Industry Structure and Debt Maturity

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Abstract

We examine the relation between product market competition and debt maturity using a large sample of firm-year observations from 1986 to 2006. To account for the endogenous relation between leverage and debt maturity, we use two-stage least squares regressions with debt maturity as the dependent variable. We find a non-linear relation between industry concentration and debt maturity, which indicates that firms operating in either the least concentrated industries or the most concentrated industries use less short-term debt. For firms in less concentrated industries, monitoring benefits of short term debt is smaller due to product market competition. For firms in more concentrated industries, short -term debt induces predatory behavior by rivals in the product market, exacerbating the liquidation risk of borrowing short term. Furthermore, the relation between industry concentration and debt maturity is more pronounced in industries where firms are more homogeneous and in industries where firms compete aggressively in the product market. Our study contributes to the capital structure literature by suggesting that product market competition affects firms' debt structure choices beyond the basic debt versus equity decision.

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1. Introduction

The role of product markets has been analyzed extensively in the context of why firms take on debt. However, much less is understood about the importance of product markets in the design of specific features of debt contracts. While product market competition disciplines managers (Hart, 1983), it also affects firms' ability to obtain external financing by inducing predatory behavior by rivals (Fudenberg and Tirole, 1986). Thus, competition can affect the frequency with which firms seek debt financing through their choice of debt maturity.

Barclay and Smith (1995) recognize the role of industry effects in debt maturity decisions by suggesting that firms in regulated industries choose less short-term debt because the agency costs of managerial discretion are lower in such industries. We add to this stream of research by relaxing the assumption in prior studies that firms' debt maturity choices are invariant to industry competition. Specifically, we examine whether firms in less concentrated industries choose their debt maturities differently from those in more concentrated industries. We also investigate how this relation between industry concentration and debt maturity is influenced by the extent to which firms in the industry are alike, and by the nature of competition in product markets (i.e., aggressive or passive).

Economic theory suggests that product market competition could affect debt maturity by influencing firms' ability to generate free cash flow and by creating incentives for rivals to engage in predatory behavior. While short-term debt facilitates monitoring through information produced at renewal, this benefit of borrowing short term may be smaller in less concentrated industries where agency problems are inherently curtailed by product market competition (e.g., Hart, 1983). Thus, as the monitoring benefits of short-term debt are likely to increase with

industry concentration, we expect a positive relation between industry concentration and the proportion of short-term debt in firms' capital structures. We refer to this effect of industry structure on debt maturity as the agency effect.

However, short-term debt also induces predatory behavior by rivals in the product market (e.g., Fudenberg and Tirole, 1986; Bolton and Scharfstein, 1990; Kanatas and Qi, 2001). As rivals with 'deep pockets' have incentives to force the exit of other firms by imposing financial constraints, the threat of predation exacerbates the liquidation risk of borrowing short term. Consequently, as predatory behavior is more likely to occur in oligopolies, we expect the predation-related costs of short-term debt to increase with industry concentration. We refer to this effect of industry structure on debt maturity as the predation effect.

Thus, the net effect of industry structure on debt maturity depends on the relative importance of the agency effect versus the predation effect in industries with varying competitive structures. In less concentrated industries, we expect the agency effect to dominate the predation effect as the potential benefits of predation are lower in such industries. However, in more concentrated industries, both agency problems as well as the risk of predation by rivals are high. Thus, if the agency effects dominate the predation effects in concentrated industries, for the overall sample, we expect a positive linear relation between industry concentration and short debt maturity (the proportion of short-term debt in total debt). On the other hand, if the predation effects outweigh the agency effects in concentrated industries, we expect short debt maturity to be positively related to industry concentration at low levels of industry concentration; and inversely related to industry concentration at higher levels of industry concentration. In other words, if predation effects are important, we expect a non-linear relation between industry concentration and short debt maturity.

We examine the relation between industry concentration and short debt maturity using a large sample of firm-year observations from 1986 to 2006. We use the sales-based Herfindahl index for all firms in the industry (based on the four-digit SIC code) and the inverse of the number of firms in the industry as measures of industry concentration. We also include the square of these measures of industry concentration as additional explanatory variables to capture the potential non-linearity in the relation between debt maturity and industry concentration.

In two-stage least squares regressions that account for the endogenous relation between leverage and debt maturity, we find that with debt maturity (short-term debt as a percentage of total debt) as the dependent variable, the coefficient on industry concentration is positive and statistically significant at conventional levels. Furthermore, the coefficient on the square of industry concentration is negative and statistically significant, suggesting the existence of a non-linear relation between industry concentration and debt maturity. Consistent with the intuition in Hart (1983), Bolton and Scharfstein (1990) and others, these findings indicate that firms operating in either the least concentrated industries or the most concentrated industries use less short-term debt. Moreover, we find that controlling for other determinants of debt maturity, the proportion of short-term debt in total debt is highest in industries with a Herfindahl index value of 0.4278. We also find that our results are robust to alternate measures of debt maturity (debt maturing in three or five years) and industry concentration (Herfindahl index or Inverse number of firms).

We conduct additional tests on sub-samples in an attempt to isolate conditions where the relation between industry structure and debt maturity is more pronounced. First, we suggest that at low levels of industry concentration, the agency effects of industry concentration on debt maturity are likely to be stronger in industries where firms are more alike because firms' costs

are likely to be correlated in such industries. Moreover, at higher levels of industry concentration, the benefits from predatory behavior are likely to increase with the degree of homogeneity among firms as the price elasticity of demand is greater among homogeneous firms. Thus, we expect the relation between industry concentration and debt maturity to be stronger in industries where firms are more homogeneous. Following the approach in Parrino (1997), we construct a measure of the degree of homogeneity between firms in the industry and categorize firms into two sub-samples based on the sample median level of homogeneity. We find that in the sub-sample of firms with above median homogeneity, the coefficient on industry concentration is positive while the coefficient on the square of this measure is negative. These coefficients are statistically significant at conventional levels. In contrast, for firms with below median industry homogeneity, the coefficients on both industry concentration as well as its square are statistically insignificant. These results suggest that the effects of product market competition on debt maturity are pronounced in industries with more homogeneous firms.

Second, we examine whether the nature of strategic interactions between firms affects the relation between industry concentration and debt maturity. When product market interactions are characterized as strategic complements, firms' cost-reducing strategies are accompanied by similar moves by rivals, thereby inducing a common component to firms' costs (Bulow, et al., 1985). As a result of the correlation between firms' costs, managers have less abnormal free cash flow to engage in non-value-maximizing behavior (Hart, 1983; Nalebuff and Stiglitz, 1983). However, when firms compete in strategic substitutes, the costs are less likely to be correlated across firms in the industry as firms' product market strategies may not evoke a similar response by rivals. Moreover, as competition is more aggressive when interactions are characterized as strategic complements, predatory behavior in concentrated industries is likely to be pronounced

when firms compete in strategic complements. Consequently, we expect the relation between industry concentration and debt maturity to be stronger in a sub-sample of firms that compete in strategic complements.

Following prior research (Sundaram, et al., 1996; Kedia, 2006; Lyandres, 2006), we construct a measure of the extent to which firms compete in either strategic substitutes or strategic complements. The results indicate that the coefficients on industry concentration and its squared value are largely significant with the expected signs in a sub-sample of firms that compete in strategic complements, but not in the sub-sample characterized by competition in strategic substitutes. This finding is consistent with firms choosing debt maturity based on the strategic behavior of rivals in the product market. Taken together, our findings suggest that industry structure significantly affects firms' debt maturity choices, and this effect is pronounced in industries where firms are more homogeneous or compete aggressively in the product market.

To the best of our knowledge, this is the first study to provide empirical evidence on the role of product market competition in determining firms' debt maturity choices. Our findings add to the growing body of research that has provided insights on the role of contracting costs, asymmetric information and taxes in explaining firms' debt maturity structures.[1] While maturity is a feature of debt contracts that is endogenously determined by firms, our findings have implications for the role of product markets in influencing other aspects of debt financing. In particular, given the differences in monitoring and length of borrowing periods for bank loans versus arm's length (public) debt, our findings have implications for firms' choice of private versus public markets for debt financing. More generally, the results suggest a role for product

[1] See e.g., Barclay and Smith, 1995; Guedes and Opler, 1996; Stohs and Mauer, 1996; Barclay, et al., 2003; Johnson, 2003; Datta, et al., 2005; Berger, et al., 2005; Benmelech, 2006; Billett, et al., 2007; Harford, et al., 2007.

market competition in the design of securities that affect firms' frequency of accessing the external capital market.

The rest of the paper proceeds as follows. In Section 2, we discuss the hypotheses and related literature. Section 3 presents a description of the sample. The empirical results are discussed in Section 4. We conclude in Section 5.

2. Hypotheses and related literature

We examine the role of product markets in firms' choice of debt maturity. Short-term debt facilitates the frequent production of information about firm performance and provides creditors the option to take control of the assets from poorly performing managers (e.g., Berglof and von Thadden, 1994; Dewatripont and Tirole, 1994; Barclay and Smith, 1995; Park, 2000; Hart, 2001; Diamond, 2004). While prior empirical studies assume that debt maturity is invariant to the competitive structure of firms' industries, competition can affect optimal debt maturity by influencing managerial discretion and the risk of premature liquidation. Hart (1983) shows that competition between firms induces a common component to firms' costs such that in competitive industries, firms are less likely to benefit from abnormal free cash flows because a decline in costs for one firm is likely to be correlated with a similar decline for other firms (see also, Nalebuff and Stiglitz, 1983; and Hermalin, 1992). As a result, if competition between firms is decreasing in industry concentration, the agency costs of managerial discretion would be smaller in less concentrated industries. Given this agency effect of industry structure, the monitoring benefits of short-term debt are likely to increase with industry concentration. This line of reasoning suggests a positive relation between firms' use of short-term debt and industry concentration.

However, competition in oligopolies can induce rivals to engage in predatory strategies, and thereby impose financial constraints that force firms to exit the market (Milgrom and Roberts, 1982). In particular, firms reduce the costs of refinancing (including costs associated with premature liquidation) by minimizing the frequency of accessing external capital markets when operating in industries where predation is more likely (e.g., Fudenberg and Tirole, 1986; Bolton and Scharfstein, 1990; Kanatas and Qi, 2001). Accordingly, by refinancing less frequently, firms mitigate the benefits to rivals undertaking predatory actions. We apply this reasoning to the context of debt maturity choice by suggesting that firms operating in markets characterized by predation are less likely to borrow short term so that the sensitivity of financing costs to predatory actions by rivals is minimized. Thus, the predation effect suggests that firms in concentrated industries would take on less short-term debt.

To summarize, the agency effect predicts a positive relation between debt maturity and industry concentration whereas the predation effect predicts an inverse relation. Overall, the relation between debt maturity and industry concentration therefore depends on the net effects of agency and predation on debt maturity. In less concentrated industries, with a large number of firms competing in the product market, the benefits from predation are likely to be small due to small gains in market share from the exit of a few firms. Consequently, as the agency effect of industry structure is likely to outweigh the predation effect in less concentrated industries, we expect firms in these industries to take on less short-term debt.

Furthermore, at higher levels of industry concentration, the market share gains from predation are likely to be high due to the presence of fewer competitors. Thus, if the predation effect dominates the agency effect at higher levels of industry concentration, we expect a non-linear relation such that short debt maturity is positively related to industry concentration at low

levels of concentration and inversely related to industry concentration at higher levels of concentration. However, if the agency effects are stronger than the predation effects, the overall relation between short debt maturity and industry concentration would be positive. The above reasoning leads to the following hypotheses:

H1: If agency effects outweigh predation effects in concentrated industries, the overall relation between short debt maturity and industry concentration is positive.

H2: If predation effects outweigh agency effects in concentrated industries, the overall relation between short debt maturity and industry concentration is non-linear, with short debt maturity increasing in industry concentration at low levels of concentration, and decreasing at higher levels of concentration.

3. Sample and variables

3.1. Sample

To assemble our sample, we identify all firms covered by Compustat for the 1986 to 2006 period. We start with 1986 since Compustat does not provide bond rating data for years prior to 1986, which we use to construct one of our control variables. Following the literature on capital structure, we exclude financial firms (SIC codes between 6000 and 6999). The resulting sample consists of a panel of 46,774 firm-year observations for 8,627 unique firms for which we can compute all the dependent and independent variables.

3.2. Variables

We construct two variables to measure the maturity structure of the firm's debt: *Debt Maturity (three years)* is the ratio of debt that matures within a three-year period (the sum of Compustat's data items 34, 91, 92) to total debt (the sum of items 9 and 34); *Debt Maturity (five years)* is the ratio of debt that matures within a five-year period (the sum of items 34, 91, 92, 93, 94) to total debt. We measure the concentration of the firm's industry using the sales-based

Herfindahl index of the firm's four-digit SIC code industry (*Industry Concentration)*. As an alternative measure, we also use *Inverse Number of Firms* defined as the inverse of the number of firms operating in the firm's four-digit SIC code industry. Since the two concentration variables have advantages and disadvantages (see Lyandres, 2006), our use of both measures is intended to check the robustness of our results to the method of measuring industry concentration. Further, to check the robustness of the results to industry classification, we use a broader definition of the firm's product market and construct the two measures of concentration using the firm's three-digit SIC codes.

Given the potential simultaneity between the firm's debt maturity and leverage decisions, we use a simultaneous equation model that treats debt maturity and firm's leverage as endogenous variables (see, e.g., Barclay, Marx, and Smith, 1997; Johnson, 2003). The firm's book leverage (*Leverage*) is defined as the book value of total debt divided by the sum of the book value of debt and market value of common equity (item 25* item 199). We instrument for leverage using *Fixed Assets Ratio*, which is the ratio of net property, plant, and equipment (item 8) to total assets, and *Profitability* defined as the ratio of operating income before depreciation (item 13) to total assets.

Following the literature (see, e.g., Barclay and Smith, 1995; Johnson, 2003, Datta et al. 2005), the control variables we use in the debt maturity equation are as follows:

1. *Market-to-Book* is the ratio of market to book value of the firm's assets, where market value of assets is computed as total assets minus book value of common equity (item 60) plus market value of common equity.
2. *Asset Maturity* is the weighted average of the maturities of the firm's current and long-term assets computed as follows: gross property, plant, and equipment (item 7)/ total

assets × (gross property, plant, and equipment/depreciation expense (item 14)) + (current assets (item 4)/total assets) × (current assets (item 4)/cost of goods sold (item 41)).

3. *Firm Size* is the natural log of the market value of assets.
4. *Regulated Dummy* is a dummy variable that equals one if the firm operates in a regulated industry, and zero otherwise. Regulated industries are those with SIC codes between 4900 and 4939 or equal to 4011, 4210, 4213, 4512, 4812, 4813.
5. *Rated Dummy* is a dummy variable that equals 1 if the firm has rated debt (item 280 is not missing), and zero otherwise.
6. *Return Volatility* is the standard deviation of the weekly returns for the fiscal year.
7. *Abnormal Earnings* is the change in operating income (item 20) per share divided by the share price at the end the previous fiscal year (item 199).
8. *Term Structure* is the difference between the rate on the 30-year US Treasury bond and the rate on the 6-month US Treasury bill. Data are from the website of the Federal Reserve Bank of St. Louis.
9. *Net Operating Loss Dummy* is a dummy that equals 1 for firms with net operating loss carryforwards (item 52), and zero otherwise.
10. *Investment Tax Credit Dummy* is a dummy variable that equals 1 for firms with investment tax credits (item 208), and zero otherwise.
11. Year and industry variables. The industry indicators are based on the firm's two-digit historical SIC code (item 324).

Table 1 shows descriptive statistics for the dependent and independent variables. The mean and median of the percentage of debt maturing in three (five) years are 49.28% and 43.75 (68.79% and 70.80%), respectively. The mean (median) of *Industry Concentration*, measured at

the four-digit level, is 0.22 (0.17), with a standard deviation of 0.17 indicating that the industries in our sample vary considerably with respect to concentration. The mean *Inverse Number of Firms* (0.06) indicate that the average four-digit industry in our sample consists of about 17 firms.

4. Results

4.1. Debt maturity and industry concentration

In order to examine the relation between debt maturity and industry concentration, we estimate a two-stage least squares (2SLS) regression model that treats debt maturity and leverage as endogenous variables. Table 2 shows estimates from the second stage of the debt maturity regression. Using *Debt Maturity (five years)* as the dependent variables (second column), we find that the coefficient on *Industry Concentration* (measured at the four-digit SIC level) is positive and statistically significant at the 1% level. Further, the coefficient on the squared value of *Industry Concentration* is negative and significant. Taken together, these results suggest there is an inverted U-shaped relation between debt maturity and concentration. This nonlinear relation is consistent with our hypothesis: at low levels of concentration, firms take on more short debt when they operate in a more concentrated industry, as predicted by the agency view of debt. However, since at high levels of concentration predatory behavior becomes more significant, an increase in concentration results in a decline in the firm's reliance on short-term debt.

As shown in the first column of Table 2, using *Debt Maturity (three years)* yields similar results, although the coefficients are not significant at conventional levels. Measuring *Industry Concentration* at the three-digit SIC level (Columns 3 & 4) yields similar and somewhat stronger results for both measures of debt maturity.

The results pertaining to the control variables are consistent with those in the literature (e.g., Barclay, Marx, and Smith, 1997; Johnson, 2003). For instance, the coefficients on (predicted) leverage are negative and highly significant in all reported models, consistent with the evidence in the literature that debt maturity increases with leverage (see, e.g, Barclay and Smith, 1995). Firms with more growth opportunities (measured using Market-to-Book) tend to take on less short-term debt, possibly to mitigate the underinvestment problem of Myers (1977). The results for the remaining controls are in keeping with the literature.

Table 3 shows second-stage estimates for a model where we use the inverse of the number of firms in the industry as a measure of the extent of industry competition. The results from this model are consistent with those reported in Table 2. For instance, the coefficients on *Inverse Number of Firms* are positive and significant in all reported models, while the coefficients on the squared value of *Inverse Number of Firms* are negative and significant. These results further suggest the presence of an invested U-shaped relation between debt maturity and industry concentration.

4.2. Debt maturity, concentration, and industry homogeneity

Our use of the concentration measures intends to capture the extent of industry competition. One shortcoming of these measures is that they do not capture whether a given industry consists of firms that are very similar, with similar technology and products, or whether the industry consists of otherwise dissimilar firms. One would expect that, for a given level of concentration, industries with similar firms should exhibit more intense competition. Aghion et al. (2005) call such industries neck-to-neck sectors. We expect that the effect of concentration on the debt maturity choice via the agency or predatory arguments should be more pronounced in such industries. We test this hypothesis below.

We use the methodology in Parrino (1997) to measure the similarity between firms in the same industry (*Industry Homogeneity*). Parrino argues that firms that use similar technology and sell undifferentiated products will have more correlated cash flows, and hence we should observe higher correlation in their stock returns. Following Parrino (1997), we compute *Industry Homogeneity* as follows. For each firm-year *i* in industry *j*, we use monthly returns for the five-year period ending at the end of the previous fiscal year to estimate the following two-factor model:

$$r_{i,t} = \beta_0 + \beta_1 r_{Ind_{j,t}} + \beta_2 r_{mt} + \varepsilon_{i,t} \quad (1)$$

where, $r_{i,t}$ is the stock return for firm *i* in industry *j* for month *t*, $r_{Ind_{j,t}}$ is the equally weighted return on a portfolio of all firms in the four-digit industry *j* in month *t***,** and r_{mt} is the value-weighted return in month *t* on a market portfolio that consists of all stocks in the CRSP database. Next, we estimate the partial correlation coefficient between the returns for the i^{th} firm and industry returns. This coefficient measures the correlation between the firm's return and industry returns after controlling for market returns. It is thus equivalent to the correlation coefficient between two residuals: one from the regression of the firm's stock returns on market returns and another from a regression of industry returns on market returns. *Industry Homogeneity* of the j^{th} industry is then defined as the mean of the absolute value of the partial correlation coefficient for each industry. Higher values of *Industry Homogeneity* should be associated with industries where firms are more similar.

To test whether the relation between debt maturity and industry concentration depends on the degree of industry homogeneity, we estimate our base model for two groups of industries based on the value of *Industry Homogeneity*: those with variable values greater than the median

and those below the median. The 2SLS estimates are reported in Table 3. For brevity we report the results when using *Industry Concentration* measured at the four-digit level. The results are qualitatively similar if we measure industry concentration at the three-digit level or if we use the inverse number of firms to measure industry concentration. The results reported in Table 4 indicate that there is an inverted U-shaped relation between debt maturing and industry concentration only for the subsample of industries with homogenous firms as shown in the first two columns. For firms in industries with below median *Industry Homogeneity*, we find an insignificant relation: the coefficients on *Industry Concentration* and its squared value are both statistically insignificant at conventional levels. The results are not sensitive to the way we measure debt maturity; we find similar results using debt maturing in three years or five years. These results provide additional support for our hypotheses.

4.3. Debt maturity, concentration, and competitive strategy

Next, we examine whether the nature of strategic interactions between industry firms affects the relation between debt maturity and industry concentration. For a given concentration level, the extent of competition in an industry may vary with other factors such the shape of the profit and cost functions and how these functions are affected by the strategic moves of industry firms. For instance, the competitive aggressiveness in an industry depends on how rivals react to actions taken by their competitors. Bulow et al. (1985) formalize two types of competitive strategies. In particular, in a duopolistic industry, firms compete in *strategic substitutes* if a more aggressive strategy by one firm (e.g., increasing output) reduces the rival's marginal profits. In such competitive environments, the rival is said to "accommodate" a strategic move by the firm and thus the competition in such industries is less aggressive. Similarly defined, competition in *strategic complements* describes competitive environments where an aggressive action by the

firm results in an increase in the rivals' marginal profits. In such industries, the rival responds with a similar move, which results in more aggressive competition.

Thus, the effect of an increase in concentration on debt maturity should be stronger in industries where firms compete in strategic complements since both the agency effect as well as the predatory effect will be more pronounced in such industries. In order to test this conjecture, one needs an empirical proxy for the nature of the industry competitive strategy.

Sundaram et al. (1996) develop a proxy (denoted competitive strategy measure or CSM) for whether firms compete in strategic complements or substitutes. Kedia (2006) and Lyandres (2006) modify this empirical proxy to control for the effect of industry stocks. We follow Lyandres (2006) to estimate CSM. For a given firm *i*, CSM is defined as:

$$CSM_i = corr\left[\frac{\Delta\tilde{\pi}_i}{\Delta\tilde{S}_i}, \Delta S_R\right], \qquad (2)$$

where $\Delta\tilde{\pi}_i$ and $\Delta\tilde{S}_i$ are the implied changes (between two consecutive quarters) in the profits and sales of the i^{th} firm, respectively; ΔS_R is the change in the firm's product market rivals' combined sales between two consecutive quarters. CSM_i is used as a proxy for the cross-partial derivative of a firm's profit with respect to its own and its rivals' sales. We then define industry CSM as the mean of CSM_i for all firms in a given industry. A Positive (negative) CSM value indicates that industry firms compete in strategic complements (substitutes). Lyandres (2006) shows that using the implied changes rather than the actual changes in profits and sales (i.e., $\Delta\tilde{\pi}_1$ and $\Delta\tilde{S}_1$ rather than $\Delta\pi_1$ and ΔS_1) reduces the bias in estimating CSM that can result from industry shocks. For instance, if the entire industry is subject to declining costs then $\frac{\Delta\pi_1}{\Delta S_1}$ and

ΔS_2 will be positively correlated even if industry firms compete in strategic substitutes (see also Kedia, 1996).

The implied changes in profits and sales are estimated using the models in Lyandres (2006) as follows. First, the parameters (α_i and β_i) of the following model are estimated:

$$\frac{S_{i,t+1} - S_{i,t}}{S_{i,t}} = \alpha_i + \beta_i \left[\frac{\pi_{i,t+1}}{S_{i,t+1}} - \frac{\pi_{i,t}}{S_{i,t}} \right] + \varepsilon_{i,t} \quad (3)$$

The implied changes in profits and sales are then defined as:

$$\Delta \tilde{S}_i = S_{i,t+1} - \tilde{S}_{i,t} = S_{i,t+1} - S_{i,t} \left[1 + \hat{\alpha}_i + \hat{\beta}_i \left[\frac{\overline{\pi_{t+1}}}{S_{t+1}} - \frac{\overline{\pi_t}}{S_t} \right] \right] \quad (4)$$

$$\Delta \tilde{\pi}_i = \pi_{i,t+1} - \tilde{\pi}_{i,t} = \pi_{i,t+1} - S_{i,t} \left[1 + \hat{\alpha}_i + \hat{\beta}_i \left[\frac{\overline{\pi_{t+1}}}{S_{t+1}} - \frac{\overline{\pi_t}}{S_t} \right] \right] \left[\frac{\pi_{i,t}}{S_{i,t}} + \left[\frac{\overline{\pi_{t+1}}}{S_{t+1}} - \frac{\overline{\pi_t}}{S_t} \right] \right] \quad (5)$$

where $S_{i,t}$ and $\pi_{i,t}$ is total sales (Quarterly Compustat's item 2) and operating profits (item 21 minus item 5) of the i^{th} firm in quarter *t*, respectively; $\frac{\overline{\pi_t}}{S_t}$ is the average of the industry profit margin in quarter t. Simply put, Equations (3), (4), and (5) are used to estimate the implied profits and sales that would have been observed if the only change was in the firm's profit function induced by a particular shock. Eq. (4) and (5) use the change in the average industry profitability $\left[\frac{\overline{\pi_{t+1}}}{S_{t+1}} - \frac{\overline{\pi_t}}{S_t} \right]$ to proxy for the shock affecting the firm's profitability.

The parameters in (3) are estimated using the previous 20 quarters (at least 10 observations are required). Next, using (4) and (5), we estimate $\Delta \tilde{\pi}_i$ and $\Delta \tilde{S}_i$ for the previous 20 quarters, which are then used to estimate CSM_i (as defined in Eq. (2)) for each firm-year in a

given four-digit SIC code industry. Finally, we obtain CSM (the mean of CSM_i) for each year and four-digit SIC code industry. Since Compustat's quarterly files do not include historical SIC codes, we get industry classification from the annual files (item 324).

Based on the sign of CSM, we classify the firms into two subsamples: the first subsample consists of firms in industries with negative CSM, or firms competing in strategic substitutes; the second subsample includes firms in industries with positive CSM, or those that compete in strategic complements. Table 5 shows 2SLS estimates from our base model for the two subsamples. The first two columns show the results for the positive-CSM subsample. When using debt maturing in five years to measure debt maturity, we find that the results pertaining to the concentration measure and its squared value are in keeping with our earlier results: the coefficient on *Industry Concentration* is positive while the coefficient on the squared value is negative, with both statistically significant at the 1% level. Measuring debt maturity using debt maturing in three years yields similar results although the coefficient on the square value of *Industry Concentration* is not significant at conventional levels (t-stat = -1.45). Turning to the negative-CSM subsample, we find that the relation between debt maturity and industry concentration is not significant at conventional levels. These results support the conjecture that the relation between industry concentration and debt maturity depends on the nature of the competitive strategy in the industry.

The results reported in Tale 5 are based on *Industry Concentration* measured at the four-digit SIC level. We repeat our analysis using a three-digit concentration measure and find similar results. Using *Inverse of Number of Firms* also yields similar results. Thus, our results appear to be robust to our measures of industry concentration.

5. Conclusion

We examine how firms' debt maturity choices are influenced by the structure of their respective industries. We hypothesize that industry structure can affect debt maturity by influencing both, the agency costs of free cash flows as well as the costs arising from predatory competition. On one hand, given the disciplinary effects of competition, the agency costs of free cash flow are likely to be lower in less concentrated industries where large numbers of firms compete with each other. On the other hand, strategic competition is more likely in highly concentrated industries, particularly when firms attempt to capture market share through predatory behavior. Consequently, while the disciplinary role of short term debt (and hence, the demand for short term debt) increases with industry concentration, the liquidation costs of taking on short term debt also rise with industry concentration. The relation between industry structure and debt maturity is thus an empirical issue that depends on the net effect of the monitoring benefits and the liquidation costs of short-term debt at various levels of industry concentration.

We test our hypotheses using a large sample of firm-year observations from 1986 to 2006. We find evidence of a non-linear relation between industry concentration and short debt maturity (the proportion of short term debt in total debt). In regressions explaining short debt maturity, the coefficients on measures of industry concentration are positive while the coefficients on the square of industry concentration measures are negative. That is, firms take on more short term debt as industry concentration increases from low levels of concentration. At higher levels of concentration, however, firms take on less short term debt as the predatory threat from rivals outweighs the monitoring benefits of taking on short term debt.

We also find that the non-linear relation between industry concentration and debt maturity exists in industries where firms compete in strategic complements or where the degree

of homogeneity between firms is higher. In contrast, industry concentration is unrelated to debt maturity in industries where firms compete in strategic substitutes or where the degree of homogeneity across firms is lower. These findings support our reasoning that both monitoring benefits as well as liquidation costs influence the relation between industry structure and debt maturity. The results are robust to alternative measures of debt maturity and to alternative measures of industry concentration. By providing evidence on the role of industry competition in affecting debt maturity decisions, our study suggests that product market competition affects capital structure decisions beyond the basic debt-equity choice.

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Table 1
Descriptive Statistics
This table reports descriptive statistics for the dependent and independent variables. The sample consists of 46,774 firm-year observations from the period 1986 to 2006. *Debt Maturity (three years)* is the ratio of debt that matures within a three-year period to total debt. *Debt Maturity (five years)* is the ratio of debt that matures within a five-year period to total debt. *Industry Concentration* is the sales-based Herfindahl index of the firm's four- (or three-) digit SIC code industry. *Inverse Number of Firms* is the inverse of the number of firms operating in the firm's four- (or three-) digit SIC code industry. *Leverage* is book value of long-term debt and debt in current liabilities divided by the sum of book value of debt and market value of common equity. *Market to Book* is the ratio of market value to book value of the firm's assets. *Asset Maturity* is the weighted average of the maturities of current and long-term assets. *Firm Size* is the natural log of the market value of assets. *Regulated Dummy* is a dummy variable that equals one if the firm operates in a regulated industry, and zero otherwise. *Rated Dummy* is a dummy variable that equals 1 if the firms has rated debt, and zero otherwise. *Return Volatility* is the standard deviation of the weekly returns for the fiscal year. *Abnormal Earnings* is the change in operating income per share divided by the previous year's share price. *Term Structure* is the difference between the rate on the 30-year US Treasury bond and the rate on the 6-month US Treasury bill. *Net Operating Loss Dummy* is a dummy that equals 1 for firms with net operating loss carryforwards, and zero otherwise. *Investment Tax Credit Dummy* is a dummy variable that equals 1 for firms with investment tax credits, and zero otherwise. *Fixed Assets Ratio* is the ratio of net property, plant, and equipment to total assets. *Profitability* is the ratio of operating income before depreciation to total assets.

	Mean	Median	STD
Dependent Variables			
Debt Maturity (three years)	49.28	43.75	33.28
Debt Maturity (five Years)	65.79	70.80	30.92
Industry Structure Variables			
Industry Concentration (four digits SIC)	0.22	0.17	0.17
Industry Concentration (three digits SIC)	0.16	0.13	0.14
Inverse Number of Firms (four digits SIC)	0.06	0.04	0.07
Inverse Number of Firms (three digits SIC)	0.04	0.02	0.05
Control Variables			
Leverage (predicted)	0.23	0.20	0.17
Market to Book	1.73	1.31	1.52
Asset Maturity	11.66	7.64	13.46
Firm Size	5.88	5.80	2.27
Regulated Dummy	0.10	0.00	0.30
Rated Dummy	0.31	0.00	0.46
Return Volatility	0.04	0.03	0.03
Abnormal Earnings	0.01	0.01	0.31
Term Structure	1.48	1.27	1.11
Net Operating Loss Dummy	0.29	0.00	0.45
Investment Tax Credit Dummy	0.12	0.00	0.33
Instruments for Leverage			
Fixed Assets Ratio	0.36	0.31	0.24
Profitability	0.09	0.12	0.21

Table 2
Regression analysis of debt maturity structure on industry concentration
This table reports the second stage estimates of a 2SLS estimation of a simultaneous equation model that treats debt maturity structure and leverage as endogenous variables. *Debt Maturity (three years)* is the ratio of debt that matures within a three-year period to total debt. *Debt Maturity (five years)* is the ratio of debt that matures within a five-year period to total debt. *Industry Concentration* is the sales-based Herfindahl index of the firm's four-digit SIC code industry (columns 1 & 2) or the firm's three-digit SIC code industry (columns 3 & 4). The control variables are described in Table 1. T-stats are in parenthesis and are based on heteroskedasticity-robust standard errors. The symbols *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Four-digit SIC Code		Three-digit SIC Code	
	Debt Maturity (three years)	Debt Maturity (five years)	Debt Maturity (three years)	Debt Maturity (five years)
Industry Concentration	4.548	9.84***	22.14***	24.59***
	(1.59)	(3.76)	(6.50)	(7.97)
Industry Concentration Squared	-4.960	-11.50***	-23.80***	-29.20***
	(-1.42)	(-3.62)	(-5.47)	(-7.37)
Control Variables				
Leverage (predicted)	-113.91***	-84.35***	-112.11***	-82.98***
	(-17.98)	(-14.93)	(-17.94)	(-14.89)
Market to Book	-2.13***	-1.93 ***	-2.03***	-1.85***
	(-8.21)	(-8.69)	(-7.98)	(-8.49)
Asset Maturity	-0.10***	-0.13***	-0.09***	-0.13***
	(-6.14)	(-9.33)	(-6.14)	(-9.34)
Firm Size	-11.24***	-7.66***	-11.24***	-7.65***
	(-29.84)	(-24.10)	(-29.97)	(-24.20)
Firm Size Squared	0.66***	0.47***	0.66***	0.47***
	(22.22)	(17.93)	(22.41)	(18.06)
Regulated Dummy	4.86***	0.66	6.73***	2.20**
	(5.65)	(0.76)	(7.53)	(2.45)
Rated Dummy	-10.45***	-15.38***	-10.64***	-15.55***
	(-16.44)	(-25.51)	(-16.96)	(-26.07)
Return Volatility	187.71***	135.12***	187.70***	135.41***
	(13.19)	(12.75)	(13.21)	(12.80)
Abnormal Earnings	1.36**	1.27***	1.35**	1.27***
	(2.31)	(2.65)	(2.31)	(2.67)
Term Structure	0.66*	0.22	0.66*	0.21
	(1.81)	(0.68)	(1.80)	(0.65)
Net Operating Loss Dummy	3.84***	2.56***	3.79***	2.53***
	(10.15)	(7.43)	(10.09)	(7.39)
Investment Tax Credit Dummy	-5.05***	-5.38***	-4.88***	-5.24***
	(-10.83)	(-12.20)	(-10.55)	(-11.96)
Intercept	-869.32***	-330.02	137.58***	129.39***
	(-3.29)	(-1.37)	(34.52)	(18.24)
Industry Indicators	Yes	Yes	Yes	Yes
Year Indicators	Yes	Yes	Yes	Yes
Number of Observations	46,774	46,774	46,774	46,774
Adjusted R-Squared	19.49%	22.08%	20.10%	22.08%

Table 3
Regression analysis of debt maturity structure on the inverse of number of industry firms
This table reports the second stage estimates of a 2SLS estimation of a simultaneous equation model that treats debt maturity structure and leverage as endogenous variables. *Debt Maturity (three years)* is the ratio of debt that matures within a three-year period to total debt. *Debt Maturity (five years)* is the ratio of debt that matures within a five-year period to total debt. *Inverse Number of Firms* is based on the number of firms in the firm's four-digit SIC code industry (columns 1 & 2) or the firm's three-digit SIC code industry (columns 3 & 4). The control variables are described in Table 1. T-stats are in parenthesis and are based on heteroskedasticity-robust standard errors. The symbols *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Four-digit SIC Code		Three-digit SIC Code	
	Debt Maturity (three years)	Debt Maturity (five years)	Debt Maturity (three years)	Debt Maturity (five years)
Inverse Number of Firms	16.85***	23.39***	40.45***	32.67***
	(3.01)	(4.65)	(5.53)	(5.03)
Inverse Number of Firms Squared	-3.89	-25.46**	-56.22***	-46.86***
	(-0.28)	(-2.05)	(-2.94)	(-2.80)
Control Variables				
Leverage (predicted)	-113.37***	-84.67***	-113.85***	-84.89***
	(-17.87)	(-14.96)	(-17.92)	(-14.97)
Market to Book	-2.08***	-1.91***	-2.09***	-1.93***
	(-8.09)	(-8.65)	(-8.11)	(-8.70)
Asset Maturity	-0.10***	-0.13***	-0.10***	-0.13***
	(-6.20)	(-9.41)	(-6.36)	(-9.55)
Firm Size	-11.24***	-7.62***	-11.27***	-7.65***
	(-29.85)	(-23.99)	(-29.98)	(-24.15)
Firm Size Squared	0.66***	0.47***	0.66***	0.47***
	(22.24)	(17.79)	(22.27)	(17.86)
Regulated Dummy	5.29***	0.86	5.70***	0.88
	(6.25)	(0.99)	(6.71)	(1.02)
Rated Dummy	-10.50***	-15.37***	-10.50***	-15.37***
	(-16.54)	(-25.50)	(-16.55)	(-25.51)
Return Volatility	188.90***	137.24***	189.34***	136.77***
	(13.15)	(12.77)	(13.19)	(12.77)
Abnormal Earnings	1.35**	1.27***	1.35**	1.27***
	(2.30)	(2.65)	(2.30)	(2.65)
Term Structure	0.67*	0.23	0.67*	0.23
	(1.82)	(0.70)	(1.83)	(0.69)
Net Operating Loss Dummy	3.84***	2.58***	3.85***	2.59***
	(10.15)	(7.50)	(10.17)	(7.50)
Investment Tax Credit Dummy	-4.97***	-5.33***	-5.02***	-5.40***
	(-10.72)	(-12.14)	(-10.80)	(-12.28)
Intercept	99.43***	108.36***	154.06***	135.72***
	(13.23)	(15.60)	(23.38)	(16.52)
Industry Indicators	Yes	Yes	Yes	Yes
Year Indicators	Yes	Yes	Yes	Yes
Number of Observations	46,774	46,774	46,774	46,774
Adjusted R-Squared	19.72%	21.59%	19.60%	21.53%

Table 4
Regression analysis of debt maturity structure: subsamples based on industry homogeneity
This table reports the second stage estimates of a 2SLS estimation of a simultaneous equation model that treats the debt maturity structure and leverage as endogenous variables. *Debt Maturity (three years)* is the ratio of debt that matures within a three-year period to total debt. *Debt Maturity (five years)* is the ratio of debt that matures within a five-year period to total debt. *Industry Concentration* is the sales-based Herfindahl index of the firm's four-digit SIC code industry. *Industry Homogeneity* is based on the Parrino's (1997) measure and captures the similarity among industry firms. The control variables are described in Table 1. T-stats are in parenthesis and are based on heteroskedasticity-robust standard errors. The symbols *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Above Median Industry Homogeneity Subsample		Below Median Industry Homogeneity Subsample	
	Debt Maturity (three years)	Debt Maturity (five years)	Debt Maturity (three years)	Debt Maturity (five years)
Industry Concentration	6.97*	14.62***	-3.95	-2.88
	(1.91)	(4.11)	(0.79)	(-0.67)
Industry Concentration Squared	-8.69**	-16.95***	6.94	4.18
	(-2.09)	(-4.20)	(1.03)	(0.73)
Control Variables				
Leverage (predicted)	-77.85***	-78.57***	-134.68***	-77.51***
	(-9.56)	(-10.17)	(-14.35)	(-9.58)
Market to Book	-1.56***	-2.64***	-2.28***	-1.35***
	(-3.45)	(-6.01)	(-7.21)	(-5.23)
Asset Maturity	-0.08***	-0.13***	-0.12***	-0.13***
	(-4.75)	(-7.61)	(-4.51)	(-5.51)
Firm Size	-13.25***	-8.33***	-10.00***	-7.83***
	(-26.42)	(-17.90)	(-18.27)	(-17.74)
Firm Size Squared	0.83***	0.52***	0.55***	0.51***
	(22.42)	(14.68)	(11.60)	(12.63)
Regulated Dummy	5.08***	3.12***	2.26	-1.42
	(5.21)	(3.02)	(1.00)	(-0.66)
Rated Dummy	-12.02***	-14.82***	-9.24***	-17.28***
	(-17.71)	(-21.47)	(-7.95)	(-16.52)
Return Volatility	170.63***	163.83***	188.18***	105.68***
	(9.50)	(9.69)	(9.61)	(8.19)
Abnormal Earnings	0.94	0.97	1.81**	1.51**
	(1.18)	(1.33)	(2.18)	(2.50)
Term Structure	0.66	0.02	0.63	0.40
	(1.40)	(0.05)	(1.11)	(0.85)
Net Operating Loss Dummy	2.34***	2.03***	4.74***	2.51***
	(4.62)	(4.11)	(8.61)	(5.32)
Investment Tax Credit Dummy	-3.27***	-4.43***	-6.62***	-5.92***
	(-5.91)	(-7.90)	(-8.66)	(-8.70)
Intercept	120.98***	121.24***	101.26***	99.12***
	(36.73)	(38.20)	(13.72)	(4.49)
Industry Indicators	Yes	Yes	Yes	Yes
Year Indicators	Yes	Yes	Yes	Yes
Number of Observations	23,423	23,423	23,351	23,351
Adjusted R-Squared	27.11%	25.40%	11.00%	18.18%

Table 5
Regression analysis of debt maturity structure: subsamples based on the Competitive Strategy Measure
This table reports the second stage estimates of a 2SLS estimation of a simultaneous equation model that treats the debt maturity structure and leverage as endogenous variables. *Debt Maturity (three years)* is the ratio of debt that matures within a three-year period to total debt. *Debt Maturity (five years)* is the ratio of debt that matures within a five-year period to total debt. *Industry Concentration* is the sales-based Herfindahl index of the firm's four-digit SIC code industry. *Competitive Strategy Measure* (CSM) captures whether competition among industry firms is in strategic complements (positive CSM) or strategic substitutes (negative CSM). The control variables are described in Table 1. T-stats are in parenthesis and are based on heteroskedasticity-robust standard errors. The symbols *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Positive CSM Subsample		Negative CSM Subsample	
	Debt Maturity (three years)	Debt Maturity (five years)	Debt Maturity (three years)	Debt Maturity (five years)
Industry Concentration	8.24**	15.75***	2.41	2.76
	(1.99)	(4.15)	(0.60)	(0.74)
Industry Concentration Squared	-7.20	-16.06***	-3.88	-5.07
	(-1.45)	(-3.54)	(-0.77)	(-1.10)
Control Variables				
Leverage (predicted)	-125.59***	-94.73***	-100.59***	-71.87***
	(-12.31)	(-10.45)	(-12.32)	(-9.86)
Market to Book	-3.11***	-2.74***	-1.30***	-1.23***
	(-6.74)	(-6.93)	(-4.31)	(-4.74)
Asset Maturity	-0.13***	-0.18***	-0.07***	-0.09***
	(-5.91)	(-8.42)	(-3.21)	(-4.63)
Firm Size	-11.27***	-7.82***	-11.37***	-7.61***
	(-19.01)	(-16.45)	(-22.99)	(-17.60)
Firm Size Squared	0.69***	0.50***	0.65***	0.45***
	(15.82)	(13.48)	(15.44)	(11.98)
Regulated Dummy	7.79***	4.08***	-1.25	-6.08
	(7.12)	(3.76)	(-0.78)	(-3.95) ***
Rated Dummy	-9.94***	-14.78***	-11.19***	-16.25
	(-11.19)	(-17.63)	(-11.94)	(-18.28) ***
Return Volatility	207.61***	151.95***	165.15***	114.57
	(7.86)	(8.45)	(11.01)	(8.95) ***
Abnormal Earnings	2.06**	1.81**	0.77	0.80
	(2.18)	(2.41)	(1.04)	(1.31)
Term Structure	0.50	0.30	0.70	0.05
	(0.95)	(0.63)	(1.37)	(0.10)
Net Operating Loss Dummy	4.05***	2.92***	3.61***	2.21***
	(7.06)	(5.57)	(7.14)	(4.82)
Investment Tax Credit Dummy	-5.39***	-6.11***	-4.25***	-3.80***
	(-8.27)	(-9.96)	(-6.24)	(-5.90)
Intercept	304.43***	413.59***	126.99***	119.30***
	(4.69)	(6.79)	(35.10)	(19.97)
Industry Indicators	Yes	Yes	Yes	Yes
Year Indicators	Yes	Yes	Yes	Yes
Number of Observations	23,142	23,142	23,632	23,632
Adjusted R-Squared	16.20%	21.95%	22.86%	21.68%