further nuance to our understanding of the relation between debt maturity and debt overhang. Our paper contributes to the debt maturity literature by offering an analytical framework quantifying corporate diversification's effect on lengthening debt maturity for multi-division firms due to reduced debt overhang.

From a purely theoretical perspective, there could be both costs and benefits associated with corporate diversification. From an empirical perspective, there is still a debate as to whether corporate diversification has any impact on firm value (e.g., Lang and Stulz, 1994;

[7]The standard deviation in the log of debt maturity is 1.07, which is equivalent to around three years for the unlogged value of debt maturity (2.91).

Berger and Ofek, 1995; Lamont and Polk, 2002; Rajan, Servaes, and Zingales, 2000; Denis, Denis, and Sarin, 1997; Levinthal and Wu, 2010; Hund et al., 2024). The diversification discount could be related to endogeneity due to self-selection bias (Campa and Kedia, 2002; Lamont and Polk, 2002; Chevalier, 2004; Villalonga, 2004b; Xiao and Xu, 2019) or measurement error (Whited, 2001). After adjusting for these factors, the diversification discount tends to disappear. Moreover, focusing on establishment-level diversification, instead of business-segments provided by Compustat, Villalonga (2004a) finds evidence of a diversification *premium*.

While most of the literature on corporate diversification tends to be empirical, recent contributions develop theoretical models allowing for endogeneity of the choice to become a diversified firm. For example, Bakke and Gu (2017) focus on the relation between corporate diversification and cash holdings. They estimate a structural model where the switch from stand-alone to multi-division firm is endogenously determined because diversifying firms tend to be larger and have better growth opportunities. Dai, Giroud, Jiang, and Wang (2024) highlights that resource allocation within the firm considers not only divisions' productivity but also their risk, and firms may opt to spin off productive divisions voluntarily to enhance liquidity. Their results echo the mixed findings from the empirical literature and emphasize the importance of accounting for the endogenous formation of conglomerates. We contribute to this literature by providing insights into a new channel, debt maturity. Our models show that the debt maturity choices are endogenous to divisional structure. When estimating the excess value, such endogeneity cannot be resolved by matching diversified firms with a control sample of stand-alone firms. Our theoretical and empirical results suggest that the conventional excess value measure could be misleading because of the endogenous nature of debt maturity in association with corporate diversification.

II. Three-Period Model

We first study a simple three-period model extending Diamond and He (2014)'s three-period numerical example of a stand-alone firm to a multi-division setting. For easy comparison, we model two firms with assets-in-place of identical size: one, S, is with a single division, and the other, M, with two divisions. Each of the assets-in-place of M, F_m, is one-half of the assets-in-place of S, F_s. S's (each of M's) assets-in-place will generate three possible cash flows at $t = 2$ as $\{24, 12, 0\}$ ($\{12, 6, 0\}$), with probability $\frac{1}{3}$ of each scenario conditional on the information at $t = 0$. The same applies to the assets-in-place of the two divisions of M. The distributions of F_m's two assets-in-place cash flows are independent of each other. There are no cash flows in other periods. The discount rate is zero.

For simplicity, we assume firm value maximization, given a firm's divisional structure (Myers, 1977; Damodaran, 2014; Diamond and He, 2014).[8]

A. Information structure and payoffs

For all three assets-in-place, there are two states: a good state and a bad state. The state of the economy is revealed at $t = 1$. We use notations G (good) and B (bad) to represent the

[8]This assumption keeps our analysis simple and focused on typical firm value maximization behavior. Thus, we rule out cases where shareholders invest in projects with negative NPV due to non-value-maximizing objectives that are out of the scope of this paper.

two states of the assets-in-place for the stand-alone firm (F_s). For the multi-division firm, we denote the states for the assets-in-place of the first division ($F_m(1)$) as $G1$ and $B1$, and for the assets-in-place of the second division ($F_m(2)$) as $G2$ and $B2$. The probability of each state is $\frac{1}{2}$, and the outcomes are independent across all assets-in-place. For any given asset-in-place, the conditional probabilities of the cash flow at $t = 2$ are as follows: if the state at $t = 1$ is good (bad), the probabilities are $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{6}$ ($\frac{1}{6}$, $\frac{1}{3}$, $\frac{1}{2}$). The conditional distributions of F_s at $t = 2$ based on the information from $t = 0$ and $t = 1$ are:[9]

$$(1) \qquad \underbrace{F_s|_{t=0} = \begin{cases} 24 & \text{with prob} = 1/3 \\ 12 & \text{with prob} = 1/3 \\ 0 & \text{with prob} = 1/3 \end{cases}}_{t=0}$$

$$(2) \qquad \underbrace{F_s|_{G,t=1} = \begin{cases} 24 & \text{with prob} = 1/2 \\ 12 & \text{with prob} = 1/3 \\ 0 & \text{with prob} = 1/6 \end{cases}, \quad F_s|_{B,t=1} = \begin{cases} 24 & \text{with prob} = 1/6 \\ 12 & \text{with prob} = 1/3 \\ 0 & \text{with prob} = 1/2 \end{cases}}_{t=1}$$

and the conditional expectation of F_s at $t = 2$ given the information from $t = 1$ is:

$$(3) \qquad \mathbb{E}\left(F_s|_{\Pi_s,t=1}\right) = \begin{cases} 16 & \text{with } \Pi_s = G \\ 8 & \text{with } \Pi_s = B \end{cases},$$

[9]The distributions of $F_m(1)$ and $F_m(2)$ are the same as those of F_s with all possible outcomes halved.

where Π_s is the state variable for F_s, which can take two realizations, G and B, with equal probability.

Since $F_m(1)$ and $F_m(2)$ are independent and $F_m = F_m(1) + F_m(2)$, we obtain F_m's conditional distribution by convolving the distributions of $F_m(1)$ and $F_m(2)$:

$$\underbrace{F_m|_{t=0} = \begin{cases} 24 & \text{with prob} = 1/9 \\ 18 & \text{with prob} = 2/9 \\ 12 & \text{with prob} = 1/3 \\ 6 & \text{with prob} = 2/9 \\ 0 & \text{with prob} = 1/9 \end{cases},}_{t=0} \quad \underbrace{F_m|_{G1G2,t=1} = \begin{cases} 24 & \text{with prob} = 1/4 \\ 18 & \text{with prob} = 1/3 \\ 12 & \text{with prob} = 5/18 \\ 6 & \text{with prob} = 1/9 \\ 0 & \text{with prob} = 1/36 \end{cases},}_{t=1} \tag{4}$$

$$\underbrace{F_m|_{B1B2,t=1} = \begin{cases} 24 & \text{with prob} = 1/36 \\ 18 & \text{with prob} = 1/9 \\ 12 & \text{with prob} = 5/18 \\ 6 & \text{with prob} = 1/3 \\ 0 & \text{with prob} = 1/4 \end{cases}, \; F_m|_{G1B2 \text{ or } B1G2,t=1} = \begin{cases} 24 & \text{with prob} = 1/12 \\ 18 & \text{with prob} = 2/9 \\ 12 & \text{with prob} = 7/18 \\ 6 & \text{with prob} = 2/9 \\ 0 & \text{with prob} = 1/12 \end{cases}}_{t=1} \tag{5}$$

the conditional expectation of F_m at $t = 2$, given the information at $t = 1$, is:

$$\mathbb{E}\left(F_m|_{\Pi_m,t=1}\right) = \begin{cases} 16 & \text{with } \Pi_m = G1G2 \\ 12 & \text{with } \Pi_m = G1B2 \text{ or } B1G2 \\ 8 & \text{with } \Pi_m = B1B2 \end{cases}, \tag{6}$$

and F_m's state variable Π_m has three realizations and its distribution is given by:

$$\Pi_m|_{t=0} = \begin{cases} G1G2 & \text{with prob} = 1/4 \\ G1B2 \text{ or } B1G2 & \text{with prob} = 1/2 \\ B1B2 & \text{with prob} = 1/4 \end{cases} \tag{7}$$

The binomial tree representations of the possible paths of F_s and F_m in the two periods are presented in Figures 1 and 2, respectively. It is worth noting that the firm value is invariant to corporate diversification when the firm is an all-equity firm, as $\mathbb{E}\left(F_s|_{t=0}\right) = \mathbb{E}\left(F_m|_{t=0}\right) = 12$. This is consistent with Mansi and Reeb (2002), in that for all-equity firms corporate diversification is unrelated to excess total firm value. However, corporate diversification does reduce the conditional standard deviation of future firm value: $\text{Std}(F_m|_{t=0}) = 6.93 < 9.80 = \text{Std}(F_s|_{t=0})$. This is consistent with the coinsurance effect of corporate diversification argued by Lewellen (1971); Galai and Masulis (1976); Hann et al. (2013).

B. Debt overhang and investment incentives

We now introduce debt into the firm value to study the effect of corporate diversification on debt overhang and shareholders' incentives. We follow Diamond and He (2014) and assume that both S and M need to raise 8.25 at $t = 0$. The debt can be either long-term (maturing at $t = 2$) or short-term (maturing at $t = 1$). As shown in Diamond and He (2014), given the payoffs above and the need to raise 8.25, the short-term and long-term debt's nominal values are $L_s^{\text{ST}} = 8.5$ and $L_s^{\text{LT}} = 12.75$ for S. Our model extension to the multi-division firm leads to $L_m^{\text{ST}} = 8.33$ and $L_m^{\text{LT}} = 10.38$ for M. Figures 1 and 2 illustrate the relation between the payoffs and the nominal values of debt for S and M, respectively. The discrepancy between the nominal debt value of S and that of M arises from the reduction in default risk due to the coinsurance effect.[10] We assume there is no cost to raise either short-term or long-term debt.[11] For simplicity, we focus on an infinitesimal investment that only weakly increases or leaves unchanged the value of each of its debt and equity claims.[12] Such investment occurs immediately after raising the debt at $t=0$, and results in a marginal increment of the final cash flows at $t=2$ equal to $\varepsilon>0$. The short-term (O_i^{ST}) and long-term debt overhang (O_i^{LT}) are:

$$O_i^{\text{ST}} = \mathbb{E}_0\left(\mathbf{1}_{\{\mathbb{E}(F_i|_{t=1})<L_i^{\text{ST}}\}}\right) \text{ and } O_i^{\text{LT}} = \mathbb{E}_0\left(\mathbf{1}_{\{F_i \text{ at } t=2<L_i^{\text{LT}}\}}\right), \text{ for } i=s \text{ and } m. \tag{8}$$

where $\mathbf{1}_{\{\cdot\}}$ is an indicator function that equals one when the condition in $\{\cdot\}$ holds, and zero otherwise. Combining (8) with the conditional distributions of F_s and F_m, we have:

$$O_s^{\text{ST}} = \frac{1}{2},\;\; O_s^{\text{LT}} = \frac{2}{3},\;\; O_m^{\text{ST}} = \frac{1}{4}, \text{ and } O_m^{\text{LT}} = \frac{1}{3}. \tag{9}$$

Comparing O_s^{ST} with O_m^{ST} and O_s^{LT} with O_m^{LT} shows that corporate diversification mitigates debt overhang in the short and long-term. Moreover, $O_m^{\text{LT}} - O_m^{\text{ST}} < O_s^{\text{LT}} - O_s^{\text{ST}}$. Thus, corporate diversification reduces the difference between long-term and short-term debt overhang (the wedge).[13]

[10]This result indirectly supports Galai and Masulis (1976); Lewellen (1971)'s argument that corporate diversification's coinsurance effect increases debt capacity.

[11]We will relax this assumption in Section II.C.

[12]This allows us to avoid complicating the analysis with potential 'risk shifting' incentives (Jensen and Meckling, 1976).

[13]O_s^{ST} and O_s^{LT} are exactly the same as those derived in Diamond and He (2014).

Now, we describe how corporate diversification affects investment incentives. Denote the percentage investment cost by λ, and let

$$(1-\lambda) > O_i^j, \tag{10}$$

where $i \in \{s, m\}$ and $j \in \{ST, LT\}$. This condition implies that a firm invests only in projects with a net present value (NPV) exceeding the debt overhang.

For S's shareholders, the condition above is satisfied if $\lambda < 1/3$, regardless of whether the firm raises short-term or long-term debt, implying an Internal Rate of Return (IRR $= (1-\lambda)/\lambda$), larger than 200%. For M's shareholders, the condition becomes $\lambda < 2/3$, or equivalently IRR $> 50\%$. Focusing on the optimal choice for short-term debt only, the investment condition modifies to $\lambda < 1/2$ (IRR $> 100\%$) for S's shareholders and $\lambda < 3/4$ (IRR $> 33.\overline{3}\%$) for M's shareholders. Therefore, all else being equal, a multi-division firm is more likely to invest in new projects than a comparable stand-alone firm. This occurs because corporate diversification mitigates debt overhang through the coinsurance effect.

Although cash holding is not explicitly modeled here, our model implies that multi-division firms have more incentives to deploy excess cash (Opler, Pinkowitz, Stulz, and Williamson, 1999) for investment. This could result in a reduction in excess cash due to reduced debt overhang, providing an alternative explanation for Duchin (2010), who finds that multi-division firms hold significantly less cash than stand-alone firms.[14]

To recap, assuming that the market value of debt is the same for both S and M, the simple

[14] We test whether Duchin (2010)'s findings are verified in our dataset in Appendix C.

model above predicts that corporate diversification mitigates the debt overhang problem by decreasing both the extent of long-term and short-term debt overhang, as well as the wedge between them. However, the simplicity of this model comes at a cost: we assume that non-interest expenses are zero, and this leads us to conclude that short-term debt is preferred to long-term debt for both single-division and multi-division firms. This confirms Myers (1977)'s suggestion that short-term debt is a possible solution to the debt overhang problem in a frictionless scenario.[15]

In the next section, we relax the assumption of zero non-interest expenses and we generalize our model to allow for a number of divisions, N, larger than two. In line with the results of our three-period model with only two divisions for M, we impose the following conditions:

$$\frac{\partial O^{\mathrm{LT}}(N)}{\partial N} < 0, \quad \frac{\partial O^{\mathrm{ST}}(N)}{\partial N} < 0, \quad \text{and} \quad \frac{\partial \Delta_O(N)}{\partial N} < 0, \tag{11}$$

where $0 < O^{\mathrm{ST}}(N) \leq O^{\mathrm{LT}}(N) < 1$ and $\Delta_O(N) = O^{\mathrm{LT}}(N) - O^{\mathrm{ST}}(N)$, that is, the wedge. Therefore, by definition, $O_s^{\mathrm{LT}} = O^{\mathrm{LT}}(1)$, $O_s^{\mathrm{ST}} = O^{\mathrm{ST}}(1)$, $O_m^{\mathrm{LT}} = O^{\mathrm{LT}}(2)$, and $O_m^{\mathrm{ST}} = O^{\mathrm{ST}}(2)$.

C. Non-interest debt expenses and debt maturity

Short-term debt is known to have disadvantages over long-term debt. For example, short-term debt has higher issuance costs and higher rollover costs than long-term debt due to the higher frequency at which short-term debt needs to be issued or rolled over (Acharya et al.,

[15] In an asymmetric conditional volatility setting, where the G state has lower volatility than the B state, Diamond and He (2014) show that long-term debt overhang can be lower than short-term debt overhang. Here we show that there is another cost-related disadvantage of short-term debt that makes long-term debt more appealing in a multi-division firm.

2011; He and Xiong, 2012; Cheng and Milbradt, 2012; Valenzuela, 2016). To incorporate these additional non-interest costs in our model, we assume the funding raised via short-term debt is proportional to investment size. Specifically, we denote $\xi \geq 0$ such extra costs and define the overhang-adjusted NPV (Chen and Manso, 2017) as follows:

$$R_i^j = \left[1 - \left(1 + \xi \mathbf{1}_{\{j=\mathrm{ST}\}}\right)\lambda\right]\varepsilon - O_i^j \varepsilon, \tag{12}$$

which can be used to compare the investment incentives under different scenarios. When $\xi = 0$, as mentioned before, short-term debt is always preferred over long-term debt in terms of investment incentives in both S and M. When $\xi > 0$, however, debt maturity preferences depend on whether the firm is diversified or not. Due to the third condition in (11) – the wedge becomes smaller as N increases – when $\xi > 0$, the overhang-adjusted NPV for projects funded using long-term debt is more likely to be higher for M than for S. To formalize this intuition and generalize its validity to a broad range of realistic scenarios, we need to introduce a regularity assumption.

Assumption 1. *The short-term debt expense ξ and the investment cost λ are independently and uniformly distributed on $[0, \bar{\xi}]$ and $[\underline{\lambda}, 1]$, respectively. $\bar{\xi}$ and $\underline{\lambda}$ satisfy the following constraints:*[16]

$$\frac{O_s^{LT} - O_s^{ST}}{1 - O_s^{LT}} + \log\left(\frac{1 - O_s^{ST}}{1 - O_s^{LT}}\right) < \bar{\xi} \leq \frac{2\left(O_s^{LT} - O_s^{ST}\right)}{1 - O_s^{LT}}, \tag{13}$$

$$0 < \underline{\lambda} < 1 - O_s^{LT}. \tag{14}$$

[16]Since $0 < O_s^{\mathrm{ST}} < O_s^{\mathrm{LT}} < 1$, it can be shown that $\frac{O_s^{\mathrm{LT}} - O_s^{\mathrm{ST}}}{1 - O_s^{\mathrm{LT}}} > \log\left(\frac{1 - O_s^{\mathrm{ST}}}{1 - O_s^{\mathrm{LT}}}\right)$ using the Mean Value Theorem. The proof is available upon request from the authors. Therefore, (13) is well-defined.

The uniform distribution assumption is common in the asset-pricing literature (Oehmke and Zawadowski, 2015; Glode and Opp, 2016; Hollifield, Neklyudov, and Spatt, 2017). Both (13) and (14) are sufficient (albeit not necessary) conditions for the proposition we introduce below. Given reasonable values of O_s^{ST} and O_s^{LT}, eq. (13) ensures $\bar{\xi} > 0$ with a bounded upper limit, and eq. (14) gives rise to plausible IRR scenarios.

Now, we use R^{ST} and R^{LT} to denote the NPV of projects funded with short-term debt and long-term debt, respectively. Moreover, P^{ST} is the probability of raising short-term debt instead of long-term debt to invest in projects with positive NPV: $P^{\mathrm{ST}} = \mathbb{E}\left(\mathbf{1}_{\{R^{\mathrm{ST}} > \max(0, R^{\mathrm{LT}})\}}\right)$. Similarly, the probability of raising long-term debt instead of short-term debt, is defined as: $P^{\mathrm{LT}} = \mathbb{E}\left(\mathbf{1}_{\{R^{\mathrm{LT}} > \max(0, R^{\mathrm{ST}})\}}\right)$. To understand the impact of corporate diversification, we use the subscript N, denoting the number of segments. Thus, P_N^{ST} and P_N^{LT} are the probability of investing using short-term and long-term, respectively, for a firm with N segments.[17]

Given these definitions, we can now introduce Proposition 1, which is proved in Appendix A.

Proposition 1. *Given a fixed market value of debt and conditions in* (11) *and Assumption 1, there exists a threshold N^* such that firms with more than N^* segments are more likely to invest using long-term debt, whereas those with fewer than N^* segments are more likely to invest using short-term debt. More formally:*

[17] $N = 1$ represents the stand-alone case.

$$\exists N^* : \begin{cases} P^{LT} < P^{ST}, & \textit{if } N < N^*; \\ P^{LT} \geq P^{ST}, & \textit{if } N \geq N^*. \end{cases}$$

Given the values of O_s^{LT} and O_s^{ST} in (9), the constraints in Assumption 1 for $\bar{\xi}$ and $\underline{\lambda}$ are:

$$0.91 < \bar{\xi} \leq 1 \text{ and } 0 < \underline{\lambda} < 1/3. \tag{15}$$

For numerical illustration, we set $\bar{\xi} = 1$, which means the short-term debt expense is shared by each investment up to the total size of the initial investment outlay before the short-term debt expense; $\underline{\lambda} = 0.25$, which means $\lambda \in [0.25, 1]$ so that each investment's IRR before the short-term debt expense is positive and no more than 300%.[18] Given these settings and the values of O^{LT} and O^{ST} in (9), we have:

$$P_s^{\text{ST}} = 0.112 > 0.047 = P_s^{\text{LT}}, \tag{16}$$

$$P_m^{\text{ST}} = 0.116 < 0.447 = P_m^{\text{LT}}, \tag{17}$$

where P_s^{ST} and P_m^{ST} are P^{ST} for the stand-alone and multi-division firms, respectively, and P_s^{LT} and P_m^{LT} are P^{LT} for the stand-alone and multi-division firms, respectively.

To see the above intuition more clearly, we plot in Figure 3 the probabilities of investing with short-term debt P_i^{ST} and long-term debt P_i^{LT} defined in Proposition 1, which are derived in Appendix A. The area of the different shapes represents the probability values. P^{ST}'s area

[18] For $\lambda \approx 0$, short-term debt becomes trivially preferable for both stand-alone and multi-division firms due to the resulting lower debt overhang. However, as $\lambda \to 0$, IRR $\to \infty$, and a lower bound of λ at 0.25 removes the possibility of unrealistic IRRs by imposing a cap at 300%.

clearly diminishes with $O^{\mathrm{LT}} - O^{\mathrm{ST}}$ getting smaller, especially P_2^{ST} which has an upper bound of $\frac{(O^{\mathrm{LT}} - O^{\mathrm{ST}})^2}{2(1 - O^{\mathrm{LT}})}$.

With this simple three-period model, we gain valuable insights into how Hann et al. (2013)'s coinsurance effect of corporate diversification alleviates debt overhang and enhances investment incentives. This model elucidates a novel prediction accounting for higher non-interest expenses for short-term debt: a positive association between corporate diversification and debt maturity. However, this three-period model is unable to incorporate more nuanced features for further analysis, such as the possibility of size heterogeneity for the segments of a multi-division firm, correlated payoffs for different segments, and continuous debt maturity. To offer further insights, in the next section we develop a continuous-time structural model using option pricing.

III. A Black-Scholes-Merton Model Variant for Corporate Diversification

In a typical setting regarding pricing the equity of a levered firm, the market value of equity at time 0 with debt maturity of t can be found using standard pricing models for call options, since equity is the residual claimant at time t (Merton, 1974). Under certain assumptions, the equity of a levered firm is essentially a European call option with the strike price equal to the face value of debt to be repaid at time t.

To parsimoniously capture the impact of corporate diversification on investment incentive and debt maturity choice, we follow Diamond and He (2014)'s analysis based on the Black-

Scholes-Merton setting and assume that the firm's only debt is a zero-coupon debt maturing at time t with a face value L and set the risk-free rate to r.[19]

Accordingly, our structural model assumes that a diversified firm with N divisions has N existing assets-in-place. We denote the risk-neutral measure by $\mathbb{Q}$ (Arnold, Hackbarth, and Xenia Puhan, 2017). The total value of a levered firm is $V_t = \sum_{i=1}^{N} v_{i,t}$, where the distribution of the value of each of the assets-in-place follows a Geometric Brownian Motion (GBM) under the $\mathbb{Q}$ measure:

$$\frac{dv_{i,t}}{v_{i,t}} = g_i dt + \sigma_i dw_{i,t}, \quad i = 1, \cdots, N, \tag{18}$$

where g_i is the growth rate of $v_{i,t}$ under the $\mathbb{Q}$ measure, $w_{i,t}$ is a Wiener process under the $\mathbb{Q}$ measure, and ρ_{ij} is the pair-wise correlation between w_i and w_j. Given this setting, since the sum of GBM is not itself a GBM, the standard Black-Scholes option pricing formula cannot be used. This means that we need to depart from the assumptions in Diamond and He (2014)'s model, since in their model V_t is assumed to be log-normally distributed. However, we can still make use of option pricing techniques. Specifically, we argue that the equity of a levered multi-division firm can be priced according to the models developed for pricing basket options, i.e., options whose underlying consists of two or more securities. For convenience, the detailed descriptions of model parameters and functions used in this section are presented in Table 2.

[19] This is also the assumption used in the original structural model by Merton (1974).

A. A basket option approach for modeling corporate diversification

At time t, we have two potential outcomes for shareholders: if $V_t < L$, debt holders take over the defaulted firm and shareholders receive zero; if $V_t \geq L$, debt holders are repaid the full amount L and shareholders receive the residual value $V_t - L$. Thus, at time 0, the market equity value of a levered firm with N divisions is:

$$E(L,t) = \mathbb{E}_0^{\mathbb{Q}}\left[\left(\sum_{i=1}^{N} v_{i,t} - L\right)^{+}\right], \tag{19}$$

and the corresponding market value of debt is $D(L,t) = V_0 - E(L,t)$. Although the exact closed-form solution of the basket option is unavailable – to the best of our knowledge – highly accurate approximations exist. Here we use Ju (2002)'s Taylor expansion approximation as the solution to eq. (19):[20]

$$E(L,t) = [U_1 N(y_1) - LN(y_2)] + L\left(z_1 p(y) + z_2 \frac{dp(y)}{dy} + z_3 \frac{d^2 p(y)}{dy^2}\right), \tag{20}$$

where $N(\cdot)$ is the standard normal CDF and $p(\cdot)$ is the normal PDF with mean $\mu(1)$ and variance $\nu(1)$,

$$y = \log(L), \quad y_1 = \frac{\mu(1) - y}{\sqrt{\nu(1)}} + \sqrt{\nu(1)}, \quad y_2 = y_1 - \sqrt{\nu(1)}$$

[20] Ju (2002)'s solution is in closed form and easy to implement. His approach is also considered the best among numerous alternative approximations studied by Dai, Li, and Zhang (2010) among others.

Closed-form expressions for $\mu(x)$, $\nu(x)$, z_1, z_2, and z_3 are provided in Appendix B.

B. Revisiting the corporate diversification's effect on debt maturity and overhang

Since we focus on debt overhang from infinitesimal investments, we define the debt overhang measure as follows:

$$O(N,t,W) = \sum_{i=1}^{N} W_i \frac{\partial D(L,t)}{\partial v_{i,0}} = 1 - \sum_{i=1}^{N} W_i \frac{\partial E(L,t)}{\partial v_{i,0}}, \tag{21}$$

where W_i is the ith element of the $N \times 1$ weighting vector W, and $\sum_i^N W_i = 1$. The debt overhang measure defined by Diamond and He (2014) under their Black-Scholes-Merton setting is a special case of eq. (21) when $N = 1$. As argued by Galai and Masulis (1976), corporate diversification increases firms' debt capacity, which could result in higher leverage and/or longer debt maturity. Since the evidence on the relation between corporate diversification and leverage is weak (see Berger and Ofek, 1995; Mansi and Reeb, 2002, and our empirical results section), and our empirical results in Section IV provide strong evidence on the positive association between corporate diversification on debt maturity, we focus on a counterfactual analysis for debt maturity while constraining the face value of debt L to be the same for both S and M.[21]

[21] In the three-period model, based on Diamond and He (2014), we keep the market value of debt constant. However, keeping the book value of debt constant is consistent with real capital markets' conventions: covenant in debt contracts usually refer to book values, rather than market values. Shareholders are reluctant to reduce the book value of debt and prefer selling assets to debt reductions, resulting in the *leverage ratchet effect* (Admati, DeMarzo, Hellwig, and Pfleiderer, 2018). However, there is an important caveat to mention: by keeping the book value of debt constant, instead of its market value, the lower debt overhang for multi-division firms could be a result of both the leverage effect and the maturity effect of Diamond and He (2014).

We use the Black-Scholes formula to price S's equity value, and we allow the debt maturity of M to vary until its equity value matches that of S. This enables us to calculate the implied debt maturity for M (that is, implied by its equity value). Shareholders maximize the firm value by choosing the optimal debt maturity, conditional on their firm's divisional structure. In other words, shareholders choose the optimal debt maturity with the *minimal* investment cost and debt overhang to achieve a given level of firm value and growth.

We impose conditions to ensure that M and S are strictly comparable. Specifically, we constrain M to have the same total assets-in-place, growth rate, market value of equity, and face value of debt as S. For simplicity, we also set each division's assets-in-place within M to have equal weights and with the same volatility as S. To price M's equity value, we also need the pair-wise correlation ρ between any two divisions, which negatively affects corporate diversification's coinsurance effect. We set the pair-wise correlation coefficient to three different levels: $\{0, 0.1, 0.3\}$. Thanks to the analytical formula in eq. (20), we can easily solve for the value of debt maturity by equalizing M's equity value to S's equity value.

The numerical results are shown in Figure 4. From the left panel of Figure 4, we can clearly see that given the same values of total assets-in-place, face value of debt, growth rate, and market value of equity, M's debt maturity is longer than that of S and increases with the number of segments, confirming the notion stated in Proposition 1 that M tend to issue long-term debt relative to S. This tendency becomes stronger as the number of segments grows. The right panel of Figure 4 shows the changing pattern of debt overhang with the increasing number of segments. The pattern matches nicely with the results in Section II that corporate diversification reduces debt overhang. We also find that as the average pair-wise correlation between divisions decreases, the debt maturity increases and the debt overhang decreases even further. This observation reinforces the idea from Section II that corporate diversification increases debt maturity and mitigates debt overhang via the coinsurance effect.

So far the analysis using the basket option approach mirrors Section II.B with enhanced flexibility in modeling. However, we have not taken into account the maturity-sensitive non-interest debt expenses. Next, we consider the costs (analogous to Section II.C) and demonstrate that the intuition of Proposition 1 on the long-term debt and short-term debt separation in multi-division firms and stand-alone firms can also be shown under the basket option approach. Specifically, we use an exponential function to capture the maturity-sensitive non-interest debt expenses and extend the overhang-adjusted NPV in eq. (12) to the following overhang and cost-adjusted NPV:[22]

$$R(N,t) = \{1 - O(N,t,W) - [1 + \exp(-bt)]\,\lambda\}\,\varepsilon, \tag{22}$$

where the cost function $\exp(-bt)$, with the maturity-sensitivity parameter $b > 0$, captures the negative correlation between non-interest debt expenses and maturity. Setting $b = 2.4$, $\lambda = 0.4$, $\rho = 0$ and $N = 6$ alongside other numerical values already set in Figure 4, we present in Figure 5 an example of long-term debt and short-term debt separation consistent with Proposition 1. Maximizing the overhang-adjusted NPV in eq. (22), there are cases where

[22]Compared with a linear function, an exponential function offers two advantages: a) it does not require an arbitrary cut-off on maturity to ensure a sizable cost of investment (that is the cost of investment is always larger than λ), and b) it provides smoothness as debt maturity increases and the difference in non-interest debt expenses for long maturities becomes negligible.

stand-alone firms' optimal debt maturity is shorter than that of multi-division firms, when all else equal. Figure 5 (X-axis and left Y-axis) presents an example of such cases.

C. Endogenous debt maturity in corporate diversification

We investigate how corporate diversification affects debt maturity and overhang by constraining the multi-division firm's book value of debt to be the same as that of the stand-alone firm. This is intentional and consistent with Admati et al. (2018)'s leverage ratchet effect – where shareholders resist book leverage reductions – and is confirmed empirically by Berger and Ofek (1995), who document that there is no economically significant difference between the book leverage of multi-division and stand-alone firms. This controlled setting allows us to isolate the impact of corporate diversification on debt maturity and overhang while holding other determinants of firm value constant.

The coinsurance effect of corporate diversification on firm risk is well understood in the corporate diversification discount literature, but there is currently no formal investigation of its potential effects on debt maturity and overhang. There is, however, some evidence suggesting that corporate diversification might benefit debt holders relative to shareholders in levered firms. Specifically, Mansi and Reeb (2002) study the risk effects of corporate diversification and its impact on firm value in levered and all-equity firms. In all-equity firms, there is no corporate diversification discount, while in levered firms shareholders' losses due to corporate diversification increase with leverage. Moreover, the overall impact of corporate diversification on excess firm value tends to be negligible in levered firms. Thus, these results suggest that the coinsurance effect reduces the market value of equity and enhances the market value of debt in levered firms. Mansi and Reeb (2002)'s argument is essentially a restatement of a potential consequence of corporate diversification that has been put forward in earlier contributions, such as Higgins and Schall (1975); Galai and Masulis (1976); Kim and McConnell (1977). The coinsurance effect of corporate diversification may result in a wealth transfer from shareholders to debt holders. However, the implicit assumption in Mansi and Reeb (2002) is that when firms diversify, they maintain the same maturity and face value of debt. This is not necessarily the case in real capital markets.

Figure 5 illustrates the effect of corporate diversification on the market value of debt and equity for a given value of debt maturity. Specifically, the right Y-axis in Figure 5 shows the market values of the stand-alone firm and the comparable multi-division firm. Assuming a debt maturity of one year for both firms, the market equity value of the multi-division firm is about 43, while that of the stand-alone firm is about 44. This result verifies Mansi and Reeb (2002)'s hypothesis: *conditional* on the assumption of the same debt maturity, the market value of equity for a stand-alone firm (red straight line in the graph) is higher than that of a multi-division firm (blue dashed straight line in the graph). However, this is a strong assumption in a world of imperfect 'me-first' rules where the shareholders control the investment decision (Galai and Masulis, 1976; Kim and McConnell, 1977).

Now, let us consider what happens if we relax the assumption of constant debt maturity. The shareholders of the multi-division firm can increase the NPV of their investments (adjusted for debt overhang and investment cost) by choosing a longer debt maturity, as shown on the left Y-axis of Figure 5. For example, choosing a debt maturity of 2.2 years – the optimal debt maturity maximizing the adjusted NPV for the multi-division firm in Figure 5 – increases the market value of equity from about 43 (for one-year maturity) to over 46. The optimal debt maturity – i.e., the debt maturity that maximizes the adjusted NPV – for the stand-alone firm is one year, which corresponds to a market value of equity of about 44. If both firms can choose their optimal debt maturity to maximize the adjusted NPV of their investments, diversifying can actually result in a premium. In other words, corporate diversification does not necessarily lead to a lower equity value if firms can increase their debt maturity when they decide to diversify, and increasing the debt maturity could lead to a diversification premium.

D. Implications for corporate diversification discount and premium

These results bear major implications on the interpretation of previous findings related to the existence of a diversification discount: if multi-division firms tend to have longer debt maturity than stand-alone firms – as we show below in our empirical exercise – due to the coinsurance effect, traditional measures of corporate diversification discount (Berger and Ofek, 1995; Mansi and Reeb, 2002) could be misleading. Our analysis here predicts that the debt maturity of multi-division firms can explain the traditional excess value measures (see equation (1) in Mansi and Reeb, 2002). Specifically, the benchmark used in conventional excess value measures is the sum of the market values of median stand-alone firms in each relevant industry segment. That is, for a multi-division firm i with m divisions, conventional excess value is measured as follows:

$$V_i^m - \sum_{j=1}^{m} \text{Mdn}\left\{V_k^s, k \in j\text{th sector}\right\}, \tag{23}$$

where V_i^m is the value of firm i and $\text{Mdn}\{V_k^s, k \in j\text{th sector}\}$ denotes the median value of stand-alone firms operating in sector j, controlled to be comparable (e.g., having the same level of sales) to division j of firm i.

However, we argue that an accurate measure of excess value should be based on a comparison of the firm's value to the sum of the (hypothetical) values of its divisions–as if each division were operated independently–with financial structures optimized for stand-alone operation. Formally:

$$V_i^m - \sum_{j=1}^{m} V_{i,j}^s, \tag{24}$$

where $V_{i,j}^s$ represents the counterfactual value of division j if it were a stand-alone firm. Importantly, $V_{i,j}^s$ is computed assuming the division adopts its own optimal debt maturity policy (the one that reflects its specific characteristics).

Replacing $V_{i,j}^s$ with $\text{Mdn}\{V_k^s, k \in j\text{th sector}\}$ in the conventional excess value measure neglects the endogenous nature of debt maturity in corporate diversification. Therefore, the debt maturity of the benchmark in the conventional excess value measure is not adjusted to reflect the benefits of reduced debt overhang that comes with corporate diversification: the debt maturity of the benchmark has a much smaller cross-sectional variation and concentrates around the median debt maturity of stand-alone firms; the debt maturity of multi-division firms is much more heterogeneous. As a result, the conventional excess value measure may misrepresent the true economic implications of corporate diversification.

According to our analysis above, overlooking the debt maturity adjustment in the benchmark causes the excess value to increase with the debt maturity. A more appropriate excess value measure taking into account the endogenous debt maturity should not have a significant association with debt maturity. Unfortunately, there is not an easy fix for the debt maturity misalignment issue in the traditional way (Berger and Ofek, 1995) of measuring excess value. Without a structural model, it will be a daunting task to calculate the optimal debt maturity for the stand-alone counterpart of the multi-division firm. A radically different approach than the traditional one could be required to handle the endogenous debt maturity choice. The structural model we develop here shows potential. But it is out of the scope of this paper to explore this potential. We leave this for future research.

IV. Evidence

Our analysis yields several predictions that establish connections between corporate diversification and various firm characteristics. Most importantly, the analysis suggests a clear relation between firms' debt maturity and their number of operational divisions. Specifically, it indicates that more diversified firms (those with more operational divisions) tend to issue debt with longer maturities due to the reduced debt overhang that comes with corporate diversification. In addition, our model also predicts that debt maturity is positively associated with the traditional measure of excess value. In this section, we conduct an empirical study presenting evidence supporting these predictions.

In Appendix C, we verify our main assumptions in the model and confirm empirical results in the previous literature. First, we test the assumption of a negative relation between the cost of debt and average debt maturity due to the higher frequency of short-term debt issues and rollover relative to long-term debt. Second, despite theoretical predictions suggesting a positive impact of diversification on debt capacity (Galai and Masulis, 1976; Lewellen, 1971), the empirical literature finds an insignificant relation between diversification and debt capacity (Berger and Ofek, 1995). For this reason, in our model, we impose that the face value of debt be the same for both stand-alone firm and multi-division firm. We thus test if multi-division firms tend to have a higher leverage than stand-alone firms and whether the number of segments increases leverage. Third, the literature provides evidence of a positive and significant relation between diversification and cash holdings (Duchin, 2010). We run regressions where CASH is the dependent variable to understand whether this is the case.

A. Data and panel regression specifications

We obtain annual firm-level data and SIC industry classifications from Compustat - Fundamentals Annual, and annual division-level data from the Compustat - Historical Segments. The sample period commences in 1978, coinciding with the availability of Compustat segment data, and ends in 2022. Following Boguth et al. (2022), we exclude firms with at least one division with SIC code within 6000-6999 (financial sector), below 1000 (agriculture), or equal to 8600, 8800, 8900, and 9000 (government, other noneconomic activities, or unclassified services). Our final sample includes 30,135 firms over 46 years of data. We also use Fama-French 48 industry classifications.[23] We follow Chen et al. (2012); Berger and Ofek (1995) to construct the key variables for our empirical analysis. We report the details of the variable definitions in Table 1. Our proxy for debt maturity is the log of

[23]The Fama-French 48 industry definitions are available on Ken French's website: https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/ftp/Siccodes48.zip

debt maturity, or DEBT_MATURITY. and our proxies for corporate diversification are a dummy identifying diversified firms – MULTI_DIVISION – and the log of the number of segments (NUM_SEGMENTS).[24] The summary statistics and pairwise correlations are presented in Table 3.

B. Debt maturity and corporate diversification

In this subsection, we present our key empirical results supporting our theoretical predictions regarding the positive association between corporate diversification and debt maturity.

1. Debt maturity before and after switches in divisional structure

Previous literature on the determinants of the decision to diversify or refocus (Campa and Kedia, 2002) neglects the role of debt maturity. In this section, we examine how DEBT_MATURITY changes around switches from being a stand-alone firm to being a multi-division firm (diversification), or *vice versa* (refocusing). Table 4 presents the results of two-sample t-tests before and after the year of the switch. Regardless of the direction of the switch, the average difference in DEBT_MATURITY between the diversified and stand-alone state is statistically significant and positive in seven cases out of eight.[25] This finding confirms that corporate diversification (refocusing) is always associated with

[24]All ratio variables are winsorized at the 1^{st} and 95^{th} percentiles to mitigate the influence of extreme values. Ratio variables are particularly susceptible to extreme outliers, especially when their denominators are very small, leading to disproportionately large values in the right tail of the distribution. Winsorizing at the 95^{th} percentile ensures that our results are not driven by such extreme observations. In the Internet Appendix, we demonstrate that our key findings remain robust to alternative winsorization thresholds.

[25]When changing from multi-division to stand-alone, the difference is statistically insignificant when we consider one year before and after the switch.

subsequently longer (shorter) debt maturity. The results in the table are consistent with those reported in Figure 6, where we visualize the median DEBT_MATURITY over an eight-year window (four years before and four years after) around the year of the switch.

2. Primary results

The central prediction of our theoretical models is that corporate diversification allows firms to have longer debt maturities. To test empirically whether this is true, we regress DEBT_MATURITY on MULTI_DIVISION and NUM_SEGMENTS and a set of control variables: MARKET_EQUITY, DEBT_TO_EQUITY, NET_INCOME, and CAPITAL_EXPENDITURE. We also include year-fixed effects and three types of cross-sectional fixed effects: firm-fixed effects, industry-fixed effects based on four-digit SIC codes, and industry-fixed effects based on the 48 Fama-French industries.

In Table 5, we report the results of these regressions. The coefficients for MULTI_DIVISION (NUM_SEGMENTS) are around 0.052 (0.041) with individual firm-fixed effects, 0.098 (0.073) with four-digit SIC industry-fixed effects and 0.107 (0.078) with 48 Fama-French industry-fixed effects. All coefficient estimates are statistically significant at the 1% level. The coefficients on MULTI_DIVISION, which range between 0.052 and 0.107, suggest that diversification is associated with an increase in debt maturity of slightly more than one year.[26] Since the median debt maturity for stand-alone firms is four years, corporate diversification allows a median stand-alone firm to increase debt maturity by around 25%.

The coefficients on NUM_SEGMENTS are positive and statistically significant, and

[26]For example, $e^{0.052} = 1.0534$.

range between 0.041 and 0.078. Since both variables are in logs, this means that a 10% increase in the number of segments increases debt maturity by around 0.39%–0.75%.[27] Therefore, our results in Table 5 suggest that the effect of corporate diversification on debt maturity is mainly driven by the transition from being a stand-alone to a diversified firm, rather than investing in one additional segment. Once a firm has diversified, increasing the degree of diversification does not lead to substantial increases in debt maturity. In the Internet Appendix, we show the results are robust to using Hoberg and Phillips (2016)'s *text-based network industry classifications* (TNIC) HHI measures.

3. Incremental explanatory power

In Table 6, we examine the incremental explanatory power – in terms of adjusted R^2 – of NUM_SEGMENTS in regressions on DEBT_MATURITY. To facilitate the comparison with the results including other explanatory variables, we report the results without firm fixed effects. Table 6a reports the results for univariate regressions. Consistent with existing literature (Stohs and Mauer, 1996), the regression on MARKET_EQUITY yields the highest adjusted R^2 (14%). The regression on NUM_SEGMENTS has the second-highest adjusted R^2, which is approximately 3.6%, corresponding to around 26% of the explanatory power of MARKET_EQUITY (as shown in the last row of Table 6a). The regressions on the other variables have an adjusted R^2 between 1.5% and 2.7%, corresponding to around 11%–19% of the explanatory power of MARKET_EQUITY.

Table 6b reports the results of multivariate regressions where we examine the

[27] For example, for the specification where the coefficient is 0.041, a 10% change in the number of segments leads to an increase in debt maturity of $(1.1^{0.041} - 1)\% = 0.39\%$.

incremental explanatory power of NUM_SEGMENTS relative to the others: DEBT_TO_EQUITY (first column), NET_INCOME (second column), CAPITAL_EXPENDITURES (third column), and MARKET_EQUITY(fourth column). In the first three columns of Table 6b, the incremental explanatory power of NUM_SEGMENTS ranges between 3% and 4%. The incremental explanatory power of the other variables ranges between 1.5% and 2.7%, consistent with the results of the univariate regression in Table 6a. However, the incremental explanatory power of NUM_SEGMENTS in the regression on MARKET_EQUITY is 0.3%. This result is not surprising: diversification and size are strongly connected, since diversified firms tend to be larger than stand-alone firms (Hund et al., 2024), and the decision to diversify is influenced by recent asset growth (Campa and Kedia, 2002). Consistent with this interpretation, the correlation between MARKET_EQUITY and NUM_SEGMENTS is 0.35, substantially higher than that between NUM_SEGMENTS and other control variables (ranging from -0.04 to 0.08; see Table 3). MARKET_EQUITY depends on both NUM_SEGMENTS and an average division size measure. Thus, the incremental value of NUM_SEGMENTS beyond MARKET_EQUITY lies in disentangling corporate diversification effects from overall firm size, offering additional insight into the determinants of DEBT_MATURITY.

4. Sub-sample analysis

To further ease the concern that the results in Table 5 could be driven by firm size, we repeat the regression of Table 5 on three sub-samples defined by *at*'s tertiles by years. The results are presented in Table 7. The positive effect of corporate diversification on debt maturity is observed in all three sub-samples, confirming that the results in Table 5 are robust. However, we do find that the coefficients of MULTI_DIVISION and NUM_SEGMENTS become smaller and less significant as the firm size moves into larger tertiles, suggesting that corporate diversification has a more pronounced effect on small and medium size firms' debt maturity than on large size firms'. Although not modeled in our theory, it is intuitively sensible that firms are less keen to adjust debt maturity after diversification when they have lower growth options for investment. Therefore, a diminishing effect of corporate diversification on debt maturity is consistent with the fact that firm growth decreases with firm size (see, e.g., Evans, 1987; Moeller, Schlingemann, and Stulz, 2004; Beck, Demirguc-Kunt, Laeven, and Levine, 2008).

C. The role of debt overhang

The central prediction of Proposition 1 is that corporate diversification leads to longer debt maturities because it mitigates the debt overhang problem. In this section, we test whether this is empirically verified using the proxy for overhang in Alanis et al. (2018) (OVERHANG).[28] Unlike other measures of debt overhang that infer default probability using credit ratings, this proxy estimates default probabilities directly using the hazard model developed by Chava and Jarrow (2004), and can therefore be applied even to firms without credit ratings. Similar to our model, this proxy is based on a positive relationship between default probability and debt overhang and a positive relationship between the market value of debt and investment. For robustness, we also construct an alternative proxy, OVERHANG_ALT, for debt overhang from our data. For ith firm in year t,

[28] We thank Emmanuel Alanis for providing us with the data. We refer the reader to equation (23) in Alanis et al. (2018) for details.

OVERHANG_ALT is defined as:

$$\text{OVERHANG\_ALT}_{i,t} = \exp\left(-\frac{capxv_{i,t}}{dt_{i,t}}\right) \tag{25}$$

This definition ensures that OVERHANG_ALT is within [0, 1] and positively (negatively) related to leverage (long-term investment), consistent with Myers (1977)'s debt overhang theory and Cai and Zhang (2011)'s empirical evidence.

To examine whether debt overhang is the channel through which corporate diversification affects debt maturity, we need to interact the proxy for debt overhang with our proxies for corporate diversification. We thus run regressions where we interact NUM_SEGMENTS with a dummy variable, OVERHANG_DUM, which is equal to one for firm i in year t if OVERHANG of firm i is higher than the median OVERHANG in year t, and zero otherwise. Using OVERHANG_DUM, instead of OVERHANG, allows us to interpret the coefficients on the interaction term NUM_SEGMENTS $\times$ OVERHANG_DUM more easily.

The results in Table 8a for OVERHANG_DUM suggest that debt overhang is positively related to debt maturity, consistent with the view that longer debt maturities are associated with higher debt overhang. The coefficient on NUM_SEGMENTS $\times$ OVERHANG_DUM is positive and statistically significant, confirming that corporate diversification's positive relation with debt maturity is stronger for firms with a higher degree of debt overhang. In other words, our results indicate that firms with higher debt overhang are more keen to take advantage of issuing longer-maturity debt when they diversify their businesses. In Table 8b, we replace OVERHANG_DUM with OVERHANG_DUM_ALT, and we find similar results:

the coefficients on OVERHANG_DUM_ALT are positive and statistically significant, as are those on the interaction term NUM_SEGMENTS × OVERHANG_DUM_ALT.

Taken together, the results in Table 8 provide corroborating evidence that debt overhang is a key factor channeling the interplay between corporate diversification and debt maturity.

D. Debt maturity and excess value

To test our prediction of the positive relation between debt maturity and the excess value (EV), we follow Berger and Ofek (1995); Mansi and Reeb (2002) and compute the EV for firms in our sample. More concretely, we measure the EV as the log difference between a firm's capital value (the market value of equity + the book value of debt) and the sum of imputed values for its segments as stand-alone entities. We calculate the imputed value of each segment by multiplying the median ratio, for stand-alone firms in the same industry, of CAPITAL_TO_SALES. The industry median ratios are based on the most refined SIC category that includes at least five single-line businesses with at least \$20 million of sales and sufficient data for computing CAPITAL_TO_SALES. Specifically, for firm i with m division, its excess value is calculated as:

$$\text{EV}_i = \text{TOTAL\_CAPITAL}_i - \log\left[\sum_{j=1}^{m} sale_{i,j} \times \text{Mdn}_j(\text{CAPITAL\_TO\_SALES})\right] \quad (26)$$

where $sale_{i,j}$ is the net sales of the jth division in firm i and $\text{Mdn}_j(\text{CAPITAL\_TO\_SALES})$ is the median CAPITAL_TO_SALES ratio of stand-alone firms in the jth division's industry. Same as Berger and Ofek (1995), extreme EVs are excluded from the analysis. "Extreme" is defined as an absolute EV value above 1.386 (i.e., actual values either more than four times imputed or less than one-fourth imputed).

The cross-sectional distribution of EV over time is presented in Figure 7. It is clear that the EV value has turned more negative in recent years, consistent with recent studies using Berger and Ofek (1995)'s EV measure. We regress the EV on DEBT_MATURITY and MULTI_DIVISION or NUM_SEGMENTS alongside the control variables and present the regression results in Table 9. The coefficients of DEBT_MATURITY are around 0.03 and highly significant at 1% level in all versions of the regressions. In economic terms, the point estimates of the coefficients mean that one standard deviation increase in DEBT_MATURITY results in a 1.6% increase in the EV. These results provide strong evidence supportive of our prediction on the positive relation between EV and debt maturity.

We also note that the coefficients of both MULTI_DIVISION and NUM_SEGMENTS are negative and significant. The negative sign of MULTI_DIVISION's coefficient is consistent with Berger and Ofek (1995, Table 3) and Mansi and Reeb (2002, Table II) indicating the EV measure is more negative for multi-division firms than stand-alone firms. The magnitude of MULTI_DIVISION's coefficient captures the difference in average EV between multi-division and stand-alone firms. This difference is about -4.8% in our sample, which is very close to Mansi and Reeb (2002)'s -4.5% in their Table II. The coefficients of NUM_SEGMENTS are around -0.044 to -0.065 in all three versions of the regression with statistical significance at 1%, indicating in economic terms that for an average multi-division firm increasing the degree of diversification by two segments will induce 7% decrease in its EV measure. These results are robust to sample selection as evidenced in

Table 10, where we repeat the same regressions in sub-samples before and after 2000 and find qualitatively the same conclusion in both sub-samples. These are evidence replicating results found in typical studies of corporate diversification. The fact that the traditional EV measure is significantly correlated with debt maturity, which is consistent with our theoretical prediction, suggests that this measure could be misleading and likely to be overstated because it does not allow for the endogenous nature of debt maturity preferences in corporate diversification choices.

V. Conclusions

In this paper, we provide a comprehensive analysis of the impact of corporate diversification on firms' debt maturity decisions, which has been long overdue considering the extensive focus in isolation on the two topics in the literature. We develop both a simple discrete-time model and a more flexible continuous-time structural model using option pricing techniques to explore the interplay between corporate diversification and debt maturity. Our analysis highlights that the coinsurance effect of corporate diversification lowers the conditional variance of future payoffs, thereby reducing default risk and alleviating debt overhang for both short- and long-term debt. In our model, long-term debt is less costly than short-term debt because it requires less frequent issuance and rollover. As a result, holding all else equal, firms with multiple divisions are more likely to issue long-term debt. This is the key prediction of our theoretical framework.

We provide empirical evidence supporting our models' assumptions and predictions. First, we find that there is a positive association between corporate diversification and debt maturity, indicating that multi-division firms have longer debt maturity compared to stand-alone firms. Second, the positive effect of diversification on debt maturity is more pronounced in small and medium-size firms, due to better investment opportunities compared to large firms.[29] Additionally, there is evidence that confirms a positive correlation between debt maturity and the traditional excess value measure. Moreover, our results show that the cost of debt decreases as the average debt maturity increases, consistent with the assumption that short-term debt is more expensive than long-term debt. These empirical findings substantiate our models' insights into the interplay between corporate diversification, debt maturity, and firm value.

To conclude, our study provides an analytical framework for examining the relationship between debt maturity and corporate diversification. Our theoretical insights and empirical findings suggest that the widely documented corporate diversification discount may be an artifact of debt maturity misalignment in the matching process, stemming from overlooked endogeneity in debt maturity decisions.

[29] A second possible interpretation of this result is that large firms might benefit less from corporate diversification because, due to their size, they may have already reached significant diversification and optimized their debt maturity structure, all else equal.

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Figure 1

Timeline of the possible paths of stand-alone firm S's assets-in-place

This figure plots all possible values of stand-alone firm S's assets-in-place on $t = 2$ and two states $\{G$ and $B\}$ on $t = 1$. The probability of each path is shown along the path. Long-term and short-term face values of debt are indicated in the graph as long and short lines with corresponding legends.

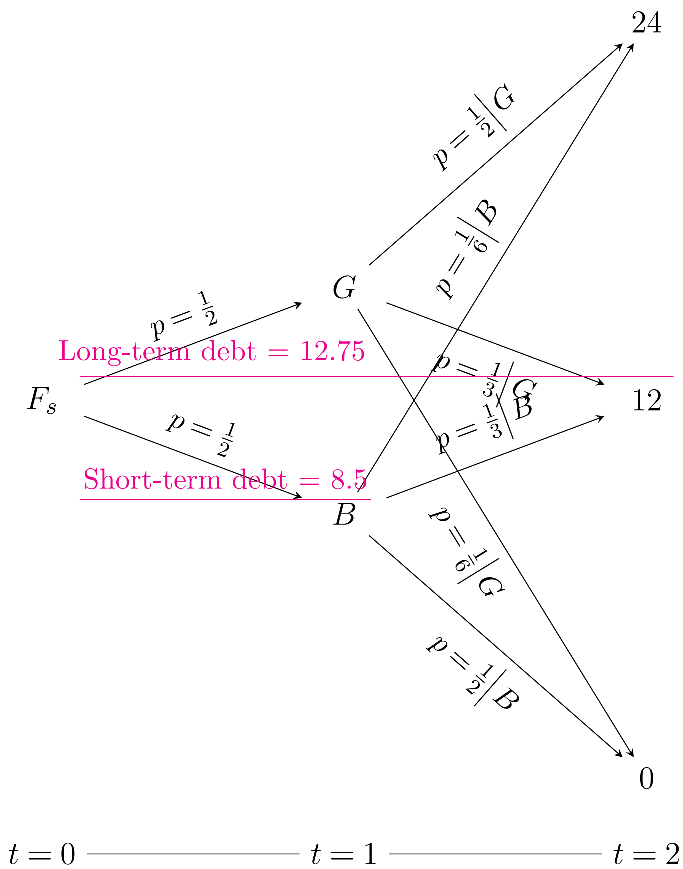

Figure 2

Timeline of the possible paths of multi-division firm M's assets-in-place

In this figure, panels (a) and (b) plot all possible values of multi-division firm M's two assets-in-place $F_m(1)$ and $F_m(2)$, respectively, on $t = 2$ and two states $\{G \text{ and } B\}$ on $t = 1$. The probability of each path is shown along the path. Panel (c) plots the same paths for the combined assets-in-place F_m for firm M. Long-term and short-term face values of debt are indicated in panel (c) as long and short lines with corresponding legends.

(a) **First assets-in-place:** $F_m(1)$ (b) **Second assets-in-place:** $F_m(2)$

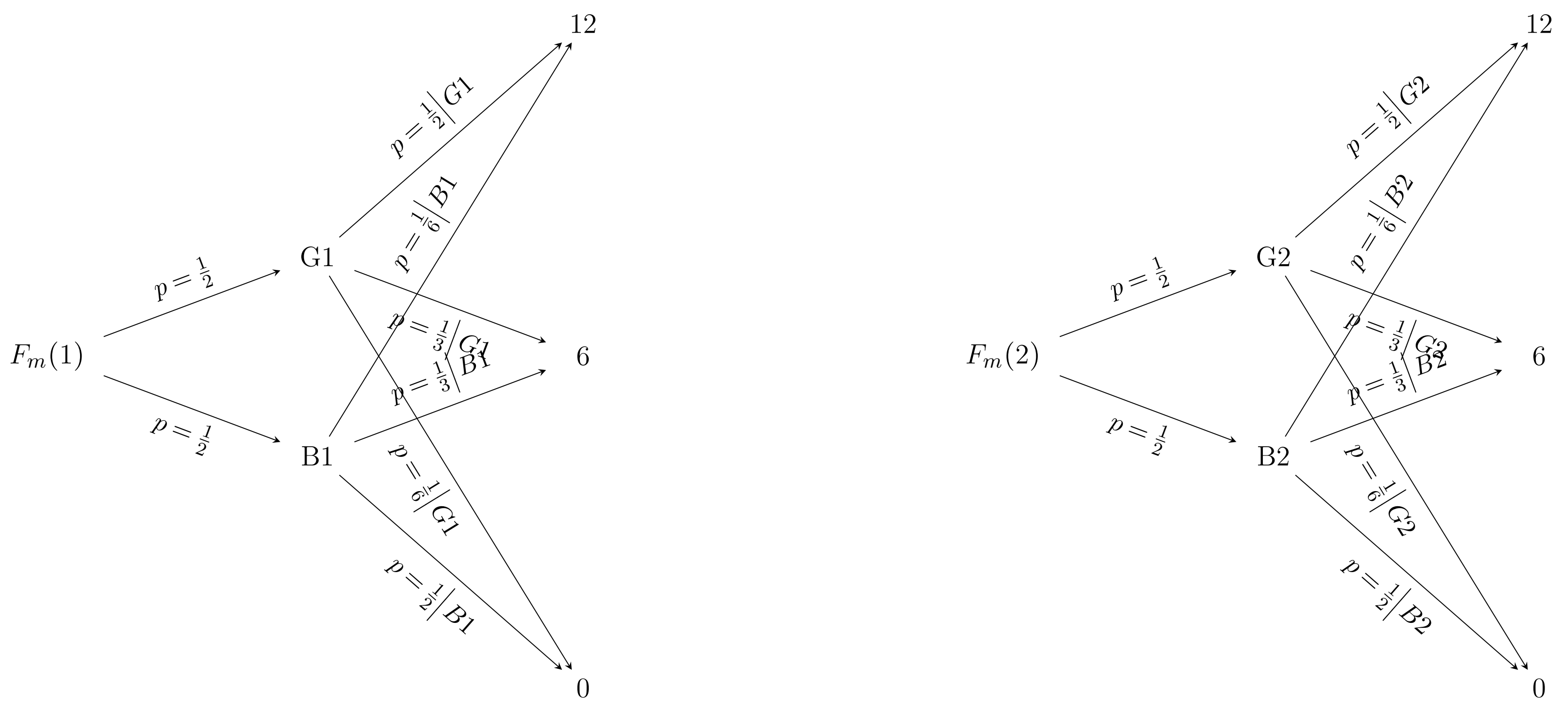

Figure 2

Timeline of the possible paths of multi-division firm M's assets-in-place (cont.)

(c) **Combined assets-in-place F_m**

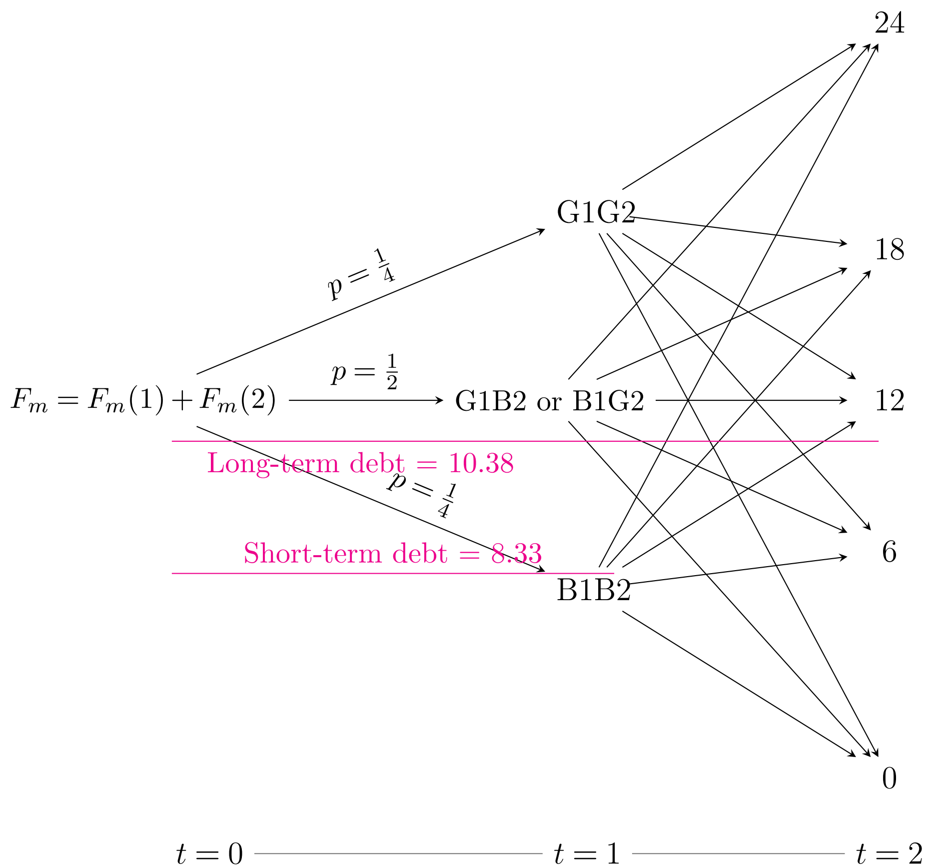

Figure 3

Plots of the numerical examples of $P_s^{\mathbf{ST}}$ and $P_m^{\mathbf{ST}}$

In this figure the areas of the different shapes represent probability values. Panels (a) and (b) respectively plot stand-alone firm S and multi-division firm M's probabilities of investing with short-term debt P_i^{ST} and long-term debt P_i^{LT} defined in Proposition 1. The formulae of different areas are presented in Appendix A. The numerical values of parameters are set as: $O_s^{\mathrm{ST}} = \frac{1}{2}$, $O_s^{\mathrm{LT}} = \frac{2}{3}$, $O_m^{\mathrm{ST}} = \frac{1}{4}$, and $O_m^{\mathrm{LT}} = \frac{1}{3}$; $\bar{\xi} = 1$ and $\underline{\lambda} = 0.25$.

(a) **Stand-alone firm** S (b) **Multi-division firm** M

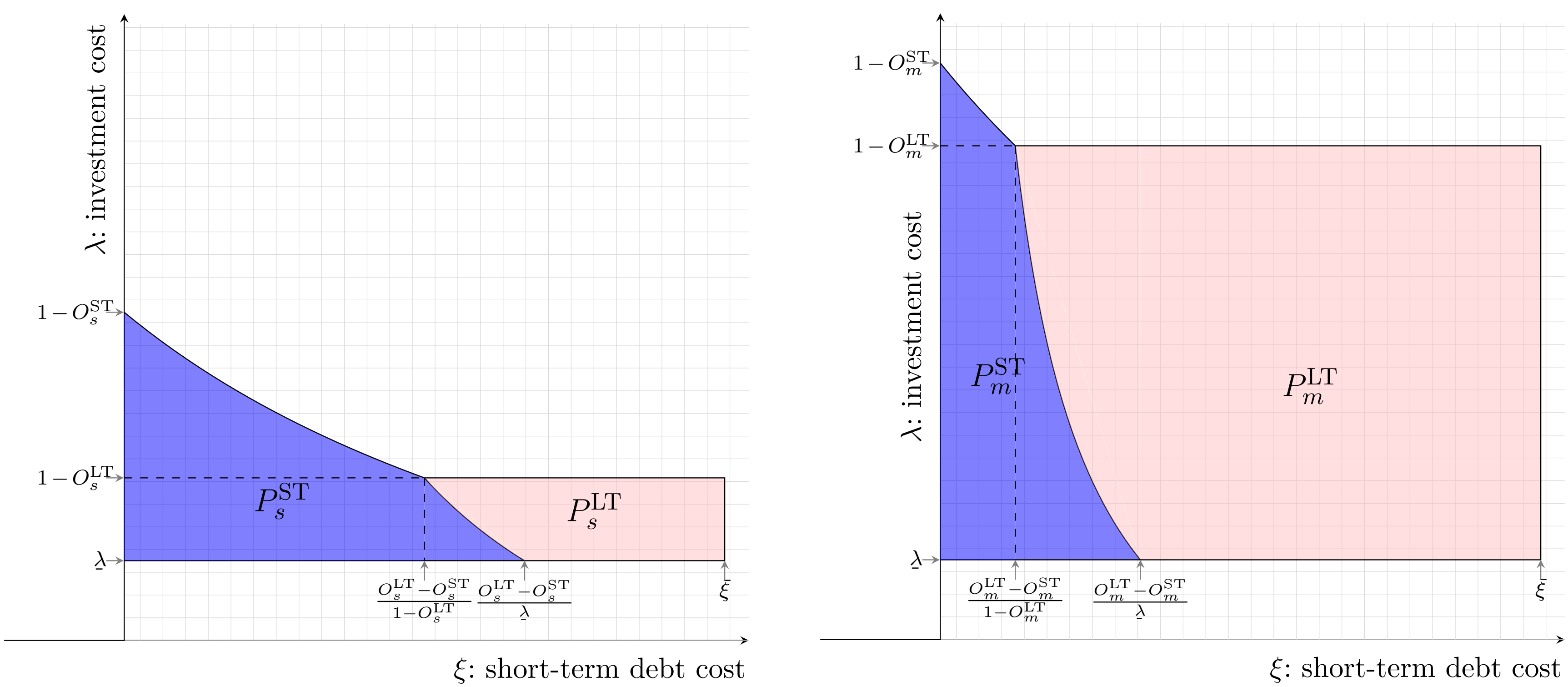

Figure 4

Debt maturity and overhang change with number of segments

The left (right) panel plots debt maturity (debt overhang) against the number of segments. The numerical values for the parameters are set as: $g_i = r = 5\%$, $\sigma_i = 0.4$, $V = 100$, $v_i = \frac{100}{N}$, $L = 60$. The three curves in the left (right) panel represent debt maturity (debt overhang) with three pair-wise correlation levels ($\rho = 0, 0.1$, and 0.3). The debt maturity and overhang of the comparable stand-alone firm are also plotted for reference purposes.

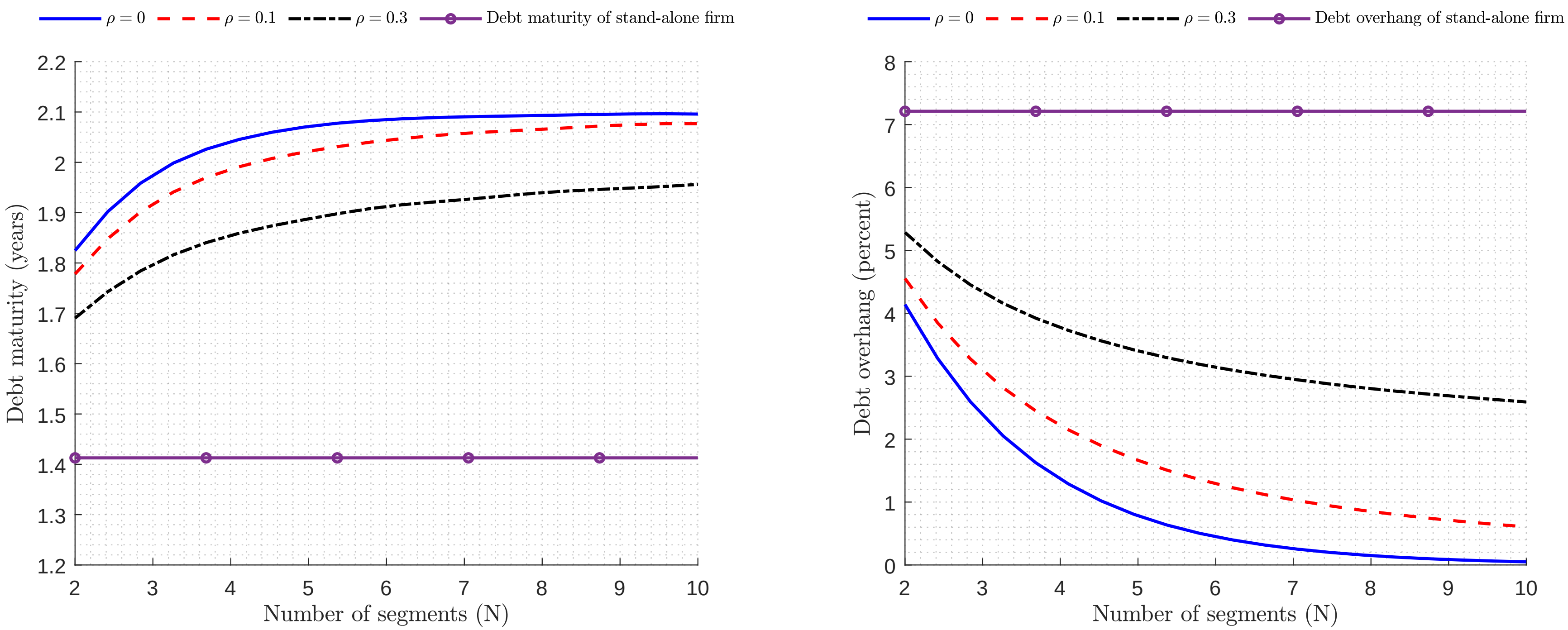

Figure 5

Optimal debt maturity in the presence of non-interest debt expenses

The left Y-axis in this figure visually compares the overhang and cost-adjusted NPVs given various debt maturities of the multi-division firm with those of the comparable stand-alone firm. The right Y-axis in this figure visually compares the corresponding market values of equity of the multi-division firm with those of the comparable stand-alone firm. The numerical values for the parameters are set as: $g_i = r = 5\%$, $\sigma_i = 0.4$, $N = 6$, $V = 100$, $v_i = \frac{100}{6}$, $L = 60$, $\rho_{i,j} = 0$.

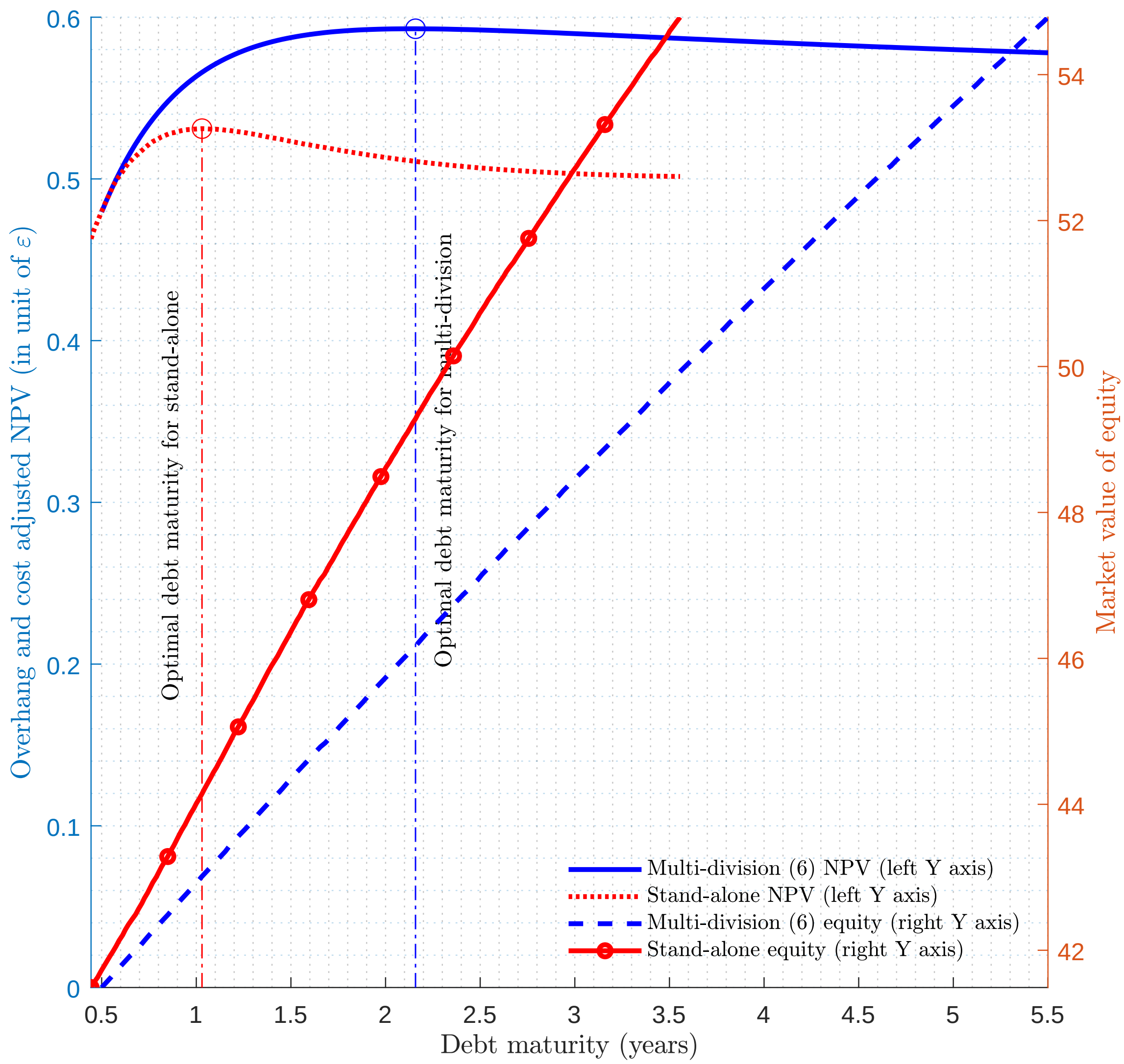

Figure 6

Debt maturity before and after diversification and refocusing

This figure plots the median DEBT_MATURITY of firms that change from stand-alone to multi-division or the other way around or both over an eight-year window around the year of the switch (four years before and four years after). The dash (solid) line shows the median DEBT_MATURITY dynamic of cases in which firms change from stand-alone to multi-division (multi-division to stand-alone)

Figure 7

Excess value cross-sectional distribution over the years

This figure plots the cross-sectional distribution of Berger and Ofek (1995)'s excess value measure from 1978 to 2022. The solid line represents the cross-sectional median of the excess value in each year. The shadowed area around the solid line represents the 25th percentile to 75th percentile of the cross-sectional distribution of the excess value in each year.

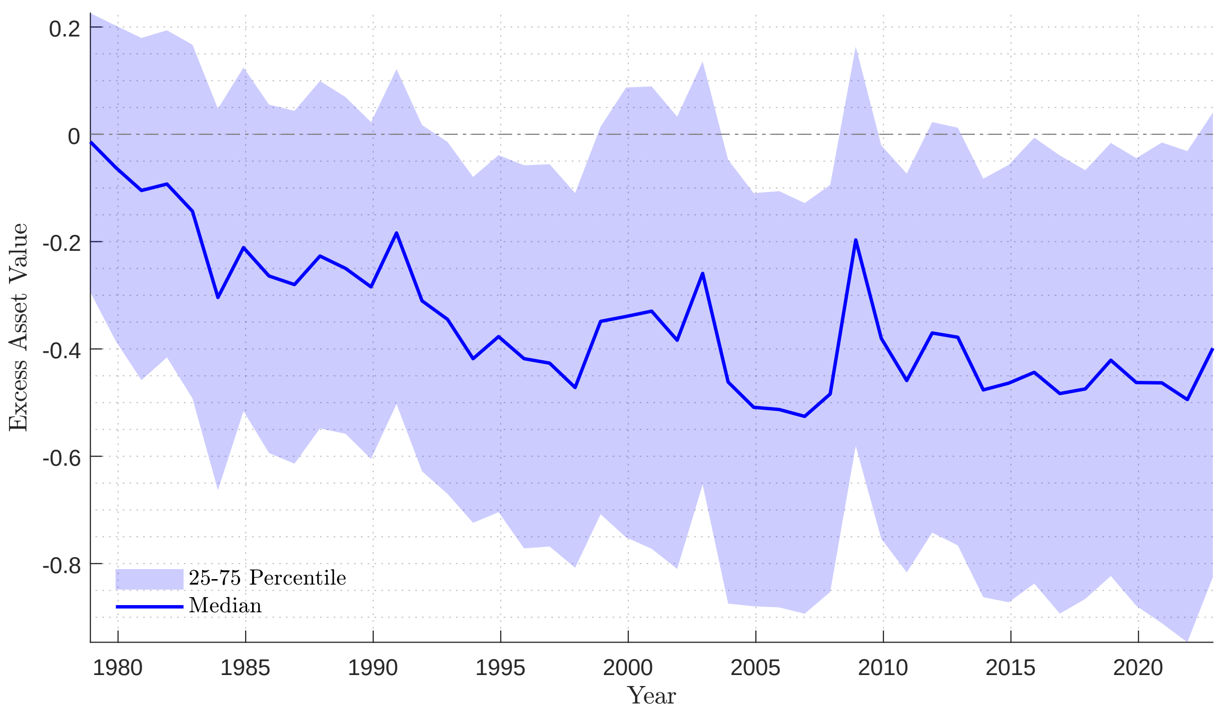

Table 1

Variable definitions

This table presents the detailed definitions of all variables constructed for the empirical study. They are DEBT_MATURITY, NUM_SEGMENTS, MULTI_DIVISION, COST_DEBT, LEVERAGE, LEVERAGE, CASH, MARKET_EQUITY, DEBT_TO_EQUITY, NET_INCOME, CAPITAL_EXPENDITURES, TOTAL_CAPITAL, CAPITAL_TO_SALES, and EV.

Variable	Definition
DEBT_MATURITY	We follow Chen et al. (2012) and construct the debt maturity measure (in years) as the book-value weighted maturity by assuming the average maturities of the six Compustat maturity categories, which are debt in current liabilities (Compustat item *dlc*), debt due in the second year (*dd*2), debt due in the third year (*dd*3), debt due in the fourth year (*dd*4), debt due in the fifth year (*dd*5), and debt due in more than five years ($dltt - dd2 - dd3 - dd4 - dd5$), to be 0.5 year, 1.5 years, 2.5 years, 3.5 years, 4.5 years, and 13 years. We use the log value of this variable in the regressions.
NUM_SEGMENTS	The number of segments is defined as the number of unique segment identifiers (*sid*) in each year (Berger and Ofek, 1995; Onali and Mascia, 2022). We use the log value of this variable in the regressions.
MULTI_DIVISION	This is an indicator variable that equals one if number of segments is larger than one and zero otherwise (Berger and Ofek, 1995; Mansi and Reeb, 2002).
COST_DEBT	We define the cost of debt measure as the ratio of total interest and related expenses (*xint*) to total debt (*dt*) (Frank and Shen, 2016).
LEVERAGE	The measure of leverage is defined as the ratio of total debt (*dt*) to total assets (*at*) (Berger and Ofek, 1995; Mansi and Reeb, 2002).
CASH	The measure of cash is defined as the cash and cash equivalents (*che*) to *at* (Duchin, 2010).
MARKET_EQUITY	The measure of market equity is used as a control for the firm size (Redding, 1997). Market equity equals the close price (*prcc_f*) times the common shares outstanding (*csho*). We use the log value of this variable in the regressions.
DEBT_TO_EQUITY	The measure of debt to equity is used as a control for the capital structure of the firm and defined as the ratio of total debt (*dt*) to shareholders' equity (*seq*).
NET_INCOME	The measure of net income is used as a control for profitability and defined as the ratio of total net income (*ni*) to *at* (Barth, Beaver, and Landsman, 1998).
CAPITAL_EXPENDITURES	The measure of capital expenditures is used as a control for long-term investment and defined as the ratio of capital expenditures (*capxv*) to *at* (Mansi and Reeb, 2002).
TOTAL_CAPITAL	The measure of total capital is used for the excess value computation and defined as *market equity* + *at* − common/ordinary equity (*ceq*) (Berger and Ofek, 1995). We use the log value of this value in the excess value computation.
CAPITAL_TO_SALES	The ratio of capital to sales is used for the excess value computation and defined as *total capital* divided by net sales (*sale*) (Berger and Ofek, 1995).
EV	We follow Berger and Ofek (1995); Mansi and Reeb (2002) and calculate the excess value as: $$\text{EV}_i = \text{TOTAL\_CAPITAL}_i - \log\left[\sum_{j=1}^{m} sale_{i,j} \times \text{Mdn}_j(\text{CAPITAL\_TO\_SALES})\right]$$ where $sale_{i,j}$ is the net sales of the jth division in firm i and Mdn_j(CAPITAL_TO_SALES) is the median CAPITAL_TO_SALES ratio of stand-alone firms in the jth division's industry.

Table 2

Basket option model parameter descriptions

This table presents the detailed descriptions of model parameters and functions used in the basket option model for corporate diversification.

Parameters and functions	Description	Cross-reference
V	Total firm asset value	eq. (18)
N	Total number of business divisions within the firm	eq. (18)
v_i	Asset value of each business division	eq. (18)
w_i	Wiener process under the $\mathbb{Q}$ measure that captures v_i's random innovation term	eq. (18)
g_i	$\mathbb{Q}$ measure growth rate of v_i	eq. (18)
σ_i	Volatility of v_i	eq. (18)
$\rho_{i,j}$	Pair-wise correlation between w_i and w_j	eq. (18)
L	Face-value of firm's zero-coupon debt	eq. (19)
t	Maturity time of firm's debt	eq. (19)
W_i	Weight of each division's asset value to total firm asset value	eq. (21)
$D(L,t)$	Market value of firm's debt	eq. (21)
$E(L,t)$	Market value of firm's equity	eq. (19)
$O(N,t,W)$	Debt overhang from infinitesimal investments	eq. (21)
$R(N,t)$	Overhang and cost-adjusted NPV	eq. (22)

Table 3

Summary statistics and pair-wise correlations

This table reports summary statistics and pair-wise correlation matrix of the variables constructed for the empirical study. They are DEBT_MATURITY, NUM_SEGMENTS, MULTI_DIVISION, MARKET_EQUITY, DEBT_TO_EQUITY, NET_INCOME, CAPITAL_EXPENDITURES, LEVERAGE, CASH, and EV. The summary statistics are presented in the six columns on the left and include the observation counts (Obs.), mean, standard deviation (SD), 10th percentile (P10), median, and 90th percentile (P90). The correlation matrix is presented in the nine columns on the right. All correlation coefficients are statistically significant at 1% level.

	Obs.	Mean	SD	P10	Median	P90	1	2	3	4	5	6	7	8	9	10
1. DEBT_MATURITY	244,533	1.33	1.07	-0.65	1.65	2.49	-									
2. NUM_SEGMENTS	265,346	0.41	0.62	0.00	0.00	1.39	0.18	-								
3. MULTI_DIVISION	265,346	0.34	0.47	0.00	0.00	1.00	0.16	0.92	-							
4. MARKET_EQUITY	236,593	4.77	2.66	1.48	4.65	8.31	0.38	0.35	0.28	-						
5. DBET_TO_EQUITY	282,466	0.45	2.03	-0.05	0.38	2.15	0.11	0.06	0.06	0.08	-					
6. NET_INCOME	281,270	-0.57	4.60	-0.61	0.02	0.12	0.16	0.08	0.08	0.16	0.06	-				
7. CAPITAL_EXPENDITURES	278,455	0.06	0.06	0.00	0.04	0.15	0.11	-0.04	-0.02	0.03	0.05	0.06	-			
8. LEVERAGE	282,678	0.32	0.30	0.03	0.26	0.67	0.07	-0.05	-0.05	-0.18	-0.07	-0.39	-0.01	-		
9. CASH	282,515	0.18	0.23	0.01	0.08	0.56	-0.16	-0.20	-0.21	-0.03	-0.10	-0.06	-0.20	-0.14	-	
10. EV	208,943	-0.31	0.56	-1.04	-0.33	0.44	0.09	-0.01	0.00	-0.04	0.05	-0.02	0.06	0.07	0.01	-

Table 4

Debt maturity before and after diversification and refocusing

This table compares the before and after DEBT_MATURITY of firms that change from stand-alone to multi-division or the other way around or both. The left (right) four columns report the comparison for cases in which firms change from multi-division to stand-alone (stand-alone to multi-division). The first and second columns report the average DEBT_MATURITY before and after the (de)diversification year, respectively. The third column reports the t-test of the difference between the after and before DEBT_MATURITY. The fourth column reports the sample size (# of obs) of the t-tests. The first four rows report the results using observations from one up to four years pre and post the (de)diversification year. The fifth row reports the number of unique firms (# of firms) in the testing sample. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively.

	Multi-division → Stand-alone				Stand-alone → Multi-division			
	Before (B)	After (A)	t-test (A - B)	# of obs	Before (B)	After (A)	t-test (A - B)	# of obs
1 year away	1.24	1.22	-0.02	2,060	1.22	1.27	0.06***	4,375
2 years away	1.26	1.23	-0.04*	4,119	1.21	1.26	0.04***	8,744
3 years away	1.28	1.23	-0.05***	6,177	1.21	1.26	0.05***	13,104
4 years away	1.30	1.22	-0.07***	8,233	1.20	1.25	0.05***	17,445
# of firms	1,013				2,213			

Table 5

Debt maturity regression results

This table provides results from separately regressing DEBT_MATURITY on MULTI_DIVISION and NUM_SEGMENTS alongside various control variables including MARKET_EQUITY, DEBT_TO_EQUITY, NET_INCOME, and CAPITAL_EXPENDITURES. The numbers of valid observations, unique firms, and adjusted R-squared are reported alongside the regression coefficient estimates. Three versions of panel regressions with fixed effects are presented. We control for year-fixed effects in all specifications. The three types of cross-sectional fixed effects are: individual firm-fixed effects, industry-fixed effects based on the four-digit SIC codes, and industry-fixed effects based on the 48 Fama-French industries. The t-statistics (reported parentheses) are based on robust standard errors adjusted for heteroskedasticity and clustering in cross-sectional fixed effects groups. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively.

	DEBT_MATURITY					
MULTI_DIVISION	0.052***		0.098***		0.107***	
	(7.70)		(8.59)		(5.21)	
NUM_SEGMENTS		0.041***		0.073***		0.078***
		(7.97)		(7.92)		(4.45)
MARKET_EQUITY	0.092***	0.092***	0.145***	0.144***	0.145***	0.144***
	(41.30)	(41.15)	(30.71)	(30.17)	(26.61)	(25.44)
DBET_TO_EQUITY	0.018***	0.018***	0.029***	0.029***	0.032***	0.032***
	(15.59)	(15.56)	(11.85)	(11.89)	(8.35)	(8.41)
NET_INCOME	0.006***	0.006***	0.015***	0.015***	0.016***	0.016***
	(10.54)	(10.54)	(11.71)	(11.75)	(10.83)	(10.90)
CAPITAL_EXPENDITURES	0.545***	0.545***	0.469***	0.471***	0.563***	0.564***
	(12.55)	(12.53)	(4.52)	(4.50)	(4.95)	(4.89)
Observations	189,798	189,798	191,831	191,831	191,831	191,831
Firms	18,794	18,794	20,827	20,827	20,827	20,827
Adjusted R-squared	0.49	0.49	0.26	0.26	0.25	0.25
Fixed Effects	year and firm	year and firm	year and 4-digit SIC	year and 4-digit SIC	year and 48 FF	year and 48 FF

Table 6

Incremental R-squared results

Panel (a) of this table shows the results of univariate regressions, where DEBT_MATURITY is separately regressed on NUM_SEGMENTS, DEBT_TO_EQUITY, NET_INCOME, CAPITAL_EXPENDITURES, and MARKET_EQUITY. Panel (b) reports the results of multivariate regressions, where DEBT_MATURITY is separately regressed on DEBT_TO_EQUITY, NET_INCOME, CAPITAL_EXPENDITURES, and MARKET_EQUITY, each including NUM_SEGMENTS as an additional explanatory variable. Both panels report the OLS coefficient estimates along with the number of valid observations and adjusted R-squared values (Adj. R-squared). The relative adjusted R-squared (Rel. Adj. R-squared) in Panel (a) is calculated as the percentage of the adjusted R-squared of the first to fourth regressions relative to that of the last regression. The incremental adjusted R-squared (Incr. Adj. R-squared) in Panel (b) is calculated as the difference between Adj. R-squared's of Panel (b) and those in Panel (a)'s second to fifth regressions. Robust standard errors, adjusted for heteroskedasticity are used to compute the t-statistics (reported in parentheses). *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively.

(a) **Univariate regressions**

	DEBT_MATURITY				
NUM_SEGMENTS	0.311***				
	(92.94)				
DEBT_TO_EQUITY		0.069***			
		(42.47)			
NET_INCOME			0.038***		
			(42.37)		
CAPITAL_EXPENDITURES				2.031***	
				(54.02)	
MARKET_EQUITY					0.149***
					(182.11)
Observations	189,798	189,798	189,798	189,798	189,798
Firms	18,794	18,794	18,794	18,794	18,794
Adj. R-squared	0.036	0.015	0.027	0.015	0.140
Rel. Adj. R-squared	25.8%	10.9%	19.3%	11%	–

(b) **Multivariate regressions**

	DEBT_MATURITY			
NUM_SEGMENTS	0.299***	0.291***	0.322***	0.104***
	(89.71)	(87.25)	(96.94)	(29.85)
DEBT_TO_EQUITY	0.063***			
	(39.59)			
NET_INCOME		0.035***		
		(41.44)		
CAPITAL_EXPENDITURES			2.205***	
			(59.49)	
MARKET_EQUITY				0.140***
				(156.80)
Observations	189,798	189,798	189,798	189,798
Firms	18,794	18,794	18,794	18,794
Adj. R-squared	0.049	0.058	0.054	0.143
Incr. Adj. R-squared	0.033	0.031	0.039	0.003

Table 7

Debt maturity regression results conditional on total assets tertiles

This table provides subsample results based on total assets (*at*) tertiles. We regress DEBT_MATURITY on MULTI_DIVISION and NUM_SEGMENTS alongside various control variables including MARKET_EQUITY, DEBT_TO_EQUITY, NET_INCOME, and CAPITAL_EXPENDITURES. The three sub-samples are defined by *at*'s tertiles by years. Panels (a), (b), and (c) report the results from the first, second, and third tertiles, respectively. The numbers of valid observations, unique firms, and adjusted R-squared are reported alongside the regression coefficient estimates. Three versions of panel regressions with fixed effects are presented. We control for year-fixed effects in all specifications. The three types of cross-sectional fixed effects are: individual firm-fixed effects, industry-fixed effects based on the four-digit SIC codes, and industry-fixed effects based on the 48 Fama-French industries. The t-statistics (reported parentheses) are based on robust standard errors adjusted for heteroskedasticity and clustering in cross-sectional fixed effects groups. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively.

(a) **Conditional on 1st *at* tertile**

	DEBT_MATURITY conditional on total assets 1st tertile					
MULTI_DIVISION	0.075***		0.113***		0.122***	
	(4.46)		(5.83)		(5.54)	
NUM_SEGMENTS		0.084***		0.105***		0.115***
		(5.40)		(6.05)		(5.40)
MARKET_EQUITY	0.058***	0.058***	0.063***	0.063***	0.061***	0.060***
	(13.42)	(13.29)	(7.27)	(7.20)	(4.93)	(4.86)
DBET_TO_EQUITY	0.008***	0.008***	0.015***	0.015***	0.017***	0.017***
	(3.23)	(3.23)	(3.75)	(3.77)	(3.38)	(3.38)
NET_INCOME	0.006***	0.006***	0.013***	0.013***	0.014***	0.014***
	(9.49)	(9.46)	(11.93)	(11.89)	(10.20)	(10.09)
CAPITAL_EXPENDITURES	0.798***	0.798***	0.845***	0.845***	0.908***	0.908***
	(9.50)	(9.50)	(8.03)	(7.99)	(8.15)	(8.12)
Observations	53,406	53,406	55,412	55,412	55,413	55,413
Firms	8,100	8,100	10,106	10,106	10,107	10,107
Adjusted R-squared	0.37	0.37	0.12	0.12	0.10	0.10
Fixed Effects	year and firm	year and firm	year and 4-digit SIC	year and 4-digit SIC	year and 48 FF	year and 48 FF

Table 7

Debt maturity regression results conditional on total assets (*at*) tertiles (cont.)

(b) **Conditional on 2nd *at* tertile**

	DEBT_MATURITY conditional on total assets 2nd tertile					
MULTI_DIVISION	0.044***		0.058***		0.069***	
	(3.42)		(3.79)		(3.12)	
NUM_SEGMENTS		0.033***		0.050***		0.060***
		(2.97)		(3.62)		(3.04)
MARKET_EQUITY	0.088***	0.088***	0.087***	0.087***	0.074***	0.074***
	(17.91)	(17.88)	(12.85)	(12.77)	(6.87)	(6.84)
DBET_TO_EQUITY	0.021***	0.021***	0.028***	0.028***	0.031***	0.031***
	(9.56)	(9.56)	(8.41)	(8.43)	(7.25)	(7.28)
NET_INCOME	0.067***	0.067***	0.098***	0.098***	0.135**	0.135**
	(3.00)	(3.00)	(2.77)	(2.77)	(2.37)	(2.37)
CAPITAL_EXPENDITURES	0.581***	0.580***	0.644***	0.646***	0.840***	0.842***
	(7.85)	(7.84)	(4.97)	(4.97)	(6.29)	(6.32)
Observations	65,387	65,387	67,368	67,368	67,369	67,369
Firms	9,397	9,397	11,378	11,378	11,379	11,379
Adjusted R-squared	0.42	0.42	0.14	0.14	0.11	0.11
Fixed Effects	year and firm	year and firm	year and 4-digit SIC	year and 4-digit SIC	year and 48 FF	year and 48 FF

Table 7

Debt maturity regression results conditional on total assets (*at*) tertiles (cont.)

(c) Conditional on 3rd *at* tertile

	DEBT_MATURITY conditional on total assets 3rd tertile					
MULTI_DIVISION	0.015*		0.037**		0.039*	
	(1.69)		(2.40)		(1.76)	
NUM_SEGMENTS		0.009		0.024**		0.024
		(1.51)		(2.28)		(1.49)
MARKET_EQUITY	0.057***	0.057***	0.039***	0.038***	0.036***	0.036***
	(14.36)	(14.34)	(7.52)	(7.39)	(5.57)	(5.46)
DBET_TO_EQUITY	0.016***	0.016***	0.024***	0.024***	0.026***	0.026***
	(10.58)	(10.56)	(9.00)	(8.99)	(6.06)	(6.06)
NET_INCOME	0.081**	0.081**	-0.046	-0.045	-0.044	-0.043
	(2.27)	(2.27)	(-0.93)	(-0.91)	(-0.79)	(-0.77)
CAPITAL_EXPENDITURES	0.299***	0.298***	0.259**	0.258**	0.197	0.193
	(4.96)	(4.94)	(2.12)	(2.10)	(1.22)	(1.20)
Observations	67,184	67,184	67,888	67,888	67,888	67,888
Firms	5,674	5,674	6,378	6,378	6,378	6,378
Adjusted R-squared	0.40	0.40	0.13	0.13	0.08	0.08
Fixed Effects	year and firm	year and firm	year and 4-digit SIC	year and 4-digit SIC	year and 48 FF	year and 48 FF

Table 8

Overhang as a channel for the debt maturity and corporate diversification association

Panel (a) of this table shows regression results from regressing DEBT_MATURITY on NUM_SEGMENTS × OVERHANG_DUM, NUM_SEGMENTS, and OVERHANG_DUM as well as only on NUM_SEGMENTS and OVERHANG_DUM alongside various control variables including MARKET_EQUITY, DEBT_TO_EQUITY, NET_INCOME, and CAPITAL_EXPENDITURES. Panel (b) shows the same results with OVERHANG_DUM replaced by OVERHANG_DUM_ALT. The numbers of valid observations, unique firms, and adjusted R-squared are reported alongside the regression coefficient estimates. Three versions of panel regressions with fixed effects are presented. We control for year-fixed effects in all specifications. The three types of cross-sectional fixed effects are: individual firm-fixed effects, industry-fixed effects based on the four-digit SIC codes, and industry-fixed effects based on the 48 Fama-French industries. The t-statistics (reported parentheses) are based on robust standard errors adjusted for heteroskedasticity and clustering in cross-sectional fixed effects groups. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively.

(a) **with OVERHANG_DUM**

	DEBT_MATURITY					
NUM_SEGMENTS × OVERHANG_DUM	0.026***		0.037***		0.037**	
	(3.48)		(2.59)		(2.15)	
NUM_SEGMENTS	0.004	0.018***	0.025**	0.045***	0.029*	0.048***
	(0.51)	(2.84)	(2.15)	(4.34)	(2.02)	(2.96)
OVERHANG_DUM	0.230***	0.244***	0.296***	0.314***	0.299***	0.318***
	(32.20)	(44.48)	(16.66)	(21.56)	(12.26)	(14.55)
MARKET_EQUITY	0.123***	0.123***	0.169***	0.169***	0.170***	0.169***
	(36.99)	(37.02)	(40.22)	(40.42)	(34.50)	(34.84)
DBET_TO_EQUITY	0.015***	0.015***	0.022***	0.022***	0.026***	0.026***
	(9.73)	(9.76)	(8.32)	(8.35)	(5.85)	(5.87)
NET_INCOME	0.038***	0.038***	0.105***	0.106***	0.115***	0.116***
	(3.68)	(3.72)	(5.47)	(5.49)	(4.36)	(4.36)
CAPITAL_EXPENDITURES	0.507***	0.509***	0.580***	0.584***	0.743***	0.747***
	(9.70)	(9.74)	(5.99)	(6.03)	(5.67)	(5.71)
Observations	117,208	117,208	119,008	119,008	119,008	119,008
Firms	11,633	11,633	13,433	13,433	13,433	13,433
Adjusted R-squared	0.48	0.48	0.26	0.26	0.24	0.24
Fixed Effects	year and firm	year and firm	year and 4-digit SIC	year and 4-digit SIC	year and 48 FF	year and 48 FF

Table 8

Overhang as a channel for the debt maturity and corporate diversification association (cont.)

(b) **with OVERHANG_DUM_ALT**

	DEBT_MATURITY					
NUM_SEGMENTS × OVERHANG_DUM_ALT	0.062***		0.158***		0.160***	
	(3.97)		(5.50)		(5.77)	
NUM_SEGMENTS	-0.020	0.026***	-0.066***	0.051***	-0.066**	0.052***
	(-1.52)	(5.22)	(-2.81)	(6.11)	(-2.54)	(3.73)
OVERHANG_DUM_ALT	0.928***	0.958***	0.891***	0.961***	0.921***	0.992***
	(57.95)	(68.57)	(24.65)	(29.44)	(20.43)	(25.23)
MARKET_EQUITY	0.115***	0.115***	0.169***	0.170***	0.169***	0.170***
	(51.18)	(51.36)	(40.14)	(40.33)	(36.05)	(36.39)
DBET_TO_EQUITY	0.011***	0.011***	0.017***	0.017***	0.019***	0.020***
	(9.66)	(9.73)	(8.09)	(8.24)	(6.61)	(6.70)
NET_INCOME	0.007***	0.007***	0.017***	0.017***	0.018***	0.018***
	(11.36)	(11.42)	(11.76)	(11.98)	(10.53)	(10.80)
CAPITAL_EXPENDITURES	2.630***	2.649***	2.604***	2.643***	2.742***	2.782***
	(49.45)	(49.88)	(25.83)	(26.21)	(25.36)	(25.74)
Observations	189,798	189,798	191,831	191,831	191,831	191,831
Firms	18,794	18,794	20,827	20,827	20,827	20,827
Adjusted R-squared	0.51	0.51	0.30	0.30	0.28	0.28
Fixed Effects	year and firm	year and firm	year and 4-digit SIC	year and 4-digit SIC	year and 48 FF	year and 48 FF

Table 9

Excess value regression results

This table provides results from regressing EV on DEBT_MATURITY and MULTI_DIVISION or NUM_SEGMENTS alongside various control variables including MARKET_EQUITY, DEBT_TO_EQUITY, NET_INCOME, and CAPITAL_EXPENDITURES. The numbers of valid observations, unique firms, and adjusted R-squared are reported alongside the regression coefficient estimates. Three versions of panel regressions with fixed effects are presented. We control for year-fixed effects in all specifications. The three types of cross-sectional fixed effects are: individual firm-fixed effects, industry-fixed effects based on the four-digit SIC codes, and industry-fixed effects based on the 48 Fama-French industries. The t-statistics (reported parentheses) are based on robust standard errors adjusted for heteroskedasticity and clustering in cross-sectional fixed effects groups. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively.

	EV					
DEBT_MATURITY	0.028***	0.028***	0.020***	0.021***	0.026***	0.026***
	(16.45)	(16.60)	(6.02)	(6.07)	(5.22)	(5.21)
MULTI_DIVISION	-0.048***		-0.050***		-0.044***	
	(-11.78)		(-5.58)		(-2.77)	
NUM_SEGMENTS		-0.065***		-0.052***		-0.044***
		(-19.77)		(-7.38)		(-3.61)
MARKET_EQUITY	0.014***	0.015***	0.005*	0.007**	0.004	0.005
	(9.75)	(10.53)	(1.66)	(2.13)	(1.02)	(1.39)
DBET_TO_EQUITY	0.012***	0.012***	0.011***	0.011***	0.013***	0.013***
	(16.62)	(16.89)	(8.47)	(8.54)	(7.32)	(7.40)
NET_INCOME	0.003*	0.003*	-0.014***	-0.014***	-0.014***	-0.014***
	(1.78)	(1.84)	(-6.85)	(-6.86)	(-6.87)	(-6.86)
CAPITAL_EXPENDITURES	-0.110***	-0.115***	-0.117*	-0.129**	-0.061	-0.072
	(-3.99)	(-4.18)	(-1.85)	(-2.02)	(-0.81)	(-0.94)
Observations	155,180	155,180	157,622	157,622	157,623	157,623
Firms	16,319	16,319	18,761	18,761	18,762	18,762
Adjusted R-squared	0.48	0.49	0.13	0.13	0.09	0.09
Fixed Effects	year and firm	year and firm	year and 4-digit SIC	year and 4-digit SIC	year and 48 FF	year and 48 FF

Table 10

Excess value subsample regression results

This table provides subsample (before and after) results from regressing EV on DEBT_MATURITY and MULTI_DIVISION or NUM_SEGMENTS alongside various control variables including MARKET_EQUITY, DEBT_TO_EQUITY, NET_INCOME, and CAPITAL_EXPENDITURES. The two sub-samples are defined as before and after 2000, which is the middle point of the sample. Panels (a) and (c) report the results from the first and second half samples, respectively. The numbers of valid observations, unique firms, and adjusted R-squared are reported alongside the regression coefficient estimates. Three versions of panel regressions with fixed effects are presented. We control for year-fixed effects in all specifications. The three types of cross-sectional fixed effects are: individual firm-fixed effects, industry-fixed effects based on the four-digit SIC codes, and industry-fixed effects based on the 48 Fama-French industries. The t-statistics (reported parentheses) are based on robust standard errors adjusted for heteroskedasticity and clustering in cross-sectional fixed effects groups. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively.

(a) **Before 2000**

	EV before 2000					
DEBT_MATURITY	0.027***	0.027***	0.026***	0.026***	0.031***	0.031***
	(12.63)	(12.64)	(6.68)	(6.68)	(7.21)	(7.17)
MULTI_DIVISION	-0.037***		-0.030***		-0.021	
	(-6.70)		(-3.13)		(-1.56)	
NUM_SEGMENTS		-0.049***		-0.030***		-0.019
		(-9.63)		(-3.59)		(-1.64)
MARKET_EQUITY	0.011***	0.012***	0.018***	0.019***	0.016***	0.016***
	(5.54)	(5.83)	(5.70)	(5.98)	(4.23)	(4.38)
DBET_TO_EQUITY	0.014***	0.014***	0.016***	0.016***	0.018***	0.018***
	(13.73)	(13.85)	(10.25)	(10.30)	(8.48)	(8.52)
NET_INCOME	0.030***	0.029***	-0.195***	-0.196***	-0.200***	-0.200***
	(2.81)	(2.76)	(-10.64)	(-10.65)	(-9.39)	(-9.35)
CAPITAL_EXPENDITURES	0.106***	0.104***	0.044	0.039	0.088	0.085
	(3.51)	(3.45)	(0.68)	(0.61)	(1.34)	(1.28)
Observations	88,822	88,822	90,652	90,652	90,654	90,654
Firms	11,243	11,243	13,073	13,073	13,075	13,075
Adjusted R-squared	0.54	0.54	0.15	0.15	0.10	0.10
Fixed Effects	year and firm	year and firm	year and 4-digit SIC	year and 4-digit SIC	year and 48 FF	year and 48 FF

Table 10

Excess value subsample regression results

(b) **After 2000**

	EV after 2000					
DEBT_MATURITY	0.026***	0.027***	0.018***	0.019***	0.025***	0.025***
	(9.83)	(10.23)	(3.96)	(4.11)	(3.84)	(3.92)
MULTI_DIVISION	-0.076***		-0.075***		-0.072***	
	(-9.43)		(-6.65)		(-3.29)	
NUM_SEGMENTS		-0.122***		-0.073***		-0.066***
		(-20.68)		(-8.59)		(-4.29)
MARKET_EQUITY	0.011***	0.013***	0.002	0.004	-0.000	0.002
	(4.49)	(5.21)	(0.36)	(0.89)	(-0.07)	(0.37)
DBET_TO_EQUITY	0.009***	0.009***	0.007***	0.008***	0.010***	0.010***
	(8.89)	(9.16)	(5.28)	(5.35)	(5.68)	(5.78)
NET_INCOME	0.005***	0.005***	-0.010***	-0.010***	-0.010***	-0.010***
	(2.87)	(2.92)	(-5.37)	(-5.40)	(-5.81)	(-5.88)
CAPITAL_EXPENDITURES	-0.784***	-0.809***	-0.710***	-0.736***	-0.559***	-0.587***
	(-11.86)	(-12.25)	(-5.98)	(-6.20)	(-3.69)	(-3.82)
Observations	65,000	65,000	66,966	66,966	66,969	66,969
Firms	8,649	8,649	10,615	10,615	10,618	10,618
Adjusted R-squared	0.53	0.53	0.14	0.14	0.08	0.08
Fixed Effects	year and firm	year and firm	year and 4-digit SIC	year and 4-digit SIC	year and 48 FF	year and 48 FF

Appendices

Appendix A: Proof of Proposition 1

Given Assumption 1, the joint probability density of ξ and λ is:

$$f_{\xi,\lambda} = \frac{1}{\bar{\xi}(1-\underline{\lambda})}. \tag{A1}$$

As mentioned in main body of the paper, P^{ST} is the probability of raising short-term debt and P^{LT} is the probability of raising long-term debt instead of short-term debt. In the description below, for brevity, we omit N for P^{ST} and P^{LT}, but they should be regarded as functions of N in all derivations here unless there is a subscript of s or m which indicates P^{ST} and P^{LT} are valued at $N=1$ (for s) or $N=2$ (for m).

Depending on whether the long-term overhang-adjusted NPV (R^{LT}) is positive or negative, we have:

Case 1: $R^{\textbf{LT}} > 0$

$$\left.\begin{array}{c} R^{\text{LT}} > 0 \Leftrightarrow \lambda < 1 - O^{\text{LT}} \\ \\ R^{\text{ST}} > \max(0, R^{\text{LT}}) \end{array}\right\} \Rightarrow \xi\lambda < O^{\text{LT}} - O^{\text{ST}} \Leftrightarrow \xi < \frac{O^{\text{LT}} - O^{\text{ST}}}{\lambda},$$

therefore, conditional on Case 1,

$$P_1^{\text{ST}} = \frac{\displaystyle\int_{\underline{\lambda}}^{1-O^{\text{LT}}} \int_0^{\frac{O^{\text{LT}}-O^{\text{ST}}}{\lambda}} d\xi d\lambda}{\bar{\xi}(1-\underline{\lambda})} = \frac{\left(O^{\text{LT}} - O^{\text{ST}}\right)\left[\ln(1-O^{\text{LT}}) - \ln(\underline{\lambda})\right]}{\bar{\xi}(1-\underline{\lambda})}.$$

Case 2: $R^{\mathbf{LT}} < 0$

$$\left.\begin{array}{c} R^{\mathrm{LT}} < 0 \Leftrightarrow \lambda > 1 - O^{\mathrm{LT}} \\ \\ R^{\mathrm{ST}} > \max(0, R^{\mathrm{LT}}) \end{array}\right\} \Rightarrow \left\{\begin{array}{c} \xi < \frac{1-O^{\mathrm{ST}}}{\lambda} - 1 \\ \\ 1 - O^{\mathrm{LT}} < \lambda < 1 - O^{\mathrm{ST}} \end{array}\right. ,$$

therefore, conditional on Case 2,

$$P_2^{\mathrm{ST}} = \frac{\int_{1-O^{\mathrm{LT}}}^{1-O^{\mathrm{ST}}} \int_0^{\frac{1-O^{\mathrm{ST}}}{\lambda}-1} d\xi d\lambda}{\bar{\xi}(1-\underline{\lambda})} = \frac{\left(1-O^{\mathrm{ST}}\right)\left[\ln(1-O^{\mathrm{ST}}) - \ln(1-O^{\mathrm{LT}})\right] - \left(O^{\mathrm{LT}} - O^{\mathrm{ST}}\right)}{\bar{\xi}(1-\underline{\lambda})}.$$

Aggregating both cases gives us:

$$\begin{aligned} P^{\mathrm{ST}} &= P_1^{\mathrm{ST}} + P_2^{\mathrm{ST}} \\ &= \frac{\left(O^{\mathrm{LT}} - O^{\mathrm{ST}}\right)\left[\ln(1-O^{\mathrm{LT}}) - \ln(\underline{\lambda}) - 1\right] + \left(1-O^{\mathrm{ST}}\right)\left[\ln(1-O^{\mathrm{ST}}) - \ln(1-O^{\mathrm{LT}})\right]}{\bar{\xi}(1-\underline{\lambda})}. \end{aligned} \tag{A2}$$

For P^{LT}, depending on whether the short-term overhang-adjusted NPV (R^{ST}) is positive or negative, we have:

Case 1: $R^{\mathbf{ST}} > 0$

$$\left.\begin{array}{c} R^{\mathrm{ST}} > 0 \Leftrightarrow \xi\lambda < 1 - \lambda - O^{\mathrm{LT}} \\ \\ R^{\mathrm{LT}} > \max(0, R^{\mathrm{ST}}) \end{array}\right\} \Rightarrow \left\{\begin{array}{c} \frac{O^{\mathrm{LT}}-O^{\mathrm{ST}}}{\lambda} < \xi < \frac{1-O^{\mathrm{ST}}}{\lambda} - 1 \\ \\ \lambda < 1 - O^{\mathrm{LT}} \end{array}\right. ,$$

therefore, conditional on Case 1,

$$P_1^{\mathrm{LT}} = \frac{\int_{\underline{\lambda}}^{1-O^{\mathrm{LT}}} \int_{\frac{O^{\mathrm{LT}}-O^{\mathrm{ST}}}{\lambda}}^{\frac{1-O^{\mathrm{ST}}}{\lambda}-1} d\xi d\lambda}{\bar{\xi}(1-\underline{\lambda})}.$$

Case 2: $R^{\mathbf{ST}} < 0$

$$\left.\begin{array}{c} R^{\mathrm{ST}} < 0 \Leftrightarrow \lambda > 1-O^{\mathrm{LT}} \\ \\ R^{\mathrm{LT}} > \max(0, R^{\mathrm{ST}}) \end{array}\right\} \Rightarrow \left\{\begin{array}{c} \xi > \frac{1-O^{\mathrm{ST}}}{\lambda} - 1 \\ \\ \lambda < 1-O^{\mathrm{LT}} \end{array}\right. ,$$

therefore, conditional on Case 2,

$$P_2^{\mathrm{LT}} = \frac{\int_{\underline{\lambda}}^{1-O^{\mathrm{LT}}} \int_{\frac{1-O^{\mathrm{ST}}}{\lambda}-1}^{\bar{\xi}} d\xi d\lambda}{\bar{\xi}(1-\underline{\lambda})}.$$

Aggregating both cases gives us:

$$\begin{aligned} P^{\mathrm{LT}} = P_1^{\mathrm{LT}} + P_2^{\mathrm{LT}} &= \frac{\int_{\underline{\lambda}}^{1-O^{\mathrm{LT}}} \int_{\frac{O^{\mathrm{LT}}-O^{\mathrm{ST}}}{\lambda}}^{\bar{\xi}} d\xi d\lambda}{\bar{\xi}(1-\underline{\lambda})} \\ &= \frac{(1-O^{\mathrm{LT}}-\underline{\lambda})\bar{\xi} - \left(O^{\mathrm{LT}}-O^{\mathrm{ST}}\right)\left[\ln(1-O^{\mathrm{LT}}) - \ln(\underline{\lambda})\right]}{\bar{\xi}(1-\underline{\lambda})}. \end{aligned} \tag{A3}$$

Next, we show $P^{\mathrm{ST}} - P^{\mathrm{LT}}$ is decreasing in N, i.e., $\frac{\partial\left(P^{\mathrm{ST}}-P^{\mathrm{LT}}\right)}{\partial N} < 0$. To this end, we define a function $G(O^{\mathrm{LT}}, \Delta_O) = P^{\mathrm{ST}} - P^{\mathrm{LT}}$ taking O^{LT} and Δ_O as arguments, which in turn are functions of N. Therefore, we have:

$$\frac{\partial\left(P^{\mathrm{ST}}-P^{\mathrm{LT}}\right)}{\partial N} = \frac{\partial G}{\partial O^{\mathrm{LT}}}\frac{\partial O^{\mathrm{LT}}}{\partial N} + \frac{\partial G}{\partial \Delta_O}\frac{\partial \Delta_O}{\partial N}. \tag{A4}$$

Simple derivations can show that:

$$\text{(A5)} \qquad \frac{\partial G}{\partial O^{\mathrm{LT}}} = \frac{\bar{\xi} - \frac{O^{\mathrm{LT}} - O^{\mathrm{ST}}}{1 - O^{\mathrm{LT}}} - \log\left(\frac{1 - O^{\mathrm{ST}}}{1 - O^{\mathrm{LT}}}\right)}{\bar{\xi}(1 - \underline{\lambda})}.$$

Given (13), we know:

$$\text{(A6)} \qquad \frac{O^{\mathrm{LT}} - O^{\mathrm{ST}}}{1 - O^{\mathrm{LT}}} + \log\left(\frac{1 - O^{\mathrm{ST}}}{1 - O^{\mathrm{LT}}}\right) < \frac{O_s^{\mathrm{LT}} - O_s^{\mathrm{ST}}}{1 - O_s^{\mathrm{LT}}} + \log\left(\frac{1 - O_s^{\mathrm{ST}}}{1 - O_s^{\mathrm{LT}}}\right) < \bar{\xi}.$$

The first inequation above is by the fact that $\frac{O^{\mathrm{LT}} - O^{\mathrm{ST}}}{1 - O^{\mathrm{LT}}} + \log\left(\frac{1 - O^{\mathrm{ST}}}{1 - O^{\mathrm{LT}}}\right)$ decreases with all O^{LT}, O^{ST}, and Δ_O. Thus, $\frac{\partial G}{\partial O^{\mathrm{LT}}} > 0$.

Similarly, substituting O^{ST} with $O^{\mathrm{LT}} - \Delta_O$, by (14) we obtain:

$$\text{(A7)} \qquad \frac{\partial G}{\partial \Delta_O} = \frac{\log\left(1 - O^{\mathrm{LT}}\right) + \log\left(1 - O^{\mathrm{ST}}\right) - 2\log\left(\underline{\lambda}\right)}{\bar{\xi}(1 - \underline{\lambda})} > 0.$$

From the conditions in (11), $\frac{\partial O^{\mathrm{LT}}}{\partial N} < 0$ and $\frac{\partial \Delta_O}{\partial N} < 0$, therefore, $\frac{\partial\left(P^{\mathrm{ST}} - P^{\mathrm{LT}}\right)}{\partial N} < 0$ is now proved.

Now, let us compare P^{LT} and P^{ST} when $N = 1$. P^{LT} and P_1^{ST} can be rewritten as:

$$\text{(A8)} \qquad P_s^{\mathrm{LT}} = \frac{\int_{\underline{\lambda}}^{1 - O_s^{\mathrm{LT}}} \left(\int_{\frac{O_s^{\mathrm{LT}} - O_s^{\mathrm{ST}}}{1 - O_s^{\mathrm{LT}}}}^{\bar{\xi}} d\xi - \int_{\frac{O_s^{\mathrm{LT}} - O^{\mathrm{ST}}}{1 - O_s^{\mathrm{LT}}}}^{\frac{O_s^{\mathrm{LT}} - O_s^{\mathrm{ST}}}{\lambda}} d\xi \right) d\lambda}{\bar{\xi}(1 - \underline{\lambda})}, \quad \text{and}$$

$$\text{(A9)} \qquad P_{s,1}^{\mathrm{ST}} = \frac{\int_{\underline{\lambda}}^{1 - O_s^{\mathrm{LT}}} \left(\int_0^{\frac{O_s^{\mathrm{LT}} - O_s^{\mathrm{ST}}}{1 - O_s^{\mathrm{LT}}}} d\xi + \int_{\frac{O_s^{\mathrm{LT}} - O_s^{\mathrm{ST}}}{1 - O_s^{\mathrm{LT}}}}^{\frac{O_s^{\mathrm{LT}} - O_s^{\mathrm{ST}}}{\lambda}} d\xi \right) d\lambda}{\bar{\xi}(1 - \underline{\lambda})},$$

respectively. Given (13), we have $P_s^{\mathrm{LT}} < P_{s,1}^{\mathrm{ST}} < P_s^{\mathrm{ST}}$. When N increases, Δ_O diminishes to zero, therefore P^{ST} converges to zero while P^{LT} converges to $\frac{1 - O^{\mathrm{LT}} - \underline{\lambda}}{1 - \underline{\lambda}} > 0$.

Taken together, $G > 0$ when $N = 1$, $G < 0$ when N is large enough, and G is monotonically decreasing in N, there must exist an N^* such that $P^{\text{LT}} < P^{\text{ST}}$ when $N < N^*$ and $P^{\text{LT}} \geq P^{\text{ST}}$ when $N \geq N^*$. This finished the proof for Proposition 1.

Appendix B: Ju (2002)'s approximation for basket option pricing

This Appendix presents details of the basket call option pricing formula in Ju (2002). The basic formula is given in eq. (20) in the main text. $\mu(x)$ and $\nu(x)$ used in the formula are defined as:

$$\mu(x) = 2\log(U_1) - \frac{1}{2}U_2(x^2), \quad U_1 = \Sigma_{i=1}^{N}\bar{v}_i, \quad \bar{v}_i = v_{i,0}e^{g_i t},$$
$$\nu(x) = \frac{1}{2}U_2(x^2) - 2\log(U_1), \quad U_2(x^2) = \Sigma_{1\leq i,j\leq N}\bar{v}_i\bar{v}_j e^{x^2\bar{\rho}_{ij}}, \quad \bar{\rho}_{ij} = \rho_{ij}\sigma_i\sigma_j t,$$

and z_1, z_2, and z_3 in the formula are defined as:

$$z_1 = d_2(1) - d_3(1) + d_4(1),$$
$$z_2 = d_3(1) - d_4(1),$$
$$z_3 = d_4(1),$$

where

$$d_1(x) = \frac{6a_1^2(x) + a_2(x) - 4b_1(x) + 2b_2(x)}{2} - \frac{120a_1^3(x) - a_3(x) + 6\left[24c_1(x) - 6c_2(x) + 2c_3(x) - c_4(x)\right]}{6},$$

$$d_2(x) = \frac{10a_1^2(x) + a_2(x) - 6b_1(x) + 2b_2(x)}{2}$$
$$- \left[\frac{128a_1^3(x)}{3} - \frac{a_3(x)}{6} + 2a_1(x)b_1(x) - a_1(x)b_2(x) + 50c_1(x) - 11c_2(x) + 3c_3(x) - c_4(x)\right],$$

$$d_3(x) = \left[2a_1^2(x) - b_1(x)\right] - \frac{88a_1^3(x)}{3} - a_1(x)\left[5b_1(x) - 2b_2(x)\right] - \left[35c_1(x) - 6c_2(x) + c_3(x)\right],$$

$$d_4(x) = a_1(x)\left[b_2(x) - 4b_1(x)\right] + c_2(x) - 10c_1(x) - \frac{20a_1^3(x)}{3},$$

$$c_1(x) = a_1(x)b_1(x), \quad a_1(x) = -\frac{x^2 U_2'}{2U_2(0)}, \quad U_2' = \Sigma_{1 \le i,j \le N} \bar{v}_i \bar{v}_j \bar{\rho}_{ij},$$

$$b_1(x) = \frac{x^4}{2U_1^3} \Sigma_{1 \le i,j,k \le N} \bar{v}_i \bar{v}_j \bar{v}_k \bar{\rho}_{ik} \bar{\rho}_{jk}, \quad b_2(x) = a_1^2(x) - \frac{a_2(x)}{2},$$

$$c_2(x) = \frac{x^6\left[9E_1 + 4E_2\right]}{144U_1^4}, \quad c_3(x) = \frac{x^6\left[4E_3 + E_4\right]}{48U_1^3},$$

$$E_1 = 8\Sigma_{1 \le i,j,k,l \le N} \bar{v}_i \bar{v}_j \bar{v}_k \bar{v}_l \bar{\rho}_{il} \bar{\rho}_{jk} \bar{\rho}_{kl} + 2U_2' U_2'', \quad U_2'' = \Sigma_{1 \le i,j \le N} \bar{v}_i \bar{v}_j \bar{\rho}_{ij}^2,$$

$$E_2 = 6\Sigma_{1 \le i,j,k,l \le N} \bar{v}_i \bar{v}_j \bar{v}_k \bar{v}_l \bar{\rho}_{il} \bar{\rho}_{jl} \bar{\rho}_{kl},$$

$$E_3 = 6\Sigma_{1 \le i,j,k \le N} \bar{v}_i \bar{v}_j \bar{v}_k \bar{\rho}_{ik} \bar{\rho}_{jk}^2, \quad E_4 = 8\Sigma_{1 \le i,j,k \le N} \bar{v}_i \bar{v}_j \bar{v}_k \bar{\rho}_{ij} \bar{\rho}_{ik} \bar{\rho}_{jk},$$

$$c_4(x) = a_1(x)a_2(x) - \frac{2}{3}a_1^3(x) - \frac{1}{6}a_3(x), \quad a_2(x) = 2a_1^2(x) - \frac{x^4 U_2''}{2U_2(0)}.$$

Appendix C: Evidence supporting model assumptions

In this appendix, we present regressions that verify our main assumptions in the model and confirm empirical results in the previous literature.

A. Debt-related expenses and maturity

Table A1 presents evidence of a negative relation between the cost of debt and average debt maturity. We regress COST_DEBT on DEBT_MATURITY and NUM_SEGMENTS alongside the control variables. The coefficients of DEBT_MATURITY in all three versions of the panel regressions are highly significant with the negative sign. The point estimates of the coefficient shown in Table A1 are around -0.04 with statistical significance at 1% level. In economic terms, the results indicate that one standard deviation decrease in DEBT_MATURITY, which is 1.07 and equals three years in maturity, results in a 0.23 standard deviation increase in COST_DEBT, which is 0.16 and equals 4%. Indeed, COST_DEBT contains both interest and non-interest debt expenses. However, it is well documented that corporate debts' interest costs increase with maturity due to positive term premia stemming from increased uncertainty about default risk and interest rate risk at long maturities (see, e.g., Johnson, 1967; Elton, Gruber, Agrawal, and Mann, 2001). Given this fact, the results presented in Table A1 provide even stronger support to the assumption of a negative relation between non-interest debt expenses and average debt maturity.

B. Leverage, cash holdings, and corporate diversification

We then examine whether our debt capacity (in the form of LEVERAGE) correlates with diversification. We regress LEVERAGE on MULTI_DIVISION and NUM_SEGMENTS alongside the control variables. The coefficients of MULTI_DIVISION and NUM_SEGMENTS in all three versions of the panel regressions are small. We take the regressions with individual firm-fixed effects (the first two columns in Table A2) as an example. Although the coefficients are statistically significant, the economic values are negligible: the coefficient for MULTI_DIVISION is only 40bps meaning on average the difference in LEVERAGE between stand-alone and multi-division firms is only 0.4%, which lends strong empirical support for the settings of our theoretical model in Section III.B.

Consistent with Opler et al. (1999); Duchin (2010); Bakke and Gu (2017); Onali and Mascia (2022), we find multi-division firms hold significantly less cash than stand-alone firms. We regress CASH on MULTI_DIVISION and NUM_SEGMENTS alongside the control variables. Table A3 presents the results. The point estimates of the coefficient for MULTI_DIVISION (NUM_SEGMENTS) shown in Table A3 are around -0.026 (-0.019) with individual firm-fixed effects, -0.048 (-0.040) with four-digit SIC industry-fixed effects and -0.056 (-0.046) with 48 Fama-French industry-fixed effects. All estimates are statistically significant at 1% level. Again, let us take the regressions with individual firm-fixed effects (the first two columns in Table A3) as an example. A median stand-alone firm's CASH is about 11%, so the coefficient of -0.026 for MULTI_DIVISION, in economic terms, means 23% reduction in cash holdings for a median stand-alone firm when it diversifies into a multi-division firm. One standard deviation increase in NUM_SEGMENTS, which is 0.62 and equivalent to two segments, reduces cash holdings by 0.06 of its standard deviation, which is 0.24. In other words, the coefficient of NUM_SEGMENTS indicates that if a median multi-division firm (with CASH = 6%) increases its number of segments by two, it can reduce its cash holdings by 24%. Although this is not an explicit prediction of our models, our theory complements Bakke and Gu (2017) and provides a novel explanation for this evidence:[30]multi-division firms tend to have lower debt overhang than stand-alone firms due to the coinsurance effect, therefore

[30]Bakke and Gu (2017) directly model cash holding in a dynamic model of corporate investment and find that investment dynamics are more important in explaining differences in cash levels between multi-division and stand-alone firms than financing frictions.

the former have better investment incentives and afford to hold less cash. The evidence we show thus far sets the scene for the key empirical results directly predicted by our models.

Table A1

Cost of debt regression results

This table provides results from regressing COST_DEBT on DEBT_MATURITY and various control variables including NUM_SEGMENTS, MARKET_EQUITY, DEBT_TO_EQUITY, NET_INCOME, and CAPITAL_EXPENDITURES. The numbers of valid observations, unique firms, and adjusted R-squared are reported alongside the regression coefficient estimates. Three versions of panel regressions with fixed effects are presented. We control for year-fixed effects in all specifications. The three types of cross-sectional fixed effects are: individual firm-fixed effects, industry-fixed effects based on the four-digit SIC codes, and industry-fixed effects based on the 48 Fama-French industries. The t-statistics (reported parentheses) are based on robust standard errors adjusted for heteroskedasticity and clustering in cross-sectional fixed effects groups. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively.

	COST_DBET		
DEBT_MATURITY	-0.035***	-0.040***	-0.041***
	(-53.34)	(-28.44)	(-21.41)
NUM_SEGMENTS	-0.008***	-0.008***	-0.008***
	(-8.47)	(-6.74)	(-5.26)
MARKET_EQUITY	-0.005***	-0.007***	-0.006***
	(-10.87)	(-13.58)	(-14.61)
DBET_TO_EQUITY	-0.002***	-0.003***	-0.003***
	(-13.09)	(-13.19)	(-10.44)
NET_INCOME	-0.001***	-0.003***	-0.003***
	(-4.93)	(-6.42)	(-6.53)
CAPITAL_EXPENDITURES	-0.085***	-0.060***	-0.076***
	(-11.44)	(-6.85)	(-5.82)
Observations	180,411	182,500	182,500
Firms	18,054	20,143	20,143
Adjusted R-squared	0.35	0.16	0.16
Fixed Effects	year and firm	year and 4-digit SIC	year and 48 FF

Table A2

Leverage regression results

This table provides results from separately regressing LEVERAGE on MULTI_DIVISION and NUM_SEGMENTS alongside various control variables including DEBT_MATURITY, MARKET_EQUITY, NET_INCOME, and CAPITAL_EXPENDITURES. The numbers of valid observations, unique firms, and adjusted R-squared are reported alongside the regression coefficient estimates. Three versions of panel regressions with fixed effects are presented. We control for year-fixed effects in all specifications. The three types of cross-sectional fixed effects are: individual firm-fixed effects, industry-fixed effects based on the four-digit SIC codes, and industry-fixed effects based on the 48 Fama-French industries. The t-statistics (reported parentheses) are based on robust standard errors adjusted for heteroskedasticity and clustering in cross-sectional fixed effects groups. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively.

	LEVERAGE					
MULTI_DIVISION	0.004**		-0.000		0.001	
	(2.53)		(-0.09)		(0.32)	
NUM_SEGMENTS		0.003***		0.003		0.004
		(2.81)		(1.31)		(1.20)
DEBT_MATURITY	0.037***	0.037***	0.051***	0.050***	0.053***	0.053***
	(50.61)	(50.60)	(23.76)	(23.69)	(16.46)	(16.41)
MARKET_EQUITY	-0.045***	-0.045***	-0.031***	-0.031***	-0.030***	-0.030***
	(-63.74)	(-63.74)	(-21.45)	(-21.57)	(-15.42)	(-15.57)
NET_INCOME	-0.016***	-0.016***	-0.024***	-0.024***	-0.024***	-0.025***
	(-41.03)	(-41.03)	(-39.08)	(-39.13)	(-36.67)	(-36.71)
CAPITAL_EXPENDITURES	-0.019*	-0.019*	-0.014	-0.012	0.031	0.033
	(-1.67)	(-1.67)	(-0.46)	(-0.38)	(0.49)	(0.53)
Observations	189,815	189,815	191,847	191,847	191,847	191,847
Firms	18,795	18,795	20,827	20,827	20,827	20,827
Adjusted R-squared	0.60	0.60	0.28	0.28	0.26	0.26
Fixed Effects	year and firm	year and firm	year and 4-digit SIC	year and 4-digit SIC	year and 48 FF	year and 48 FF

Table A3

Cash regression results

This table provides results from separately regressing CASH on MULTI_DIVISION and NUM_SEGMENTS alongside various control variables including DEBT_MATURITY, MARKET_EQUITY, DEBT_TO_EQUITY, NET_INCOME, and CAPITAL_EXPENDITURES. The numbers of valid observations, unique firms, and adjusted R-squared are reported alongside the regression coefficient estimates. Three versions of panel regressions with fixed effects are presented. We control for year-fixed effects in all specifications. The three types of cross-sectional fixed effects are: individual firm-fixed effects, industry-fixed effects based on the four-digit SIC codes, and industry-fixed effects based on the 48 Fama-French industries. The t-statistics (reported parentheses) are based on robust standard errors adjusted for heteroskedasticity and clustering in cross-sectional fixed effects groups. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively.

	CASH					
MULTI_DIVISION	-0.026***		-0.048***		-0.056***	
	(-25.79)		(-5.99)		(-3.78)	
NUM_SEGMENTS		-0.019***		-0.040***		-0.046***
		(-25.23)		(-6.32)		(-3.98)
DEBT_MATURITY	-0.004***	-0.004***	-0.011***	-0.011***	-0.013***	-0.013***
	(-7.95)	(-7.97)	(-6.66)	(-6.73)	(-3.81)	(-3.88)
MARKET_EQUITY	0.013***	0.013***	0.004***	0.005***	0.004*	0.005**
	(34.51)	(34.62)	(3.20)	(3.65)	(1.97)	(2.30)
DBET_TO_EQUITY	-0.002***	-0.002***	-0.004***	-0.004***	-0.005***	-0.005***
	(-12.56)	(-12.54)	(-10.56)	(-10.54)	(-7.21)	(-7.25)
NET_INCOME	-0.001***	-0.001***	-0.001**	-0.001**	-0.001**	-0.001**
	(-3.01)	(-3.02)	(-2.10)	(-2.17)	(-2.35)	(-2.47)
CAPITAL_EXPENDITURES	-0.192***	-0.192***	-0.188***	-0.191***	-0.205***	-0.210***
	(-29.27)	(-29.20)	(-5.49)	(-5.60)	(-3.94)	(-4.00)
Observations	189,784	189,784	191,817	191,817	191,817	191,817
Firms	18,794	18,794	20,827	20,827	20,827	20,827
Adjusted R-squared	0.67	0.67	0.34	0.34	0.29	0.29
Fixed Effects	year and firm	year and firm	year and 4-digit SIC	year and 4-digit SIC	year and 48 FF	year and 48 FF

Internet Appendix: Corporate Diversification and Debt Maturity

Enrico Onali and Xiaoxia Ye[1]

A. Supplementary results

Hoberg and Phillips (2016) examine firms' distinctions from competitors using innovative time-varying measures of product similarity derived from text-based analysis of 10-K product descriptions. These measures enable the creation of unique industry classifications, shedding light on discussions of high competition, manager-identified peer rivals, and shifts in industry competitors after external shocks. Their text-based network industry classifications (TNIC) HHI variable is a concentration measure based on textual analysis and firm sales data from COMPUSTAT, and is computed using the Herfindahl-Hirschmann sum of squared market shares formulation.[2] Hoberg and Phillips (2016)'s TNIC3HHI provides an alternative (inverse) measure of number of segments. Table S1 provides the results of regressing DEBT_MATURITY on *TNIC3HHI*. TNIC3HHI is inversely related to the number of segments, we observe significantly negative coefficients of TNIC3HHI in two out of the three FE specifications. Using TNIC3HHI as an additional control variable does not weaken the results in Table 5 in any way as shown in Table S2.

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[2]Available online at https://hobergphillips.tuck.dartmouth.edu/industryconcen.htm.

Table S1

Debt maturity regression results using TNIC3HHI

This table provides results from regressing DEBT_MATURITY on *TNIC3HHI* alongside various control variables including MARKET_EQUITY, DEBT_TO_EQUITY, NET_INCOME, and CAPITAL_EXPENDITURES. *TNIC3HHI* is from Hoberg and Phillips (2016) and available online at https://hobergphillips.tuck.dartmouth.edu/industryconcen.htm. The numbers of valid observations, unique firms, and adjusted R-squared are reported alongside the regression coefficient estimates. Three versions of panel regressions with fixed effects are presented. We control for year-fixed effects in all specifications. The three types of cross-sectional fixed effects are: individual firm-fixed effects, industry-fixed effects based on the four-digit SIC codes, and industry-fixed effects based on the 48 Fama-French industries. The t-statistics (reported parentheses) are based on robust standard errors adjusted for heteroskedasticity and clustering in cross-sectional fixed effects groups. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively.

	DEBT_MATURITY		
TNIC3HHI	-0.031**	-0.045*	-0.012
	(-2.12)	(-1.67)	(-0.19)
MARKET_EQUITY	0.105***	0.151***	0.154***
	(31.01)	(37.06)	(29.00)
DBET_TO_EQUITY	0.018***	0.026***	0.031***
	(13.28)	(10.60)	(6.54)
NET_INCOME	0.012**	0.049***	0.056***
	(2.25)	(5.35)	(4.74)
CAPITAL_EXPENDITURES	0.481***	0.293**	0.425**
	(7.31)	(1.98)	(2.51)
Observations	111,097	112,760	107,324
Firms	11,519	13,182	13,029
Adjusted R-squared	0.47	0.25	0.22
Fixed Effects	year and firm	year and 4-digit SIC	year and 48 FF

Table S2

Debt maturity regression results using TNIC3HHI as a control variable

This table provides results from separately regressing DEBT_MATURITY on DEBT_MATURITY on MULTI_DIVISION and NUM_SEGMENTS alongside various control variables including *TNIC3HHI*, MARKET_EQUITY, DEBT_TO_EQUITY, NET_INCOME, and CAPITAL_EXPENDITURES. *TNIC3HHI* is from Hoberg and Phillips (2016) and available online at https://hobergphillips.tuck.dartmouth.edu/industryconcen.htm. The numbers of valid observations, unique firms, and adjusted R-squared are reported alongside the regression coefficient estimates. Three versions of panel regressions with fixed effects are presented. We control for year-fixed effects in all specifications. The three types of cross-sectional fixed effects are: individual firm-fixed effects, industry-fixed effects based on the four-digit SIC codes, and industry-fixed effects based on the 48 Fama-French industries. The t-statistics (reported parentheses) are based on robust standard errors adjusted for heteroskedasticity and clustering in cross-sectional fixed effects groups. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively.

	DEBT_MATURITY					
MULTI_DIVISION	0.035***		0.076***		0.083***	
	(3.88)		(5.76)		(3.64)	
NUM_SEGMENTS		0.029***		0.059***		0.063***
		(4.22)		(5.87)		(3.43)
TNIC3HHI	-0.021	-0.021	-0.047*	-0.047*	-0.023	-0.023
	(-1.41)	(-1.40)	(-1.78)	(-1.78)	(-0.41)	(-0.40)
MARKET_EQUITY	0.105***	0.104***	0.149***	0.148***	0.150***	0.149***
	(30.14)	(30.07)	(35.31)	(35.18)	(28.50)	(28.50)
DBET_TO_EQUITY	0.018***	0.018***	0.027***	0.027***	0.031***	0.031***
	(12.67)	(12.65)	(10.48)	(10.50)	(6.56)	(6.59)
NET_INCOME	0.011*	0.011*	0.047***	0.047***	0.055***	0.055***
	(1.85)	(1.85)	(5.20)	(5.21)	(4.58)	(4.59)
CAPITAL_EXPENDITURES	0.501***	0.501***	0.349**	0.354**	0.476***	0.480***
	(7.46)	(7.45)	(2.36)	(2.38)	(2.84)	(2.83)
Observations	105,652	105,652	107,323	107,323	107,324	107,324
Firms	11,357	11,357	13,028	13,028	13,029	13,029
Adjusted R-squared	0.47	0.47	0.24	0.24	0.22	0.22
Fixed Effects	year and firm	year and firm	year and 4-digit SIC	year and 4-digit SIC	year and 48 FF	year and 48 FF

B. Key results based on alternative winsorization thresholds

In this appendix, we show that our key results are robust to alternative winsorization thresholds in Tables S3 and S4 below.

Table S3

Debt maturity regression results based on winsorization at 1^{st} and 99^{th} percentile

This table provides results (based on data Winsorized at 1^{st} and 99^{th} percentile) from separately regressing DEBT_MATURITY on MULTI_DIVISION and NUM_SEGMENTS alongside various control variables including MARKET_EQUITY, DEBT_TO_EQUITY, NET_INCOME, and CAPITAL_EXPENDITURES. The numbers of valid observations, unique firms, and adjusted R-squared are reported alongside the regression coefficient estimates. Three versions of panel regressions with fixed effects are presented. We control for year-fixed effects in all specifications. The three types of cross-sectional fixed effects are: individual firm-fixed effects, industry-fixed effects based on the four-digit SIC codes, and industry-fixed effects based on the 48 Fama-French industries. The t-statistics (reported parentheses) are based on robust standard errors adjusted for heteroskedasticity and clustering in cross-sectional fixed effects groups. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively.

	DEBT_MATURITY					
MULTI_DIVISION	0.052***		0.098***		0.108***	
	(7.80)		(8.65)		(5.20)	
NUM_SEGMENTS		0.042***		0.073***		0.078***
		(8.08)		(7.97)		(4.45)
MARKET_EQUITY	0.094***	0.094***	0.147***	0.146***	0.147***	0.146***
	(42.15)	(41.99)	(30.61)	(30.12)	(26.34)	(25.26)
DBET_TO_EQUITY	0.013***	0.013***	0.024***	0.024***	0.026***	0.026***
	(17.55)	(17.54)	(20.51)	(20.56)	(15.41)	(15.56)
NET_INCOME	0.006***	0.006***	0.015***	0.015***	0.016***	0.016***
	(10.46)	(10.46)	(11.74)	(11.78)	(10.99)	(11.06)
CAPITAL_EXPENDITURES	0.431***	0.431***	0.316***	0.317***	0.379***	0.379***
	(12.81)	(12.79)	(3.96)	(3.93)	(4.52)	(4.45)
Observations	189,798	189,798	191,831	191,831	191,831	191,831
Firms	18,794	18,794	20,827	20,827	20,827	20,827
Adjusted R-squared	0.49	0.49	0.27	0.27	0.25	0.25
Fixed Effects	year and firm	year and firm	year and 4-digit SIC	year and 4-digit SIC	year and 48 FF	year and 48 FF

Table S4

Excess value regression results based on winsorization at 1^{st} and 99^{th} percentile

This table provides results (based on data Winsorized at 1^{st} and 99^{th} percentile) from regressing EV on DEBT_MATURITY and MULTI_DIVISION or NUM_SEGMENTS alongside various control variables including MARKET_EQUITY, DEBT_TO_EQUITY, NET_INCOME, and CAPITAL_EXPENDITURES. The numbers of valid observations, unique firms, and adjusted R-squared are reported alongside the regression coefficient estimates. Three versions of panel regressions with fixed effects are presented. We control for year-fixed effects in all specifications. The three types of cross-sectional fixed effects are: individual firm-fixed effects, industry-fixed effects based on the four-digit SIC codes, and industry-fixed effects based on the 48 Fama-French industries. The t-statistics (reported parentheses) are based on robust standard errors adjusted for heteroskedasticity and clustering in cross-sectional fixed effects groups. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively.

	EV					
DEBT_MATURITY	0.028***	0.028***	0.020***	0.020***	0.025***	0.026***
	(16.58)	(16.73)	(5.93)	(5.97)	(5.15)	(5.14)
MULTI_DIVISION	-0.046***		-0.049***		-0.041**	
	(-11.46)		(-5.38)		(-2.62)	
NUM_SEGMENTS		-0.064***		-0.051***		-0.042***
		(-19.41)		(-7.13)		(-3.42)
MARKET_EQUITY	0.014***	0.015***	0.005	0.007**	0.004	0.005
	(9.90)	(10.68)	(1.62)	(2.08)	(1.04)	(1.40)
DBET_TO_EQUITY	0.005***	0.005***	0.006***	0.006***	0.007***	0.007***
	(11.51)	(11.71)	(7.36)	(7.42)	(6.69)	(6.75)
NET_INCOME	0.003*	0.003*	-0.014***	-0.014***	-0.014***	-0.014***
	(1.74)	(1.80)	(-6.89)	(-6.89)	(-6.93)	(-6.92)
CAPITAL_EXPENDITURES	0.013	0.009	0.054	0.045	0.105*	0.096*
	(0.59)	(0.41)	(1.22)	(1.02)	(1.97)	(1.78)
Observations	155,180	155,180	157,622	157,622	157,623	157,623
Firms	16,319	16,319	18,761	18,761	18,762	18,762
Adjusted R-squared	0.48	0.48	0.13	0.13	0.09	0.09
Fixed Effects	year and firm	year and firm	year and 4-digit SIC	year and 4-digit SIC	year and 48 FF	year and 48 FF