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The Maturity Structure of Corporate Debt

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ABSTRACT

We provide an empirical examination of the determinants of corporate debt maturity. Our evidence offers strong support for the contracting-cost hypothesis. Firms that have few growth options, are large, or are regulated have more long-term debt in their capital structure. We find little evidence that firms use the maturity structure of their debt to signal information to the market. The evidence is consistent, however, with the hypothesis that firms with larger information asymmetries issue more short-term debt. We find no evidence that taxes affect debt maturity.

FINANCIAL ECONOMICS HAS MADE significant progress in explaining the incentives that lead large public corporations to choose particular financing policies. Increasingly, the profession is moving beyond an examination of the basic leverage choice to more detailed aspects of the financing decision. In this article, we extend this literature by employing data from a large sample of firms to examine hypotheses about the determinants of the maturity structure of the firm's debt.

We group the hypotheses that have been offered to explain corporate debt maturity into three categories: contracting-cost hypotheses, signaling hypotheses, and tax hypotheses. Our evidence supports the contracting-cost hypotheses. Consistent with Myers (1977), firms with more growth options in their investment opportunity sets have less long-term debt in their capital structure. Large firms and regulated firms have more long-term debt. The evidence on signaling hypotheses is mixed. We find limited evidence that firms use debt maturity to signal information to the market. However, our evidence is consistent with a pooling equilibrium in which firms with larger potential information asymmetries (measured by the amount of growth options in their investment opportunity sets) issue more short-term debt. Our evidence also suggests a nonmonotonic relation between credit standing and debt maturity as predicted by Diamond (1993). We find no evidence that taxes affect debt maturity.

We develop the hypotheses in Section I and describe our data in Section II. In Section III, we test hypotheses about variation in debt maturity structure, and in Section IV, we examine the robustness of our results. We present our conclusions in Section V.

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I. The Theory of Debt Maturity

Three nonmutually exclusive sets of hypotheses have been proposed to explain corporate debt maturity: contracting-cost hypotheses, signaling hypotheses, and tax hypotheses. In this section, we summarize these basic hypotheses to guide the structure of our empirical tests and the interpretation of our results.

A. Contracting-Cost Hypotheses

A.1. Investment Opportunity Set

Myers (1977) argues that a corporation's future investment opportunities are like options. The value of these options depends on the likelihood that the firm will exercise them optimally. With risky fixed claims in the firm's capital structure, the benefits from undertaking profitable investment projects are split between stockholders and bondholders. In some cases, bondholders capture enough of the benefits so that a profitable project does not offer stockholders a normal return. In these cases, stockholders have incentives to reject positive net present value projects. Myers calls this the underinvestment problem.

With more growth options in the firm's investment opportunity set, the conflict between stockholders and bondholders over the exercise of these options is greater. Myers argues that a firm can control this incentive problem in several ways: by including less debt in its capital structure, by including restrictive covenants in its indenture agreements, or by shortening the effective maturity of its debt. Specifically, Myers notes that if the debt matures before any opportunity to exercise the real investment options, this disincentive to invest is eliminated. Hence, firms with more growth options in their investment opportunity sets should employ shorter-maturity debt.[1]

If the firm could costlessly recapitalize itself, this disincentive to invest would be eliminated (Fama (1978)). For example, consider a firm with a growth opportunity that requires an investment in one year. This firm has the same incentive to invest whether it has one-year debt outstanding or ten-year debt that it repays after one year. But the recapitalization strategy requires that the firm repurchase its outstanding long-term debt at prices that do not reflect the value of the new project. If information about the project causes the prices of its long-term debt to rise, then the benefits from the project are again shared between the stockholders and bondholders—whether the bonds are repurchased or not—and the underinvestment incentive remains. Issuing short-term debt avoids this problem. It fixes the price at

[1]See also Barnea, Haugen, and Senbet (1980). Moreover, recent articles that focus on managerial discretion derive implications that are similar to those of Myers. For example, Stulz (1990) and Hart and Moore (1990) argue that debt prevents firms from making bad investments. They suggest that firms with few growth options should issue more long-term debt because long-term debt is most effective at limiting managerial discretion.

which the firm repurchases its debt and allows stockholders to capture more (if not all) of the benefits from its new investments.[2]

Myers' analysis thus provides a rationale for value-maximizing firms to match the effective maturities of their assets and liabilities. At the end of an asset's life, the firm faces a reinvestment decision. Issuing debt that matures at this time helps to reestablish the appropriate investment incentives when new investment is required. More importantly, however, this analysis indicates that the maturity of a firm's tangible assets is not the sole determinant of its debt maturity. The firm's intangible assets (its growth options) play a critical role as well.

Implicitly, Myers must also assume that the cost of rolling short-term debt is greater than the cost of issuing long-term debt. If there were no differential costs of short-term debt, then all firms would prefer short-term debt under the contracting-cost hypothesis. The higher costs of short-term debt potentially include: (1) higher out-of-pocket flotation costs, (2) greater opportunity costs of management time in dealing with more frequent debt issues, and (3) reinvestment risk and potential costs of illiquidity (reinvestment risks and liquidity are discussed in more detail in Section I.*B*).

Stulz and Johnson (1985) suggest that the firm can control the underinvestment problem by retaining the ability to issue fixed claims with high priority (such as secured debt). Financing new investment projects with high-priority claims limits wealth transfers from stockholders to existing bondholders and thus reduces the incentives for stockholders to forego these projects. Ho and Singer (1982) argue that even if short-term and long-term debt have the same priority in bankruptcy, short-term debt has a higher effective priority outside bankruptcy because it is paid first. Thus issuing short-term debt to finance new investment projects offers potential benefits that are similar to those from issuing secured debt for controlling the underinvestment problem.

Finally, Smith and Warner (1979) hypothesize that risky firms benefit from placing more restrictive covenants in their debt. Covenants reduce moral-hazard problems (including the underinvestment problem) that occur after the debt is issued. When a restrictive debt covenant is violated, it is often optimal to renegotiate the debt agreement rather than forcing the borrower into bankruptcy. The Trust Indenture Act of 1939, however, limits the discretion that may be allocated to the trustee in a public debt issue. It thus is costly to renegotiate covenants in public debt agreements outside the

[2] Issuing callable debt also limits the potential wealth transfers from stockholders to bondholders and thus can help reduce the underinvestment problem. Callable debt is likely to be an imperfect substitute for short-term debt, however. For example, if market interest rates rise, causing the long-term debt to trade at a discount, then it is costly for the firm to call the debt to exercise a growth option. In addition, long-term debt generates other conflicts between stockholders and bondholders (such as the incentive to substitute more risky for less risky investments), which are not reduced by call provisions.

bankruptcy process. Private lenders, therefore, have a comparative advantage in writing debt contracts with restrictive covenants.[3] Fama (1985) argues that banks have a comparative advantage over other private lenders in monitoring such loans. (Consistent with this hypothesis, James (1987) finds a positive and statistically significant price reaction associated with bank loan announcements, but insignificant price reactions for public and nonbank private debt announcements.) To maximize the effectiveness of these monitoring activities, most bank loans are short term. By reducing the term of the debt, the bank maintains a stronger bargaining position, and that can affect the firm's investment policy. For example, consider a firm with outstanding public debt that would forego the exercise of a growth option. With short-term debt, the bank can make exercise of the option a condition for refunding. This suggests that high-growth firms that choose bank financing over public or nonbank private debt will have more short-term debt.

A.2. Regulation

Smith (1986) argues that managers of regulated firms have less discretion over future investment decisions than managers of unregulated firms. This reduction in managerial discretion reduces the adverse incentive effects of long-term debt. The contracting-cost hypothesis thus implies that regulated firms will have longer-maturity debt than unregulated firms.

A.3. Firm Size

Firm size is potentially correlated with debt maturity for several reasons. Issuance costs for public issues have a large fixed component resulting in significant scale economies. Smaller firms are less able to take advantage of these scale economies; they typically opt for private debt with its lower fixed costs and consequently lower overall costs.[4] Small firms that choose bank debt over public debt because of the lower flotation costs will have more short-term debt.

Firms with foreign operations are more likely to issue foreign debt to manage their currency exposure. Many foreign debt markets are less liquid than U.S. debt markets, especially for longer maturities.[5] Thus, multinational firms are likely to have more short-term debt. If larger firms are more likely to have foreign operations, this induces a negative relation between size and debt maturity.

[3] Monitoring by private lenders also involves costs, however. In addition to the direct costs of monitoring, there are costs of designing and enforcing the contracts (see Berlin and Loeys (1988)).

[4] Blackwell and Kidwell (1988) find that small, risky firms issue privately placed debt almost exclusively while larger, less risky firms are more likely to issue public debt.

[5] Although derivatives also can be employed to manage currency exposures, they are least likely to be available specifically in currencies where the debt maturities are most restricted.

B. Signaling Hypotheses

B.1. Firm Quality

Flannery (1986) and Kale and Noe (1990) examine signaling implications of the firm's debt-maturity choice. The pricing of long-term debt is more sensitive to changes in firm value than the pricing of short-term debt. Thus, although mispricing of the firm results in both long-term and short-term debt being mispriced, the mispricing of the long-term debt is greater. If the bond market cannot distinguish between high-quality and low-quality firms, high-quality (undervalued) firms will want to issue the less underpriced short-term debt. Low-quality (overvalued) firms will want to issue the more overpriced long-term debt. Rational investors understand these incentives when valuing risky corporate debt. In equilibrium, however, with risky debt of both maturities issued, high-quality firms will issue more short-term debt and low-quality firms will issue more long-term debt.

B.2. Pooling Equilibria

In addition to a separating signaling equilibrium (in which the firm's choice of debt maturity reveals its type) a pooling equilibrium is also possible. In a pooling equilibrium, both high and low quality firms issue debt of the same maturity. Flannery argues that firms with large potential information asymmetries (such as high-growth firms) are likely to issue short-term debt because of the larger information costs associated with long-term debt. Firms with smaller potential information asymmetries will be less concerned about the signaling effects of their debt maturity choice, and are more likely to issue long-term debt.

B.3. Credit Risk

As in other signaling models, Diamond (1991, 1993) assumes that firms with favorable private information about future profitability will prefer to issue short-term debt. Diamond argues, however, that short-term borrowing also exposes firms to the risk of excessive liquidations. Lenders are reluctant to refinance the debt if bad news arrives. In Diamond's analysis, firms with the highest credit ratings issue short-term debt because this refinancing risk is small. Firms with lower credit ratings prefer long-term debt to reduce this refinancing risk. Firms with very poor credit ratings, however, are unable to borrow long-term because of the extreme adverse-selection costs. Thus, there are two types of short-term borrowers: those with very good credit ratings and those with very poor credit ratings; firms in between are more likely to issue long-term debt.

Rajan (1992) argues that owners of firms with public debt outstanding will continue some projects that would be abandoned without the debt. He assumes that an optimal liquidation policy would be based on private information. Public debt contracts, therefore, cannot be contingent on such an optimal policy. If private lenders have access to better information about the value of the firm's assets, however, short-term private debt contracts can induce more efficient liquidation policies.

C. Tax Hypotheses

C.1. Term Structure

Brick and Ravid (1985) analyze tax implications of the debt maturity choice. Because the firm can default on its promised debt payments, the expected value of the firm's tax liabilities depends on the maturity structure of its debt whenever the term structure of interest rates is not flat. They assume that the probability of default increases with time, and the value of the firm's interest tax shield is reduced upon default. (This occurs, for example, if in reorganization, the firm faces binding constraints on the use of tax-loss carry-backs.) If the yield curve is upward sloping, the expectations hypothesis implies that in early years the interest expense from issuing long-term debt is greater than the expected interest expense from rolling short-term debt. But the interest expense is less in later years. In this case, Brick and Ravid argue that issuing long-term debt reduces the firm's expected tax liability and consequently increases the firm's current market value. Conversely, if the term structure is downward sloping, issuing short-term debt increases firm value. Thus, the tax hypothesis implies that firms employ more long-term debt when the term structure has a positive slope.

Lewis (1990) argues that taxes have no effect on optimal debt maturity. He notes that Brick and Ravid assume that the firm selects its leverage before the debt-maturity structure is chosen. If optimal leverage and debt-maturity structures are chosen simultaneously, then the debt-maturity structure is irrelevant.

II. Data

For our empirical investigation of the determinants of corporate debt maturity, we construct a large sample of firms. Our data set merges the COMPUSTAT expanded annual industrial and full-coverage files, the COMPUSTAT research annual industrial file, and the Center for Research in Securities Prices (CRSP) New York Stock Exchange (NYSE)/American Stock Exchange (AMEX) and Nasdaq files. We restrict our sample to firms with Standard Industrial Classification (SIC) codes from 2000 to 5999 to focus on the industrial corporate sector. Our data span the years 1974 through 1992.

A. Debt Maturity

A.1. Measuring Debt Maturity

COMPUSTAT reports the amount of long-term debt payable in years one through five from the firm's fiscal year end. To measure the maturity structure of a firm's debt, we examine the percentage of the firm's total debt (long-term debt plus debt in current liabilities) that has a maturity of more than three years. Several firms on the COMPUSTAT file report less than 0 percent or more than 100 percent of their total debt maturing in more than three years. Since these observations apparently reflect data-coding errors,

Table I

Summary Statistics for the Percentage of Total Debt That Matures in More Than One, Two, Three, Four, and Five Years from the Fiscal Year-End

Sample: All firms on both Center for Research in Securities Price(s) and COMPUSTAT between 1974 and 1992 with Standard Industrial Classification (SIC) codes from 2000 to 5999 (39,949 firm-year observations).

Percentage of Debt That Matures in More Than	Mean	Standard Deviation	25th Percentile	Median	75th Percentile	Value-Weighted Mean*
One year	71.8	28.2	59.8	82.9	92.7	73.0
Two years	60.9	29.1	42.6	69.5	84.0	65.7
Three years	51.7	28.9	29.5	57.1	75.1	58.7
Four years	43.7	28.1	19.7	46.0	66.4	52.2
Five years	36.6	27.2	11.5	35.8	58.1	45.9

*Weighted by total debt outstanding.

we discard them. The choice of three years, admittedly, is arbitrary. Our results are qualitatively similar, however, using the percentage of debt maturing in more than one, two, four, or five years.[6]

We measure debt maturity as the ratio of long-term debt to total debt in order to separate the debt maturity decision from the leverage decision. Titman and Wessels (1988) examine the ratio of long-term debt to total assets and the ratio of short-term debt to total assets. Their evidence shows that firms with higher leverage issue both more long-term debt and more short-term debt. Their specification, however, does not provide a clear picture of how the mix of long-term and short-term debt varies with firm characteristics. By examining long-term debt as a fraction of total debt, we more carefully focus on the debt maturity decision.

A.2. Descriptive Statistics on Debt Maturity

Table I provides debt-maturity summary statistics for the pooled time series and cross-section of firms on CRSP and COMPUSTAT between 1974 and 1992 (39,949 firm-year observations). The table reports the percentage of total debt that matures in more than one through five years from the firm's fiscal year-end. On average, these firms have 71.8 percent of their debt due in more than one year, 51.7 percent of their debt due in more than three years, and 36.6 percent of their debt due in more than five years. There is also considerable cross-sectional variation in debt maturity. For example, the

[6]We could also estimate a more complicated measure of the duration of the firm's debt. However, given the data limitations, any duration estimate would likely be a linear combination of the amount of debt due in years one through five from the firm's fiscal year-end. Since all of these measures provide the same qualitative results individually, we also expect any linear combination to provide the same qualitative results.

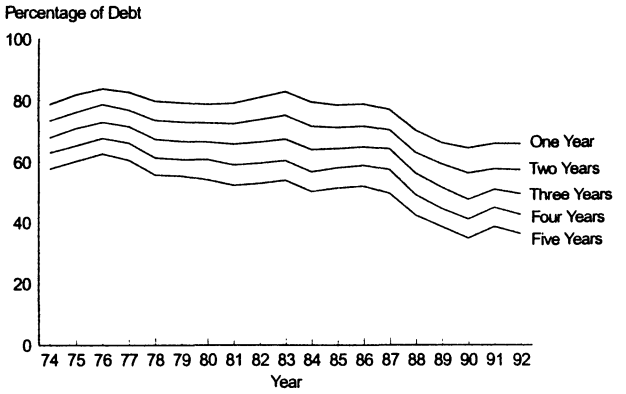

Figure 1. Cross-sectional weighted average of the percentage of total debt that matures in more than one, two, three, four, and five years from the fiscal year end. Observations are weighted by the total amount of debt outstanding. Sample: All firms on both Center for Research in Securities Prices and COMPUSTAT between 1974 and 1991 with SIC codes from 2000 to 599 (39,949 firm-year observations).

interquartile range for the percentage of debt due in more than three years extends from 29.5 to 75.1 percent.

To reflect the potential impact of firm size on the debt-maturity decision, we also report the value-weighted average debt maturity. By weighting observations by the firm's total debt outstanding, this average provides a more representative estimate of economy-wide debt maturity. On the short end of the maturity spectrum, the value-weighted and equally weighted averages are similar. For longer debt maturities, however, the difference is larger. The average percentage of debt that matures in more than five years increases from 36.6 percent (equally weighted) to 45.9 percent (value-weighted).

For each year from 1974 to 1992, Figure 1 presents the cross-sectional weighted average of the percentage of debt due in more than one through five years. The figure shows that, over this period, debt maturity reaches a peak in 1976 (with 73.0 percent of debt due in more than three years) and declines thereafter. In 1992, the weighted average percentage of debt due in more than three years is 49.5 percent. Since the value-weighted and equally weighted averages exhibit a similar pattern, this reduction does not appear to be caused by the addition of more small firms to the COMPUSTAT database in later years.[7]

A.3. Potential Measurement Problems

Using COMPUSTAT balance-sheet data provides a broad view of corporate debt. In addition to bonds and mortgages, long-term debt also includes

[7]In 1987, the Financial Accounting Standards Board adopted FAS 94 requiring firms to include majority owned subsidiaries in their consolidated financial statements. For some firms (for example, firms with captive finance subsidiaries), this resulted in a reduction in their reported debt maturity.

capitalized lease obligations, forestry and paper companies' timber contracts, publishing companies' royalty contracts payable, and similar long-term fixed claims. Short-term debt (debt in current liabilities) includes short-term notes, bank acceptances and overdrafts, the current portion of long-term debt, and sinking funds or installments on loans.

In principle, a theory of debt maturity should apply to this broad spectrum of corporate liabilities. In practice, including these nondebt fixed claims is unlikely to have a material effect on the analysis. In our sample, the most widely used nondebt fixed claims are capitalized leases. Capitalized leases appear on the balance sheet in 44 percent of our firm-year observations. For these firms, the lease obligations represent 20 percent of total debt; for all firm-years in the sample, lease obligations represent 9 percent of total debt.

To the extent that the firm's debt contains imbedded options in the call or sinking-fund provisions, our measure overstates the effective maturity. This measurement-error problem introduces a potential bias if the use of these provisions is correlated with our independent variables. For example, firms with more growth options might include more imbedded options in their debt contracts. This implies that the firms that are expected to employ the shortest-term debt will have the largest overstatement. Therefore, such a measurement problem would bias our tests against finding results consistent with the contracting-cost hypothesis.

A similar measurement problem occurs with affirmative covenants in debt agreements. Affirmative covenants require firms to maintain specified levels in accounting-based financial ratios. (For example, an affirmative covenant might specify a minimum level of working capital or net worth.) The violation of an affirmative covenant is an event of default typically giving the lender the right to accelerate the maturity of the debt (see Smith (1993)). Thus, to the extent that the debt includes affirmative covenants, our measure also overstates effective maturities. Affirmative covenants are virtually exclusively employed in private debt agreements. This implies that small, risky firms, which we expect to employ private debt agreements, have the biggest overstatement. This again biases our tests against finding results consistent with the contracting-cost hypothesis.

B. Exogenous Variables

B.1. Investment Opportunity Set

Smith and Watts (1992) and Gaver and Gaver (1993) examine the association between measures of the firm's investment opportunity set and the firm's financing, compensation, and dividend policies. These studies employ the ratio of the market value of the firm's assets to their book value as a proxy for growth options. The firm's balance sheet does not include intangible assets like growth options. More growth options thus increase the firm's market value in relation to its book value. Consistent with incentive-contracting hypotheses, Smith and Watts find that the market-to-book ratio is significantly associated with the firm's observed policy choices. Thus, the principal variable used in this study to proxy for the firm's investment opportunity set

is the market-to-book ratio. We estimate the market value of the firm's assets as the book value of assets minus the book value of equity plus the market value of equity. The market-to-book ratio is the estimated market value of assets divided by the book value of assets. This estimated market-to-book ratio has several extreme observations. For example, 98 percent of the ratios are between 0.5 and 6.9. The range for this variable, however, is 0.1 to 291.3. To eliminate the influence of these extreme observations on the regression results, we discard observations if the market-to-book ratio is greater than ten. (Discarding these observations reduces the statistical significance of this variable in the regressions, but increases the size of the coefficient.)

B.2. Regulation

To estimate the effects of regulation, we construct a dummy variable that is set equal to one for firms in regulated industries and zero otherwise. Regulated industries include railroads (SIC code 4011) through 1980, trucking (4210 and 4213) through 1980, airlines (4512) through 1978, telecommunications (4812 and 4813) through 1982, and gas and electric utilities (4900 to 4939).

B.3. Firm Size

We measure firm size as the natural logarithm of our estimate of the market value of the firm in constant 1972 dollars.

B.4. Firm Quality

The signaling literature has given little attention to defining quality in a way that is empirically observable. However, signaling models all assume that managers have better (or more timely) information about firm value than investors. To estimate quality empirically, we use the firm's abnormal future earnings. We assume that high-quality (undervalued) firms have positive future abnormal earnings and low-quality (over-valued) firms have negative future abnormal earnings. Assuming that earnings follow a random walk, we define abnormal earnings in year $t + 1$ as earnings per share in year $t + 1$ (excluding extraordinary items and discontinued operations and adjusted for any changes in shares outstanding) minus earnings per share in year t, divided by the year t share price. This variable also has several extreme observations. For example, 98 percent of the abnormal earnings are between -1.2 and 1.6, while the range for this variable is $-92{,}773$ to 1,451. We discard observations if the absolute value of the abnormal earnings variable is greater than five. Discarding these observations has a material effect on the estimated coefficient for the abnormal-earnings variable. This coefficient is not significantly different from zero in any regression that includes these extreme observations. Discarding these observations, however, has little effect on the other variables in the regression.

B.5. Term Structure

To measure the term structure of interest rates, we subtract the month-end yield on six-month government bonds from the month-end yield on ten-year government bonds. This yield spread is then matched with the month of the

companies' fiscal year-end. Data on government bond yields are from Citibase.

III. The Determinants of Debt Maturity Structure

The debt-maturity decision is one of several financing choices that the firm must make simultaneously. When deciding how to finance itself, the firm must choose between debt and equity. If it chooses debt, it must also choose the maturity of that debt, the priority, whether the debt is public or private, and other contract provisions, including call and convertibility provisions and restrictive covenants. Ideally, we would like to provide a system of simultaneous equations to control for these joint decisions. Unfortunately, the theory currently is not rich enough to provide the necessary identifying restrictions for this system.

Although these financing decisions are determined jointly, theory suggests that they are driven by the same underlying firm characteristics. For example, a firm with more growth options in its investment opportunity set is likely to have less debt its capital structure, and the debt it issues is likely to have shorter average maturity. A growth firm is also more likely to issue private debt with higher priority and more restrictive covenants. Our regressions should be interpreted as reduced-form regressions from this system. Since we are unable to provide the identifying restrictions for the simultaneous system, we restrict our choice of independent variables to those that we believe are most likely to be exogenous—i.e., measures of the firm's investment opportunity set, its informational environment, and its regulatory and tax status.

Table II reports pooled time series, cross-sectional regressions of the percentage of a firm's debt payable in more than three years on its market-to-book ratio, a regulation dummy, the log of firm value, the firm's future abnormal earnings, and the risk-free term structure. Regression (1) in Table II is a ordinary-least-squares (OLS) regression on the entire pooled time series and cross section (37,979 firm-year observations).[8]

Since the normal OLS assumption of independent errors is unlikely to be satisfied in this regression, the t-statistics are potentially overstated. To account for the potential error-dependence problem, regression (2) is a cross-sectional regression using the time-series mean of each variable by firm (5,545 observations). Running the regression in a single cross-section eliminates the problem of serially correlated errors. The cross-sectional regression preserves the dispersion across firms, but does not exploit any time-series variation in the observations.

In regression (3), we use a fixed-effects regression as an alternate method for dealing with the problem of serially correlated errors. In this regression, we subtract the firm-specific time-series mean for each variable from each

[8]The number of observations in Table II is smaller than the number of observations in Table I because the abnormal earnings variable cannot be calculated for the final data year, and because observations with extreme values are excluded from the regressions. Less than 1 percent of the sample (386 firm-years) is discarded due to extreme observations.

Table II

Regressions Estimating the Determinants of Corporate Debt Maturity

The Percentage of debt that matures in more than three years is regressed on the firm's market-to-book ratio, a dummy variable for firms in regulated industries, the natural log of firm value (market value of equity plus book value of liabilities in constant dollars), the firm's future abnormal earnings, and the risk-free term structure (the difference between ten-year government bond yields and six-month government bond yields). The table reports estimates from pooled ordinary least squares, cross-sectional ordinary least squares and fixed-effects regressions. Sample: All firms on both Center for Research in Securities Prices and COMPUSTAT between 1974 and 1991 with Standard Industrial Classification (SIC) codes from 2000 to 5999. (White-adjusted t-statistics in parentheses)

Independent Variable	Predicted Sign	(1) Pooled Regression	(2) Cross-Sectional Regression	(3) Fixed Effects
Intercept		36.74 (89.50)	31.49 (27.98)	N.A.
Market-to-book ratio	−	−4.37 (−25.42)	−4.78 (−15.12)	−2.33 (−9.51)
Regulation dummy	+	6.66 (8.96)	8.91 (3.97)	3.54 (3.29)
Log of firm value	+	5.28 (75.98)	6.31 (35.98)	5.03 (18.81)
Abnormal earnings	−	−1.94 (−5.04)	−2.94 (−2.38)	−1.28 (−4.11)
Term structure	+	−0.32 (−3.07)	−0.63 (−1.21)	−0.21 (−2.84)
R^2		0.16	0.26	0.61[a]
F		1414.42	398.14	116.17
Number of observations		37969	5545	37155[b]

[a]The adjusted R^2 for the fixed effects regression includes the fixed effects. The adjusted R^2 excluding the fixed effects is 0.02.

[b]The fixed effects regression excludes firms with only one observation.

observation. (This technique is equivalent to adding a dummy variable for each firm in the sample.) Thus, although this regression preserves the time-series dispersion in the sample, it ignores most of the information from differences across firms.[9]

A. Regression Results

Consistent with the contracting-cost hypothesis, the coefficient on the market-to-book ratio is negative and highly significant in all three regressions. The *t*-statistic for this variable ranges from −9.51 for the fixed-effects regression to −25.42 for the pooled OLS regression. This coefficient indicates that, on average, firms with more growth options (as proxied by the market-to-book ratio) have significantly less long-term debt. It is also consistent with the hypothesis that firms with larger potential information asymmetries issue less long-term debt.

To derive a better understanding of the economic significance of this result, we calculate the impact of moving from the tenth to the ninetieth percentile for the market-to-book ratio in our sample. The estimated coefficient from the pooled regression implies that this move reduces the fraction of long-term debt by 9.6 percentage points.

The dummy variable for firms in regulated industries is significantly positive; *t*-statistics range from 3.29 to 8.96. Other things equal, regulation increases the proportion of long-term debt by 6.6 percentage points.

The coefficient for the log of firm value is positive and significant in all three regressions; *t*-statistics range from 18.81 to 75.98. The economic significance of this variable is also dramatic. The pooled-regression coefficient implies that moving from the tenth to the ninetieth percentile for firm size increases the fraction of long-term debt by 27.7 percentage points.

The regressions provide some support for the signaling hypothesis; *t*-statistics range from −2.38 to −5.04, implying that firms with higher future earnings have more short-term debt. But the economic significance of this factor is questionable. For abnormal earnings, the pooled regression coeffi-

[9]The regressions in Tables II and III are potentially misspecified because the dependent variable is restricted between zero and one. Thus, we reestimate these regressions using the appropriate Tobit estimator. This procedure results in no material changes in any of the estimated coefficients or their standard errors. We also examine the White (1980) specification test; it indicates whether regression errors are heteroskedastic or if the errors and explanatory variables are nonlinearly dependent. The White chi-square test of first- and second-moment specification generally shows that the null hypothesis of no misspecification can be rejected. The White procedure also produces a variance-covariance matrix that provides the opportunity to calculate test statistics of the right size. The White standard errors reported for our estimated coefficients do not differ materially from the OLS estimates. We also estimate these relations with a random-effects model. The generalized least squares random-effects estimator is a weighted average of the cross-sectional and fixed-effects estimators and, as such, provides an intermediate solution between ignoring all of the time-series variation in the sample, and ignoring all of the cross-sectional variation in the sample. When we estimate the random-effects model, the coefficients are similar to those in the fixed-effects regression and the *t*-statistics are slightly larger than those in the fixed-effects regression.

cient implies that moving from the tenth to the ninetieth percentile reduces the fraction of long-term debt by 0.6 percentage points. While the time-series stability of a firm's investment opportunities is plausible, firm quality is less likely to be stable over time. For example, such stability would be difficult to reconcile with the existing evidence on market efficiency. The prediction of the signaling hypothesis is thus primarily time-series in nature. Consequently, it is not surprising that the coefficient on the abnormal-earnings variable has lower significance in the cross-sectional regression.[10]

Table II results provide no support for the Brick and Ravid tax hypothesis. Inconsistent with their hypothesis, the coefficient for the term-structure variable is significantly negative in the pooled and fixed-effects regressions.[11] For the term-structure variable, the point estimate from the pooled regression implies that moving from the tenth to the ninetieth percentile of the term-structure variable would increase long-term debt by only 1.1 percentage points. This limited impact is broadly consistent with Lewis' (1990) analysis; he argues that if optimal debt-asset ratios and debt-maturity structures are chosen simultaneously, then taxes do not affect optimal debt maturity. The prediction of the tax hypothesis is also primarily time-series in nature.

The F-statistics indicate that each of the regressions in Table II is significant at reasonable levels. Adjusted R^2s of 0.16 and 0.26 in the pooled and cross-sectional regressions with the much smaller R^2 of 0.02 in the fixed-effects regression (when the influence of the fixed effects are excluded) suggest that it is primarily the variation in maturity structure across firms that provides the explanatory power in these regressions.

B. Correlations Among Financial Policy Variables

Smith and Watts (1992) argue that if the firm's investment opportunity set is an important determinant of its financing, dividend, and compensation policies, then the investment opportunity set induces correlations among these corporate policies. If the firm's investment opportunity set is also an important determinant of its debt maturity structure, then debt maturity should be correlated with leverage, payout, and compensation policies.

In Table III, we report the Pearson correlation coefficients between the percentage of debt payable in more than three years, leverage (book value of debt divided by the market value of the firm), and dividend yield (dividend

[10] By using future abnormal earnings as a proxy for managers' asymmetric information about firm value, we create a potential identification problem between the contracting-cost hypothesis and the signaling hypothesis. If firms with significant growth options experience sustained earnings growth, our random-walk model of normal earnings would identify these firms as high-quality firms.

[11] The tax-related benefit of issuing longer-term debt when the term structure is upward sloping should increase with the probability that the firm will file for bankruptcy. To provide a more powerful test of the tax hypothesis, we construct an interactive variable that is the product of the firm's bond rating and the term structure of interest rates. The bond-rating variable is equal to one if the firm is rated AAA, through 27 if the firm is rated CCC or below; it is set equal to 28 for firms without an S&P bond rating. When we add this variable to the regressions in Table II, the coefficient is not significantly different from zero.

Table III

Pearson Correlation Coefficients between Debt Maturity, Leverage, and Dividend Yield

Sample: All firms on both Center for Research in Securities Prices and COMPUSTAT between 1974 and 1992 with Standard Industrial Classification (SIC) codes from 2000 to 5999. 39,949 observations. (p-Values in parentheses.)

	Percentage of Debt Due in More than 3 Years	Leverage	Dividend Yield
Percentage of debt due in more than 3 years	1.000		
Leverage	0.120 (0.0001)	1.000	
Dividend yield	0.049 (0.0001)	0.040 (0.0001)	1.000

per share divided by price). As predicted by the incentive-contracting hypothesis, the correlation between debt maturity and leverage is significantly positive, indicating that firms with greater leverage have more long-term debt. The correlation between debt-maturity and dividend yield is also significantly positive, indicating that firms with higher dividend yields tend to have more long-term debt.

IV. Specification Checks

A. Investment Opportunity Set

The market-to-book ratio is an admittedly noisy proxy for growth options. To analyze the robustness of our results to alternate proxies, we reestimate the regressions reported in Table II. In Table IV, we examine the firms' annual research and development expenses as a percentage of firm value, depreciation as a percentage of firm value, the earnings-price ratio, and the asset-return standard deviation (the firm's stock-return standard deviation in percent times its equity-to-value ratio). We expect firms with lower research and development expenses, more depreciation expenses, higher earnings-price ratios and lower return standard deviations, to have more tangible assets and fewer growth options in their investment opportunity sets. In these regressions, the coefficients on the investment-opportunity-set proxies are all statistically significant (t-statistics range from 12.06 to 28.75 in absolute value) and have the signs predicted by the contracting-cost hypothesis. (The sample sizes for these regressions are smaller than the sample size in Table II due to missing COMPUSTAT data.)

Including these alternate measures of the investment opportunity set generally leaves unaffected the other estimated coefficients. A noteworthy exception is in regression (3). If the earnings-price ratio is used as the measure of growth options, the abnormal-earnings variable changes sign and

Table IV

Specification Checks for Regressions Estimating the Determinants of Corporate Debt Maturity

The percentage of debt that matures in more than three years is regressed on a proxy for the firm's investment opportunity set, a dummy variable for firms in regulated industries, the natural log of firm value (market value of equity plus book value of liabilities in constant dollars), the firm's future abnormal earnings, and the risk-free term structure (the difference between ten-year government bond yields and six-month government bond yields). The investment-opportunity-set variables include the firm's research and development (R&D) expense divided by firm value, depreciation expense divided by firm value, the earnings-price ratio, and the firm's asset return standard deviation (stock return standard deviation times the equity-to-firm-value ratio). Sample: All firms on both Center for Research in Securities Prices and COMPUSTAT between 1974 and 1991 with Standard Industrial Classification (SIC) codes from 2000 to 5999. (White-adjusted t-statistics in parentheses)

Independent Variable	Predicted Sign	(1)	(2)	(3)	(4)
Intercept		35.83 (71.77)	28.30 (65.25)	31.72 (89.98)	44.87 (79.92)
R&D/firm value	−	−0.77 (−15.05)			
Depreciation/firm value	+		0.74 (12.06)		
Earnings-price ratio	+			13.21 (20.59)	
Asset return std. deviation	−				−0.89 (−28.75)
Regulation dummy	+	4.50 (2.87)	6.17 (8.10)	7.37 (9.95)	6.32 (8.72)
Log of firm value	+	4.37 (49.20)	5.31 (75.46)	4.96 (69.33)	4.05 (50.39)
Abnormal earnings	−	−1.78 (−3.33)	−2.39 (−6.16)	2.30 (4.57)	−1.60 (−4.06)
Term structure	+	−0.77 (−5.58)	−0.59 (−5.78)	−0.37 (−3.55)	−0.25 (−2.42)
R^2		0.12	0.14	0.15	0.16
F		627.80	1261.15	1296.79	1347.16
Number of observations		22072	37955	37643	35274

becomes significantly positive (the t-statistic is 4.57). This suggests potential regression misspecification and multicollinearity between the variables. In an efficient market, firms with high expected growth rates in earnings will have high current prices; thus, on average, firms with large abnormal future earnings tend to have low current earnings-price ratios.

B. Scale Economies, Public Debt, and Commercial Paper

B.1. Scale Economies

Firms with little outstanding debt are likely to receive short-term loans from a bank rather than issue long-term bonds and incur the higher fixed costs of a public issue. Thus, there is a potential mechanical association between leverage and debt maturity involving firms with low levels of debt. Smith and Watts (1992) find a negative relation between leverage and the firm's market-to-book ratio. Hence, a mechanical association between leverage and debt maturity could generate a spurious relation between debt maturity and the firm's market-to-book ratio.

To test for this potential spurious correlation, we exclude firms that have small amounts of total debt. Regression (1) in Table V reports the coefficients from our basic regression excluding firms that have less than $50 million of total debt. (The $50 million cutoff is approximately equal to the tenth percentile of our sample firms that have public debt ratings.) Excluding these firms reduces the number of observations from 37,969 to 11,798 and the number of different firms from 5,545 to 1,580.

The t-statistics for the estimated coefficients generally decline with the sample size. However the coefficient on the market-to-book ratio remains negative and significant, and the coefficient on the regulation dummy remains positive and significant as in all previous regressions. Thus, a mechanical relation between debt maturity and the total amount of debt or leverage does not appear to drive our basic results.

The only material change in this regression is that the coefficient on firm size is small and only marginally significant. If we exclude firms with less than $100 million of total debt (approximately equal to the twenty-fifth percentile of firms with public debt ratings in our sample), the coefficients for the market-to-book ratio and the regulation dummy are again unaffected.[12] However, the coefficient on firm size now becomes negative and statistically significant. This effect on the firm-size coefficient indicates a nonmonotonic relation between firm size and debt maturity. Debt maturity increases with firm size for firms smaller than $1 billion of market value. After that point, there appears to be a negative relation between size and maturity.

B.2. Public Debt and Commercial Paper

As noted above, scale economies associated with public debt issues make this market inaccessible to many companies with small amounts of total debt.

[12] This regression is not reported in the table.

Table V

Specification Checks for Regressions Estimating the Determinants of Corporate Debt Maturity

The percentage of debt that matures in more than three years is regressed on the firm's market-to-book ratio, a dummy variable for firms in regulated industries, the natural log of firm value (market value of equity plus book value of liabilities in constant dollars), the firm's future abnormal earnings, the risk-free term structure (the difference between ten-year government bond yields and six-month government bond yields), dummy variables for firms with Standard and Poors bond and commercial-paper ratings, a numeric variable for the firm's bond rating (set equal to one for AAA through 27 for CCC or below, and equal to 28 for nonrated firms), and three-digit SIC industry dummy variables. Sample: All firms on both Center for Research in Securities Prices and COMPUSTAT between 1974 and 1991 with Standard Industrial Classification (SIC) codes from 2000 to 5999. (White-adjusted t-statistics are in parentheses)

Independent Variable	Firms with more than $50 Million of Total Debt (1)	Includes Public Bond Rating and Commercial Paper Dummies (2)	(3)	Includes 3-digit SIC Industry Dummies (4)
Intercept	64.98	37.38	−2.76	NA[a]
	(60.67)	(87.40)	(−1.23)	
Market-to-book ratio	−2.53	−4.12	−4.05	−3.58
	(−4.63)	(−24.12)	(−23.84)	(−19.84)
Regulation dummy	7.48	6.86	6.70	5.09
	(10.04)	(8.93)	(8.69)	(4.55)
Log of firm value	0.39	4.72	5.00	4.99
	(2.51)	(55.69)	(57.67)	(62.44)
Abnormal earnings	−1.26	−1.95	−1.94	−1.72
	(−1.57)	(−5.06)	(−4.94)	(−4.54)
Term structure	0.04	−0.30	−0.39	−0.30
	(0.26)	(−2.90)	(−3.83)	(−2.98)
Bond rating dummy		11.21	33.69	
		(28.22)	(25.97)	
Commercial paper dummy		−13.72	−9.52	
		(−20.67)	(−14.20)	
Bond rating for rated firms			1.40	
			(18.44)	
F-Statistic for industry dummies[b]				[25.82]
R^2	0.01	0.17	0.18	0.21
F	21.03	1138.51	1043.92	932.49
Number of observations	11798	37969	37969	37969

[a]This regression is run without an intercept because there is a dummy variable for each 3-digit SIC industry.

[b]The F-statistic for the industry dummies (in parentheses) tests whether the industry dummies are jointly different from zero.

Since public debt issues tend to have long maturities, this implies a potential mechanical relation between access to the public debt market and a firm's debt maturity.

Similarly, the high fixed cost of commercial paper programs excludes all but the largest firms from this source of funds. Commercial paper (short-term promissory notes issued in the open market) offers an alternative to bank borrowing for large corporations with strong credit ratings. The most common maturity of commercial paper is 30 to 50 days. (The maturity of commercial paper is generally less than 270 days because the Securities Act of 1933 exempts such issues from registration.) Thus, firms with commercial paper programs are likely to have more short-term debt.

We examine the sensitivity of our results to the firms' use of public debt and commercial paper. In regression (2) of Table V we include dummy variables to indicate whether the firm has an Standard and Poor's (S&P) bond rating or an S&P commercial-paper rating.[13] As expected, the coefficient for the bond-rating dummy is significantly positive and the coefficient for the commercial-paper dummy is significantly negative. However, the inclusion of these variables does not affect the size or the statistical significance of the other coefficients. Thus, access to public debt and commercial paper markets does not appear to be driving our basic results.

C. Signaling and Credit Risk

We have used the bond and commercial paper ratings to provide information about potential mechanical relations between the firm's choice of debt instruments and debt maturity; these results are also potentially relevant for examining signaling models that relate credit risk to debt maturity. Although the data are not ideally suited to test these hypotheses, we examine the relation between bond ratings and debt maturity. Regression (3) in Table V includes a bond-rating variable; it equals to one if the firm's S&P bond rating is AAA, through 27 if the bond rating is CCC or below. This variable is set equal to 28 for firms without S&P bond ratings. The coefficient on the bond-rating variable is positive and significant (t-statistic is 18.44), indicating that lower-rated firms issue more long-term debt than higher-rated firms. The positive coefficient for the bond-rating dummy variable, however, indicates that non-rated firms (which tend to be small firms with the lowest credit standing) have more short-term debt. Thus, the evidence suggests a nonmonotonic relation between credit standing and debt maturity as predicted by Diamond (1993).

Although there is evidence of a nonmonotonic relation between debt maturity and credit standing, this evidence should be interpreted with some caution. For firms with public debt ratings, the relation between debt maturity and bond rating is strictly monotonic; the nonmonotonicity is driven

[13] COMPUSTAT does not report data on commercial-paper ratings before 1985. Thus the commercial-paper dummy variable is set equal to zero for all firms prior to 1985.

solely by the nonrated firms. As one moves from the sample of firms with S&P bond ratings to those that do not have ratings, however, many things change. In particular, firms typically get bond ratings only if they issue public debt. Thus, firms without S&P bond ratings have mostly private debt which, on average, has shorter maturity regardless of the firm's credit rating.

D. Industry Effects, Deregulation, and Time Trends

D.1. Industry Effects

To determine the relative importance of industry-specific versus firm-specific effects, we reestimate the regressions in Table II including dummy variables for 2-digit and 3-digit SIC industries. We report the results using 3-digit industry dummies in regression (4) of Table V. The F-statistic for the industry dummies indicates that they are jointly different from zero ($F = 25.82$). However, the adjusted R^2 in this regression increases from 0.16 in regression (1) of Table II to only 0.21 with the 3-digit SIC industry dummies. The adjusted R^2 for the regression with 2-digit industry dummies (not reported here) is 0.19. In addition, adding these dummy variables has no material effect on any of the other regression coefficients. Evidence of standard industry practices still would be consistent with the hypotheses in Section I. For example, knowledge of a firm's industry may be highly correlated with its investment opportunities. Nevertheless, the evidence suggests that firm-specific characteristics (such as size and market-to-book ratios) are more important than industry-specific effects in determining a firm's debt maturity.

D.2. Deregulation

Four major industries in our sample (airlines, railroads, trucking, and telecommunications) experienced significant deregulation during our sample period. If the effect of regulation is to decrease managerial discretion over future investment decisions, and thus increase debt maturity, then these firms should shorten their debt maturity following deregulation. As predicted, all four industries have significantly more short-term debt after deregulation. Following deregulation, the average percentage of debt due in more than three years fell from 67 to 64 percent in the airline industry, from 76 to 67 percent in the railroad industry, from 74 to 65 percent in the telecommunications industry, and from 57 to 46 percent in the trucking industry. The observed reduction in debt maturity for these industries, however, can be explained almost entirely by the more general trend in debt maturities reported in Figure 1. Including this more general time trend in debt maturity eliminates the significance of the effect of deregulation.

D.3. Time Trends

The fact that the effects of deregulation are obscured by the general time trend in debt maturity raises the possibility that this trend has a significant effect on other regression coefficients. We test the importance of this time

trend and for other temporal effects (such as business cycle effects). We reestimate the regressions in Table II using both a linear time-trend variable and annual dummy variables. As expected from Figure 1, both the time-trend and dummy-variable approaches indicate that economy-wide debt maturity declined over this period. None of the other regression coefficients are materially affected in magnitude or statistical significance, however, by the inclusion of a time trend or year dummies. (Since there is no material change in any of the regression coefficients of interest, we do not report this regression.)

V. Conclusions

Our examination of the determinants of corporate debt maturity supports the hypothesis that firms with more growth options in their investment opportunity sets issue more short-term debt. This result is consistent with Myers' (1977) prediction that reducing debt maturity helps control the underinvestment problem. We also find that regulated firms issue more long-term debt. This is consistent with Smith's (1986) argument that regulation reduces the firm's discretion over corporate investment policy, thus controlling the underinvestment problem. The empirical results are robust to alternate measures of the investment opportunity set. Our methods also suggest that growth options in the firm's investment opportunity set are important in explaining both the time-series and cross-sectional variation in the firm's maturity structure.

We provide evidence of a strong association between firm size and debt maturity: large firms issue a significantly higher proportion of long-term debt. This is consistent with the observation that small firms rely more heavily on bank debt that typically has shorter maturity than public debt. We also document a reliably positive association between the existence of an S&P bond rating and debt maturity, and a reliably negative association between the existence of a commercial paper rating and debt maturity.

Our evidence provides less support for the hypothesis that firms use the maturity of their debt to signal information to the market. Although the estimated coefficient on the abnormal earnings variable is significantly negative, the economic impact of this variable is trivial. The results are consistent, however, with the hypothesis that firms with potentially large information asymmetries (such as high-growth firms) issue more short-term debt. Consistent with Diamond's (1993) hypothesis, our evidence also suggests that firms with the highest and lowest credit risk issue short-term debt while firms with intermediate credit risk issue long-term debt. The tax hypothesis is not significant in explaining the debt maturity choice.

Our analysis has some potentially important limitations. First, the power of the hypothesis tests are not all equal. For example, we examine variation in debt maturity across all of the firms' outstanding debt. More powerful tests of the signaling hypotheses may come from examining the variation in debt maturity at issuance.

Second, our data employ a broad definition of debt. Although we believe the behavior of the aggregate is more important than the behavior of any single component, more disaggregated data would facilitate investigation of the richness of the debt-maturity policy. For example, our evidence indicates that firms with more growth options in their investment opportunity sets issue more short-term debt. Yet we do not know how much of the total variation is the result of variation among instruments with different average maturities (such as long-term public debt and short-term bank debt) and how much is due to variation in the maturity of a given set of instruments (such as 20-year and 12-year public debentures). Similarly, we do not have data on foreign borrowing. Thus, we cannot identify the variation in debt maturity attributable to the differential maturity of U.S. versus foreign debt. A more detailed examination of the mix of debt instruments issued by different types of firms would provide important texture to our understanding of how firms achieve their observed debt maturity structure.

Finally, we have simply taken the COMPUSTAT definition of the amount of debt that matures in a given year to analyze the maturity choice. Many debt issues have provisions that specify imbedded options to modify the repayment schedule. For example, both call provisions and optional sinking fund payments reduce the effective maturity of a debt issue. Debt covenants, especially affirmative covenants in private debt agreements, also allow the lender to accelerate the payment schedule if the borrower breaches the covenant. The appropriate adjustment in our methods to reflect this maturity flexibility is not obvious.

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