Debt Maturity Structure and Firm Investment

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This study shows that the maturity structure of a firm's debt has a significant impact on its investment decisions. We show, after controlling for the effect of the overall level of leverage, that a higher percentage of long-term debt in total debt significantly reduces investment for firms with high growth opportunities. In contrast, the correlation between debt maturity and investment is not significant for firms with low growth opportunities. The results are strong at the firm level and at the business segment level. These results hold even after controlling for the endogeneity problem inherent in the relationship between total leverage, the maturity composition of leverage, and investment.

How a firm's level of debt and the maturity structure of the debt affect its investment decisions are fundamental issues in corporate finance. In a Miller-Modigliani world with complete markets, a firm's financial policy—including the maturity of its debt—has no bearing on its investment decisions. In a world with incomplete markets, however, agency problems inherent in interactions between shareholders, debtholders, and management, and associated with the level of leverage and its maturity composition, give rise to underinvestment or overinvestment incentives. A firm's financial policy may have a significant effect on its investment. Several empirical studies have investigated the relationship between firm leverage and investment. For example, Lang, Ofek, and Stulz (1996) and Aivazian, Ge, and Qiu (2005) directly test the effect of leverage on firm investment and find that leverage is significantly negatively related to investment. However, no empirical study has explored the effect of the maturity structure of corporate debt on corporate investment. Whether and to what extent debt maturity influences firm investment remains an unresolved empirical issue.

In this article, we directly test for the relationship between debt maturity and firm investment. We find that longer debt maturity is associated with less investment for firms with high growth opportunities. In contrast, debt maturity is not significantly related to investment for firms with low growth opportunities. These results support the prediction of Myers (1977) that debt maturing after the expiration of the growth option causes underinvestment problems. High-growth opportunity firms are more likely to face an underinvestment problem compared with low-growth opportunity firms and, thus, the negative effect of longer debt maturity on investment should be stronger for high-growth opportunity firms.

Note, however, that leverage and its maturity structure are not exogenous to investment. The negative linkage between investment and long-term debt may be due to the firm's adjustment of its level of debt, and the maturity structure of the debt, in view of anticipated future investment opportunities. Indeed, if future investment opportunities are anticipated and leverage adjustment

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costs are low, managers can reduce leverage and shorten debt maturity to mitigate the underinvestment problem; thus, it may be that debt maturity structure has no significant impact on investment once this endogeneity bias is taken into account. We employ two alternative approaches to correct for the endogeneity bias.

One approach follows that of Lang et al. (1996) who distinguish between the impact of leverage on growth in a firm's core business and that in its non-core business. They argue that a firm determines its leverage according to growth opportunities in its core business segment, and that its capital structure is weakly exogenous to investment in its non-core business segment. If capital structure has no impact on investment, one should not observe a strong relationship between leverage and investment in the firm's non-core segment. The other approach uses the instrumental variable method to address the endogeneity problem. Here, the maturity of the firm's assets and the tangibility of the assets are used as instrumental variables for debt maturity and leverage, respectively. Overall, our results indicate that the negative effect of longer debt maturity on investment remains strong for non-core business segments, and these results are robust using the instrumental variable approach. Thus, our results hold even after correcting the endogeneity bias, and support the hypothesis that debt maturity structure has a significant impact on firm investment.

The rest of the article proceeds as follows. Section I reviews the theoretical underpinnings of the linkage between debt maturity and investment. Section II presents the baseline results on the relationship between debt maturity and investment and addresses the endogeneity issue. Section III concludes the article.

I. The Debt Maturity-Investment Relationship

That debt maturity could affect corporate investment was pointed out in a seminal paper by Myers (1977), who analyzed possible externalities generated by debt on shareholders' (and management's) optimal investment strategy. If debt matures after the expiration of the firm's investment option, it reduces the incentives of the shareholder-management coalition in control of the firm to invest in positive net-present-value investment projects since the benefits accrue, at least partially, to the bondholders rather than accruing fully to the shareholders. Hence, compared to firms with shorter debt maturities, firms with long-term debt are less likely to exploit valuable growth opportunities.

The extant literature focuses on ways in which firms can resolve the underinvestment problem, including the shortening of the maturity of debt to enable refinancing before the investment option expires. Stohs and Mauer (1996) argue that firms trade off the benefits and costs of alternative debt maturity structures by taking into account the underinvestment costs of debt, the signaling effects of debt, liquidity risk, asset maturity structure, and tax status. They find that debt maturity is inversely related to firm quality and to the firm's effective tax rate and risk, and directly related to its asset maturity.[1] But, they find only mixed support for the hypothesis that debt maturity is inversely related to growth opportunities. Other studies such as Barclay and Smith (1995), Guedes and Opler (1996), Barclay, Marx, and Smith (2003) and Scherr and Hulburt (2001) provide strong evidence that corporate debt maturity is negatively associated with growth opportunities.

[1]Stohs and Mauer's (1996) results support Diamond's (1991) liquidity risk theory and the implied non-monotonic relationship between bond ratings and debt maturity structure. Liquidity risk is the risk that a viable and solvent firm may become illiquid and unable to get refinancing; it is engendered by debt that is of shorter maturity than the cash flow stream generated by the firm's assets.

The above studies imply that potential underinvestment costs induced by longer maturity debt lead firms to reduce debt maturity when anticipating growth opportunities. Although these results are consistent with Myers' (1977) underinvestment hypothesis, they do not provide direct evidence on the effect of debt maturity on investment expenditures. In this study, we examine whether and to what extent debt maturity influences firm investment, taking into account any *ex ante* restructuring of debt maturity in anticipation of investment opportunities. To clarify the nature of the relationship between debt maturity and investment opportunities, we next discuss the theoretical underpinnings of such links.

As noted, the underinvestment incentives generated by debt could be mitigated by the firm's financing through short-term debt or, if future growth opportunities are recognized sufficiently early, by the lowering of the level of leverage and its maturity when the firm has outstanding debt. It is important, therefore, to distinguish between the cases where growth opportunities are anticipated and those where they are unanticipated. In the former case, the firm can simply issue short-term debt or, if it has outstanding debt, lower leverage and its maturity by renegotiating with its debtholders, thereby attenuating potential underinvestment problems. In fact, if bargaining costs are small, renegotiations between debtholders and shareholders to buy back debt can internalize externalities generated by leverage, in effect attenuating the underinvestment problem.[2] In general, the structure of anticipations concerning future growth opportunities and the costs of recontracting are both crucial for determining the impact of debt maturity on corporate investment.[3]

Unanticipated growth opportunities, on the other hand, leave less scope for attenuating underinvestment problems. Renegotiations with debtholders tend to be more time constrained and hence more costly in comparison to the case in which growth is anticipated. Also, with unanticipated growth, negotiations may have to be completed quickly before the growth opportunities dissipate through competition. Time-constrained negotiations are likely to result in higher transaction or adjustment costs in the buying back of debt. The implication is that anticipation of growth opportunities and renegotiation costs are negatively correlated, which implies that long-term debt has a much more pronounced negative influence on investment when growth is unanticipated than when it is anticipated since the adjustment costs of debt are higher in the former case.

It follows from the above discussion that there are several reasons why debt maturity can influence a firm's investment. First, and as the extant empirical results suggest, firms shorten debt maturity *ex ante* in response to anticipated growth opportunities. However, various costs constrain firms from fully adjusting debt maturity so that longer debt maturity could result in underinvestment ex post. Second, if investment opportunities are not fully anticipated, longer debt maturity may have a more significant influence on investment since there is less scope for shortening the maturity structure of debt. Recent empirical evidence suggests that the rebalancing of corporate capital structure to its optimal level is subject to significant adjustment costs (see Betker, 1997; Fama and French, 2002; Baker and Wurgler, 2002; and Leary and Roberts, 2005). Such adjustment costs imply a sticky debt-maturity structure. Therefore, even if firms strive to attenuate the investment effect of debt maturity when anticipating growth opportunities, various costs associated with the adjustment of debt

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[2]For a discussion of these issues, see Barnea, Haugen, and Senbet (1980, 1981) and Aivazian and Callen (1980).

[3]Thus, a negative empirical association between investment and the maturity composition of leverage when growth opportunities are fully anticipated reflects the actions of the firm to tailor leverage to growth opportunities, or the effect of growth opportunities on leverage. There may, of course, be offsetting benefits to longer maturity debt—such as reduced liquidity risk or greater tax shields—to trade off against these potential agency costs, but the optimal level of debt maturity that emerges till be influenced by (anticipated) growth opportunities.

maturity may prevent the resolution of the underinvestment problem. Unanticipated investment opportunities may make the problem more severe. A test of the effect of debt maturity on firm investment allows for a direct assessment of the extent to which debt maturity influences investment, given the various debt restructuring constraints faced by firms.

II. The Impact of Leverage and Debt Maturity on Firm Investment

Subsection A describes the data and the empirical methodology employed, Subsection B reports our baseline results, and Subsection C addresses the endogeneity issue and carries out robustness tests.

A. Data and Empirical Method

The data for this study are extracted from the Compustat active and research files for the period 1982 to 2002. We exclude financial firms (6000-6999) from our sample due to regulation complications in the financial-services sector. Following Barclay and Smith (1995), we measure a firm's debt maturity as the percentage of the firm's total debt that has a maturity of more than three years.[4] The leverage level is measured as the book value of total debt (the sum of short-term and long-term debt) divided by the book value of total assets.[5] In the estimated investment equation, we include cash flow to control for the firm's financial constraints, and Tobin's Q to control for growth opportunities. We include lagged investment to capture the accelerator effect of investment.

Specifically, we estimate the following equation:

$$I_{i,t}/K_{i,t-1} = \beta \times MATURITY_{i,t-1} + \gamma \times LEVERAGE_{i,t-1} + \eta \times (CF_{i,t}/K_{i,t-1}) + \delta \times Q_{i,t-1} + \varphi \times (I_{i,t-1}/K_{i,t-2}) + \mu_i + \lambda_t + \varepsilon_{i,t} \quad (1)$$

where $I_{it}/K_{i,t-1}$ is firm investment, measured as capital expenditures minus depreciation and normalized by net fixed assets at the beginning of the year. $MATURITY_{i,t-1}$ is the debt maturity of firm i in period t-1. $LEVERAGE_{i,t-1}$ is the leverage level of firm i in period t-1. $CF_{i,t}/K_{i,t-1}$ is cash flow, which is measured as the sum of earnings before extraordinary items and depreciation normalized by net fixed assets at the beginning of the year. Tobin's Q in year t, Q_t, is defined as the market value of the total assets of the firm divided by the book value of assets and is a proxy for growth opportunities. We calculate the market value of the firm as the sum of total liabilities, the value of the common stocks, and the book value of preferred stocks. $I_{i,t-1}/K_{i,t-2}$ is the investment of firm i in period t-1 normalized by the net fixed assets of firm i in period t-2. μ_i is the individual effect of firm i. λ_t is a dummy variable denoting year and is included to control for macroeconomic shocks; $\varepsilon_{i,t}$ is the error term.

Table I provides descriptive information on the variables used in this study.[6] One can see that there is a high variation in the investment rate of US firms. The mean ratio of net investment to fixed assets is 0.08 with a standard deviation of 0.29, which is almost four times the mean. The sample average Tobin's Q is 1.67, which reflects market expectations of

[4]For a robustness check, we also use four-and five-year maturities to distinguish short-term from long-term debt. The results are qualitatively unchanged.

[5]Lang et al. (1996) and Opler and Titman (1994) discuss the reasons for the use of book values.

[6]To avoid the effect of outliers, we winsorized the observations following Cleary (1999). The cutoff values are 2 and -2 for investment/net fixed assets; 5 and -5 for cash flow/net fixed assets; 10 and 0 for Tobin's Q, 1 and 0 for debt maturity, and 1 and 0 for leverage.

Table I. Summary Statistics of Debt Maturity, Leverage, and Growth Opportunities

The sample consists of all firms except for financial firms listed in the Compustat. The sample spans the years 1982-2002. Firm investment is measured as capital expenditures minus depreciation and normalized by fixed assets at the beginning of the year. Cash flow is measured as the sum of earnings before extraordinary items and depreciation normalized by fixed assets at the beginning of the year. Tobin's Q is defined as the market value of the total assets of the firm divided by the book value of assets and is a proxy for growth opportunities. We calculate the market value of the firm as the sum of total liabilities, the value of the common stocks, and the book value of preferred stocks. Debt maturity is measured as the percentage of long-term debt in total debt. Leverage is measured as the ratio of total debt to total assets. To avoid the effect of outliers, we winsorized the observations following Cleary (1999). The cutoff values are 2 and -2 for investment/net fixed asset, 5 and -5 for cash flow/net fixed asset, 10 and 0 for Tobin's Q, 1 and 0 for debt maturity, and 1 and 0 for leverage.

Variables	Mean	Standard Deviation	Minimum	Median	Maximum
Investment $_{t}$	0.08	0.29	-2.00	0.04	2.00
Cash flow $_{t}$	0.32	0.95	-5.00	0.24	5.00
Tobin's Q $_{t-1}$	1.67	1.24	0.14	1.29	10.00
Maturity $_{t-1}$	0.66	0.29	0.00	0.74	1.00
Leverage $_{t-1}$	0.25	0.19	0.00	0.24	1.00

strong growth opportunities for US firms over this sample period. This is reasonable for our sample period of the 1980s and 1990s, a period marked by large growth in the US economy. The average leverage level is 0.25 with a standard deviation of 0.16. The average proportion of the long-term debt to total debt is 66% with a standard deviation of 0.29, indicating that, on average, firms hold more long-term debt than short-term debt.

A potential problem in this estimation process is the possible high correlation between the various regressors. As mentioned earlier, firms with high growth opportunities, i.e., high Tobin's Q, will reduce their leverage level and adjust the term structure of their debt in favor of short-term debt. This may lead to serious multicollinearity among the Tobin's Q, leverage, and the debt maturity variables. To ascertain the degree of multicollinearity, we report the correlation matrix between all the regressors in Table II. As this table shows, the correlation between the regressors is not high. The correlation between Tobin's Q and leverage is –0.177, and the correlation between Tobin's Q and debt maturity is only -0.131. Thus, multicollinearity is not a serious problem in our study.

Since lagged investment is included as a regressor and is correlated with the individual effect μ_i, a pooling regression and a random-effect model yield biased estimators. Although the fixed-effect estimator eliminates the individual effect by transforming data into deviations from the within-group mean, it is still biased because the within-group mean of lagged investment is correlated with the mean of the error term. To deal with this potential bias, we apply the generalized method of moments (GMM) developed by Arellano and Bond (1991). This method first differences the data to eliminate the individual effect μ_i, and then utilizes all the lagged values of the regressors as instruments. The orthogonal moment conditions for the regressions are:

Table II. Correlation Matrix of Dependent and Independent Variables

This table reports the correlation coefficients among firm investment, cash flow, Tobin's Q, debt maturity, and leverage.

	Investment $_t$	Investment $_{t-1}$	Cash Flow $_t$	Tobin's Q_{t-1}	Maturity $_{t-1}$	Leverage $_{t-1}$
Investment $_t$	1.000					
Investment $_{t-1}$	0.479	1.000				
Cash Flow $_t$	0.132	0.018	1.000			
Tobin's Q $_{t-1}$	0.192	0.180	0.018	1.000		
Maturity $_{t-1}$	-0.013	-0.0003	-0.009	-0.131	1.000	
Leverage $_{t-1}$	-0.127	-0.082	-0.127	-0.177	0.279	1.000

$$E[(\varepsilon_{i,t}-\varepsilon_{i,t-1})X_{i,t-j}]=0 \qquad j=2,\ldots,\ t-1;\ t=3,\ldots,T \tag{2}$$

where $X_{i,t}$ includes the measures of leverage, debt maturity, cash flow, and Tobin's Q. Under the assumptions that there is no second-order serial correlation in the error terms, and that the explanatory variables are predetermined or exogenous, this GMM framework yields consistent estimators.

B. Baseline Results

The baseline results of the estimated investment equation are reported in Table III. Column 2 of Table III reports the GMM estimators for the full sample. The effects on investment of variables such as Tobin's Q, cash flow, and lagged investment have the expected signs; and current investment is positively correlated with last-period investment, which implies that there is an accelerator effect. Tobin's Q, which measures growth opportunities, has a significant and positive impact on investment. Higher cash flow is associated with greater investment. These results are consistent with those of previous studies on the sensitivity of investment to cashflow (Fazzari, Hubbard, and Petersen, 1988 and Kadapakkam, Kumar, and Riddick, 1998) and of investment to leverage (Lang et al., 1996 and Aivazian et al., 2005).

The variables of particular interest to our study are the maturity structure of debt, $MATURITY_{i,t-1}$, and leverage level, $LEVERAGE_{i,t-1}$. The results show that leverage level has a negative impact on investment at the 1% significance level. The estimated coefficient of $LEVERAGE_{i,t-1}$ is –0.244, which implies that a one-standard-deviation increase in the leverage level will lead to a 0.046 decrease in investment. The results also show that the estimated coefficient of debt maturity is negative and significantly different from zero at the 1% level. After controlling for the effect of leverage, a one-standard deviation increase in the debt maturity structure on average reduces the firm investment-to-assets ratio by 0.01. Since the

Table III. Debt Maturity, Leverage and Firm Investment

This table provides the empirical results of the effects of leverage and debt maturity on the investment of firms with high-growth opportunities and low-growth opportunities. The specification is:

$$I_{i,t} / K_{i,t-1} = \alpha + \beta \times MATURITY_{i,t-1} + \gamma \times LEVERAGE_{i,t-1} + \eta \times (CF_{i,t} / K_{i,t-1}) + \delta \times Q_{i,t-1} + \varphi \times (I_{i,t-1} / K_{i,t-1}) + \mu_i + \lambda_t + \varepsilon_{i,t}$$

where I_{it} / $K_{i,t-1}$ is firm investment, $MATURITY_{i,t-1}$ is the debt maturity of firm i at period t-1. $LEVERAGE_{i,t-1}$ is the leverage level of firm i at period t-1. $CF_{i,t} / K_{i,t-1}$ is cash flow, which is measured as the sum of earnings before extraordinary items and depreciation, normalized by fixed assets at the beginning of the year. Q_t is defined as the market value of total assets of the firm divided by the book value of assets and is a proxy for growth opportunities. Growth opportunities are measured by Tobin's Q. High or low-growth opportunity firms are identified as those whose Tobin's Q is above and below median Tobin's Q, respectively. GMM estimators are reported in this table. z-statistics are provided in parenthesis below the coefficient estimates.

		Growth Opportunities	
	All Sample	**Low**	**High**
Investment $_{t-1}$	0.227***	0.157***	0.210***
	(29.39)	(14.96)	(17.60)
Leverage $_{t-1}$	-0.244***	-0.393***	-0.194***
	(-7.95)	(-9.14)	(-4.10)
Maturity $_{t-1}$	-0.035***	0.018	-0.089***
	(-3.08)	(1.19)	(-4.94)
Tobin's Q_{t-1}	0.051***	0.055***	0.052***
	(17.81)	(7.46)	(14.85)
Cash flow $_t$	0.050***	0.041***	0.050***
	(15.12)	(10.17)	(11.01)
Constant	-0.007***	-0.004***	-0.009***
	(-13.02)	(-4.72)	(-6.07)
Year Dummies	Yes	Yes	Yes
Observations	20650	10374	10276
	(2504)	(1852)	(1904)

***Significant at the 0.01 level, respectively.
**Significant at the 0.05 level, respectively.
*Significant at the 0.10 level, respectively.

average investment-to-assets ratio is 0.08, the result indicates that a one-standard deviation increase in debt maturity structure leads to a 12.5% decrease of average investment. Thus, the effect of debt maturity on investment is not only statistically significant but also economically significant.

Debt maturity could have a differential impact on investment for firms with different growth prospects. High-growth opportunity firms are more likely to face an underinvestment problem compared with low-growth opportunity firms. Therefore, the negative effect of longer debt maturity on investment—the underinvestment problem—should be stronger for high-growth opportunity firms. To test this hypothesis, we separate firms into high- and low-growth opportunity groups and test the impact of debt maturity on the two groups separately.[7]

Columns 3 and 4 of Table III report GMM estimators for both groups. One can see that the coefficients for leverage are negative and significant at the 1% level for both types of firms. The results are consistent with those of Lang et al. (1996) and Aivazian et al. (2005) and suggest that, holding debt maturity constant, a high leverage level would reduce investment incentives for both types of firms. In contrast, the effects of debt maturity are quite different for high- and low-growth opportunity firms. The coefficient on debt maturity is significant and negative for firms with high growth opportunities while it is insignificant for firms with low growth opportunities. For firms with high growth opportunities, a one-standard-deviation increase in debt maturity reduces the investment-to-asset ratio by 0.026, which accounts for 32.5% of the average investment-to-asset ratio. The result suggests that the effect of debt maturity is economically significant for high-growth firms. These results provide strong support for Myers' (1977) underinvestment hypothesis; high-growth opportunity firms are more likely to face underinvestment problems, and long-maturity debt significantly discourages investment.

Systematic differences may exist in the investment behavior of firms in different industries. To control for industry effects and to test the robustness of the results, we transform all the variables into deviation-from-industry mean and perform the same exercise. The estimation of the investment equation using industry-adjusted variables yields similar results: all else being equal, a higher proportion of long-term debt in total debt is associated with less investment for high-growth opportunity firms but not for low-growth opportunities firms.[8]

C. The Endogeneity Issue and Robustness Tests

Both debt maturity and total leverage may be affected by expected investment opportunities. In theory, even if long-term debt generates underinvestment incentives, this effect could be mitigated by the firm taking corrective action and lowering the level and maturity of debt if growth opportunities are recognized sufficiently early. The maturity of debt is optimally reduced by management *ex ante* in view of anticipated ex post investment opportunities, so that the impact of debt on growth is mitigated. In the regression analysis, the independent variable Tobin's Q reflects publicly available information about investment opportunities. However, a firm's debt maturity and leverage choice may also reflect private information observed by managers. We adopt the following two alternative approaches to deal with this endogeneity problem pertaining to the relationship between debt maturity, leverage and investment: first, we treat *LEVERAGE* and *MATURITY* as endogeneous variables, and include two instrumental variables in the instrument matrix in the GMM framework. Second, we follow the approach of Lang et al. (1996), and separate the firm's business into core and non-core segments. Since growth opportunities in non-core segments are less likely to affect the financial structure of the firm, the endogeneity problem is mitigated in the estimation of the investment equation for non-core segments.

The essence of the instrumental-variable approach is to find exogeneous variables uncorrelated with investment, but strongly correlated with capital structure. A potential instrumental variable for leverage is the tangibility of assets, which is measured as the proportion of the value of property, plant, equipment plus the value of inventory in total assets. A possible instrumental variable for debt maturity is the maturity of firm assets. Following Stohs and Mauer (1996), asset maturity is measured as the weighted average of

[7]Growth opportunities are measured by Tobin's Q. High- and low-growth opportunity firms are identified as those whose Tobin's Q is above and below the median Tobin's Q, respectively.

[8]The results are not reported here but are available upon request.

the maturity of long-term assets and current assets. The maturity of long-term assets is measured as gross property, plant, and equipment divided by depreciation; the maturity of current assets is defined as current assets divided by the cost of goods. The weight for long-term assets is the share of gross property, plant, and equipment in total assets, and the weight for current assets is the share of current assets in total assets.

Using tangibility and maturity of assets as instrumental variables can be justified on the basis of the following arguments: First, bankruptcy costs are an important determinant of the firm's leverage level, and tangible assets tend to reduce bankruptcy costs and increase leverage. Also, firms with more tangible assets should find asset substitution (risk shifting) more difficult, which lowers the agency costs of debt and raises optimal leverage (Williamson, 1988). Therefore, tangibility of assets should be highly correlated with the firm's leverage level. Second, firms can match the maturities of their assets and liabilities to attenuate underinvestment problems, which suggests a negative relationship between asset maturity and short-term debt. Finally, the tangibility and maturity of assets are not highly correlated with the firm's investment opportunities: the correlation coefficient between tangible assets and investment is –0.027, while the correlation between asset maturity and investment is 0.013.

Table IV reports the results from the instrumental variable approach and they show a similar pattern to the baseline results. There is a significant and negative relationship between leverage and investment for both high-growth and low-growth opportunity firms. Also, longer debt maturity is significantly associated with less investment for firms with high growth opportunities, which suggests that the endogeneity problem does not present a serious bias in our estimations.

We have shown that the level of debt and its maturity significantly affects a firms' investment policy, especially for those with high-growth opportunities. These results are robust when we use the instrumental variable approach to address the endogeneity issue. However, choosing suitable instrumental variables is not without controversy. We adopt the second approach to address the endogeneity problem pertaining to capital structure and investment. We separate the diversified firms' businesses into core and non-core segments and test the impact of debt maturity on investments in these two segments. The rationale for this approach, which was proposed by Lang et al. (1996) in their study of the impact of leverage on investment, is that debt maturity should be more affected by growth opportunities in the firm's core business than in its non-core business. Therefore, if debt maturity proxies for investment opportunities, we should not observe a strong relationship between the firm's debt maturity and its non-core investment.[9]

We follow the approach of Lang et al. (1996) and combine the Compustat segment files with firm files. We define a segment as a core-segment if the segment's two-digit SIC code is the same as the SIC code of the firm, and categorize the others as non-core segments. According to this definition, there are 3560 core segments and 4817 non-core segments in our sample. Since the segment file only provides limited information about segments, we cannot estimate Equation (1) at the segment level. Following Lang et al. (1996), we regress segment investment on segment return to assets (ROA), firm leverage, and firm debt maturity. Investments in core and non-core segments are measured by capital expenditures minus depreciation and normalized by fixed assets at the beginning of the year. The fixed-effect model is used to estimate this investment equation.

Table V reports the results of the estimated investment equation for core and non-core

[9]Similar approaches have been used by several authors in testing for liquidity effects on firm investment. For example, Lamont (1997) tests the impact of a liquidity shock generated by oil price changes on investment activity in oil companies' non-oil divisions.

Table IV. Debt Maturity, Leverage, and Firm Investment: Instrumental Variable Approach

This table provides the empirical results of the effects of leverage and debt maturity on the investment of firms with high-growth opportunities and low-growth opportunities. Lagged maturity and leverage are treated as endogenous variables, and lagged tangibility of assets and maturity of assets are used as instrumental variables. GMM estimators are reported in this table. z-statistics are provided in parentheses below the coefficient estimates.

		Growth Opportunities	
	All Sample	Low	High
Investment $_{t-1}$	0.218***	0.147***	0.203***
	(28.06)	(13.93)	(16.98)
Leverage $_{t-1}$	-0.280***	-0.443***	-0.257***
	(-7.45)	(-8.67)	(-4.68)
Maturity $_{t-1}$	-0.079***	-0.034	-0.109***
	(-3.57)	(-1.44)	(-3.67)
Tobin's Q_{t-1}	0.048***	0.053***	0.048***
	(16.66)	(7.40)	(13.60)
Cash flow $_t$	0.047***	0.030***	0.050***
	(14.27)	(7.34)	(11.00)
Constant	-0.007***	-0.005***	-0.008***
	(-12.52)	(-6.15)	(-5.36)
Year Dummies	Yes	Yes	Yes
Observations	20003	9974	10029
(Firms)	(2446)	(1803)	(1864)

***Significant at the 0.01 level, respectively.
**Significant at the 0.05 level, respectively.
*Significant at the 0.10 level, respectively.

business segments. We are more interested in the results for non-core segments since the endogeneity problem is mitigated there. The results show that leverage has a negative effect on investment, and also that long-term debt has a significant and negative effect on investment in both core and non-core segments. The evidence here does not support the argument that the endogeneity problem between debt maturity and investment explains away the negative relationship between longer debt maturity and firm investment.

III. Conclusion

This article investigates the impact of corporate debt maturity structure on investment. The underinvestment hypothesis predicts that debt maturing after the expiration of the firm's growth options deters investment incentives. Hence, shortening debt maturity is one effective way of mitigating such incentives and increasing firm investment. The extant literature focuses on how firms adjust debt maturity structure in response to growth opportunities to attenuate potential underinvestment costs of leverage. In this article, we examine the extent to which the maturity of debt influences firm investment expenditures, taking into account the

Table V. Debt Maturity and Firm Investment in Core and Non-core Segments

This table provides the empirical results of the effects of leverage and debt maturity on investment in core and non-core segments. We define a segment as a core segment if the segment's two-digit SIC code is the same as the SIC code of the firm; we categorize the others as non-core segments. According to this definition, there are 3560 core segments and 4817 non-core segments in our sample. Investments in core and non-core segments are measured by capital expenditures minus depreciation and normalized by fixed assets at the beginning of the year. ROA is the return on asset which is observed in the same year as the dependent variables. Fixed effect estimators are reported in this table; t-statistics are provided in parentheses below the coefficient estimates.

	Non-Core Segments	Core Segments
ROA_t	0.116***	0.048***
	(11.01)	(9.82)
$Leverage_{t-1}$	-0.066***	-0.114***
	(-3.14)	(-9.15)
$Maturity_{t-1}$	-0.035***	-0.011**
	(-3.46)	(-1.97)
Constant	0.030**	0.027***
	(2.41)	(3.72)
Year Dummies	Yes	Yes
R-square	0.01	0.02
Observations	20055	17061
(Segments)	(4817)	(3560)

***Significant at the 0.01 level, respectively.
**Significant at the 0.05 level, respectively.
*Significant at the 0.10 level, respectively.

restructuring of debt maturity in anticipation of investment opportunities.

We directly tested for the effect of debt maturity on firm investment. We find that longer debt maturity reduces firm investment, especially for firms with high growth prospects. An increase in one standard deviation of the ratio of long-term debt (maturity of more than three years) to total debt is associated with an average decrease of 0.01 and 0.026 in the investment-to-assets ratio for all firms and high-growth firms, respectively. Given that the average investment-to-asset ratio is 0.008, the results indicate that the effect of debt maturity structure on firm investment is both statistically and economically significant. The results provide evidence supporting the hypothesis that underinvestment costs are engendered by high maturity debt.

The relationship between debt maturity and firm investment is strong at the firm level and at the business segment level. The negative association between debt maturity and firm investment holds even after controlling for the endogeneity problem inherent in the relationship between total leverage, the maturity composition of leverage, and investment. The results suggest that various costs associated with shorter debt maturity constrain firms from fully adjusting their debt maturity in response to anticipated growth opportunities and are consistent with those of Stohs and Mauer (1996). The evidence supports the conjecture that unanticipated investment opportunities and adjustment costs of capital structure make it difficult for firms to fully adjust debt maturity in anticipation of new investment opportunities and, as a consequence, debt maturity structure does significantly influence corporate investment.

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