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# The Determinants of Debt Maturity at Issuance: A System-Based Model

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**Abstract.** We examine the determinants of corporate debt maturity while taking into account the interdependent relation between maturity and leverage. We do this by estimating a simultaneous-equations model on debt maturity and leverage for a sample of bond-issuing firms. To compare with previous studies, we also estimate a single-equation model on debt maturity using OLS. We define debt maturity as either the maturity of bonds at issuance (incremental approach), or the percentage of a firm's total debt that matures in more than three years (balance-sheet approach). Corroborating the findings of many previous studies, our single-equation OLS results support the underinvestment hypothesis purporting that firms with greater growth opportunities have shorter-term debt. However, under the simultaneous-equations model, the negative relation between a firm's debt maturity and its growth opportunities ceases to hold. Instead, it is the leverage decision that is influenced by growth opportunities. This suggests that existing models may overestimate the effect of growth opportunities on debt maturity.

**Key words:** debt maturity, debt issuance, leverage, system-based models

**JEL Classification:** G32

## I. Introduction

A firm's choice of debt maturity is an integral part of its capital structure decision. Researchers have put forward several hypotheses identifying factors that determine corporate debt maturity. These factors include underinvestment due to agency problems, maturity matching between assets and liabilities, information asymmetry, liquidation risk, taxes and flotation costs.

Empirical models of debt-maturity behavior follow two approaches in measurement of maturity: the balance-sheet approach and the incremental approach. The balance-sheet approach defines debt maturity as either the percentage of a firm's total debt outstanding that has a short or long remaining time to maturity (e.g., Barclay and Smith, 1995), or the weighted-average maturity of a firm's liability items (e.g., Kim, Mauer and Stohs, 1995; Stohs and Mauer, 1996).[1] The incremental approach, as in Mitchell (1991, 1993) and Guedes and Opler (1996), defines debt maturity as the maturity of the debt instruments at issuance.

As pointed out by Stohs and Mauer (1996) and Guedes and Opler (1996), each approach has its advantages and disadvantages. For example, the incremental approach is well-suited to examine whether firms' debt-maturity choice can signal their future prospects, but it is not suitable to test theories that suggest firms match their asset maturity to the average maturity of their liabilities.

Debt maturity and leverage are the twin dimensions of corporate capital structure. In spite of the fact that their joint nature has been established theoretically (e.g., Lee, Thakor and Vora, 1983; Diamond, 1991; and Leland and Toft, 1996), none of the extant studies has tested a firm's debt maturity at issuance and its leverage decisions simultaneously.[2] Given the interdependence of maturity and leverage decisions, the use of a single-equation model that arbitrarily assumes away such interdependencies may produce misleading conclusions.

This paper contributes to the literature in the following ways. First, we examine corporate bond maturity and issue size jointly within a simultaneous-equations framework. Estimation of the model is carried out by two-stage least squares (2SLS) for a sample of bond issues during 1973–1994. To compare the findings with those of the previous studies, we also estimate a single-equation model on bond maturity using ordinary least squares (OLS). Our findings under the single-equation model support the underinvestment hypothesis maintaining that firms with more growth opportunities issue shorter-term debt. This result corroborates the findings of many extant studies on growth opportunities. However, the results under the simultaneous-equations model suggest that growth opportunities exert no influence on a firm's debt maturity, indicating that most existing models may overestimate the effect of growth opportunities on debt maturity. These findings support the prediction of Mauer and Ott (2000) that shortening debt maturity can no longer alleviate the underinvestment problem once leverage is controlled for.

Second, as a robustness check, we also estimate a system-based model on debt maturity and leverage using a balance-sheet approach for a panel data set of the bond issuers over the 22-year period from 1973 to 1994. As in Barclay and Smith (1995) and Barclay, Marx and Smith (2001), we estimate the debt maturity as the percentage of a firm's total debt that has a maturity of more than three years. Our fixed-effects and random-effects 2SLS results confirm our findings on growth opportunities under the incremental approach.

Third, we examine industry differences in the choice of corporate debt maturity. In particular, we study the determinants of debt maturity for industrial, financial, and utility firms separately. Our results indicate that the determinants of debt maturity and the sensitivity of debt maturity to these determinants do vary across industries.

The remainder of the paper is organized as follows. Section II presents the testable hypotheses. Section III discusses the model specification. Data sources and sample statistics are described in Section IV. Section V reports the empirical results and Section VI concludes.

## II. The determinants of corporate debt maturity

### *A. Underinvestment hypothesis*

Myers (1977) shows that some positive net present value (NPV) investments will not be undertaken if bondholders are expected to capture the benefits of the investments at the expense of shareholders. He argues that a firm's future investment opportunities can be viewed as options, and with more growth options in the firm's investment opportunity set, the underinvestment problem resulting from the conflict between shareholders and bondholders over the exercise of these options is greater. Myers suggests that the firm can alleviate the underinvestment problem by issuing shorter-term debt that matures before the growth options are exercised. The underinvestment hypothesis based on Myers (1977) maintains that, firms with more growth opportunities issue shorter-term debt, all else equal.

### *B. Asymmetric information hypothesis*

Flannery (1986) shows that when information is asymmetric between lenders and firms, the nature of equilibrium is determined by the level of transaction (flotation) costs. In the absence of transaction costs, lenders will be unable to distinguish between good-quality and bad-quality borrowers. In this case, a pooling equilibrium occurs where both good-quality and bad-quality borrowers issue short-term debt. However, when transaction costs are sufficiently large, a separating equilibrium will hold with good-quality borrowers issuing short-term debt and bad-quality borrowers issuing long-term debt. This implies the following asymmetric information hypothesis: good-quality firms issue short-term debt, while bad-quality firms issue long-term debt.

### *C. Liquidation risk hypothesis*

Along the same lines taken by Flannery (1986), Diamond (1991) assumes that borrowers have private information about their credit quality. In addition, Diamond assumes that a firm is subject to liquidation risk. Liquidation risk is defined as the risk that a firm is unable to pay back its debt and thus will be liquidated by lenders. Diamond demonstrates that a firm's optimal maturity structure trades off a preference for short maturity due to the expected improvement in its credit rating, against its liquidation risk. He argues that borrowers with high credit ratings will issue short-term debt because the effect of a debt upgrade at the time of refinancing outweighs the liquidation risk. Borrowers with lower ratings prefer long-term debt because the liquidation risk dominates the information effect. However, borrowers with very low rating can borrow only short-term debt because they are screened out of the long-term debt market. Thus, the liquidation risk hypothesis based on Diamond (1991) postulates the following nonmonotonic relation between a firm's liquidation risk and its debt maturity: all else equal, borrowers with high credit ratings prefer short-term debt, those with intermediate ratings prefer long-term debt, and those with low ratings can issue only short-term debt.

### *D. Tax hypothesis*

Brick and Ravid (1985, 1991) introduce the tax hypothesis under both interest rate certainty and interest rate uncertainty. Under interest rate certainty and an upward-sloping yield curve, they show that it is beneficial for a firm to issue long-term debt. This is because the higher tax shield of the long-term debt, compared to that of the short-term debt, reduces the firm's expected tax liabilities and consequently, increases its market value. They also show that, if the yield curve is downward sloping, firms tend to issue short-term debt.

In the case of interest rate uncertainty, Brick and Ravid (1991) demonstrate that there is even a greater impetus for firms to issue long-term debt than under interest rate certainty. This is because interest rate uncertainty increases the long-term debt capacity of the firm and thus increases the present value of the tax benefits of its interest payments. We therefore have the following tax hypothesis: all else equal, a firm's debt maturity increases with the slope of the yield curve.

### *E. Flotation cost hypothesis*

Kane, Marcus and McDonald (1985) value the levered firms under the assumption that such firms have the option to rebalance their debt ratio every $T$ periods, and bankruptcy costs, issue costs and debt tax shields are non-zero. Their simulation results show that the higher the flotation costs associated with a debt issue, the greater is the optimal maturity of the debt, since more time is required to amortize the flotation cost. Moreover, Fisher, Heinkel and Zechner (1989) suggest that small debt issues incur larger proportional transaction costs than large issues, and issue size is positively related to firm size. We therefore hypothesize that, all else equal, smaller firms have longer bond maturities.

## III. Model specification

### *A. The single-equation model*

Our basic model examines the determinants of corporate bond maturity within a single-equation framework. Estimation of the basic model allows a comparison of the results found here with those of Marr and Ogden (1989), Mitchell (1993), Morris (1992), Barclay and Smith (1995), Kim, Mauer and Stohs (1995), Guedes and Opler (1996), Stohs and Mauer (1996), and Scherr and Hulburt (2001) who also adopt single-equation models.

The framework adopted here, however, does go beyond the existing studies in two ways. First, as dictated by theory, we extend the existing models by introducing the amount of debt issued as one of the determinants of debt maturity. This variable is a critical part of a firm's capital structure decision and its omission may lead to inconsistent estimates. Second, we investigate debt maturity choices for three industries (industrial, financial, and utility firms), separately. The use of aggregate data comprising firms with dissimilar behavior may distort the magnitude and even the direction of the interdependencies among the variables of interest.

The hypotheses in Section II are first tested with the following single-equation OLS regression:

$$M = a_m X_m + b_m S + e_m. \tag{1}$$

In this model, $M$ is the term to maturity of the bond issues (measured in years),[3] $X_m$ is a vector of predetermined explanatory variables, $S$ is the ratio of a firm's issue proceeds to its book value of total assets (or incremental leverage), $a_m$ is a vector of coefficients, $b_m$ is the coefficient on $S$, and $e_m$ is a random error term. The variables included in equation (1) will be further described in Section III.C.

The issue of simultaneity or interdependence between debt maturity and leverage has been well recognized in the extant theoretical studies. However, empirical research lags behind in recognizing the interdependent nature of debt maturity and leverage. None of the existing studies has empirically examined the choice of debt maturity at issuance and the amount of debt issued within a system-based model. The simultaneous-equations model described below is used to fill this gap.[4]

### *B. The simultaneous-equations model*

When a firm issues new debt, it needs to decide the maturity and the size of the debt (incremental leverage) concurrently. Based on the theoretical discussions presented in Section II, the following simultaneous-equations model is used to carry out the tests of the hypotheses:

$$M = a_m X_m + b_m S + e_m \tag{2}$$

$$S = a_s X_s + b_s M + e_s. \tag{3}$$

In this model, the first equation is the same as equation (1) and its notations have been defined earlier. We use $a_s$ and $b_s$ to denote the parameters for the issue-size equation. Vectors $X_m$ and $X_s$ contain sets of overlapping, but not identical explanatory variables, and $e_m$ and $e_s$ are zero-mean and constant-variance random-error terms, which may be correlated.

Because bond maturity and issue size are endogenous, using OLS to estimate each of the equations separately may generate biased and inconsistent estimates.[5] To address this problem, 2SLS is employed to estimate the system-based model. Since the number of exogenous variables excluded from each equation in the model is at least as large as the number of endogenous variables included in that equation, identification of the parameters in the model is assured.

### *C. Proxy variables*

This subsection describes the explanatory variables in the system and the nature of their effects.

***C.1 The debt-maturity equation.*** The explanatory variables in equation (2) include a vector of predetermined variables $X_m$ and the issue-size ratio $S$. Vector $X_m$ includes variables that proxy for growth opportunities, firm quality, liquidation risk, term structure, firm size, pre-issue leverage, call provision, and industry classification.

*Growth opportunities.* As in Barclay and Smith (1995), Stohs and Mauer (1996), and Guedes and Opler (1996), growth opportunities are proxied by the ratio of the market value of a firm's assets to the book value of its assets ($M/B$). The market value of assets is measured as the book value of assets minus the book value of equity plus the market value of equity. According to the underinvestment hypothesis, firms facing greater growth opportunities issue shorter-term debt. Hence, we expect the coefficient on $M/B$ to be negative.

*Firm quality.* Firm quality is proxied by earnings change, defined as changes in earnings per share, from year $t$ to year $t+1$, divided by the stock price in year $t$ (Barclay and Smith, 1995; Stohs and Mauer, 1996). Earnings change is taken as a prediction of the firm's abnormal future earnings, with good-quality (bad-quality) firms showing positive (negative) future abnormal earnings. The asymmetric information hypothesis maintains that managers have superior information, compared to outside investors, about the value of the firm and hence, good-quality (bad-quality) firms tend to issue shorter-term (longer-term) bonds. Under this hypothesis, the coefficient on earnings change should be negative.

*Liquidation risk.* Moody's bond rating is used to proxy for a firm's liquidation risk. There are 24 ranks in Moody's bond rating ($A_{aa} = 1$ to $C = 24$). As in Stohs and Mauer (1996), we include both Moody's bond rating and the square of this variable as explanatory variables in the debt-maturity equation. If, as suggested by Diamond (1991), borrowers with good credit ratings prefer short-term debt, those with intermediate ratings prefer long-term debt, and those with poor ratings can issue only short-term debt, this nonmonotonic relation between a firm's liquidation risk and debt maturity should be captured by a positive coefficient on bond rating and a negative coefficient on the square of bond rating.

*Term structure of interest rates.* As in Barclay and Smith (1995) and Stohs and Mauer (1996), the slope of the term structure (yield spread) is constructed by subtracting the yield on a six-month Treasury bill from the yield on a ten-year government bond. According to the tax hypothesis, which maintains that a firm's debt maturity increases with the slope of the yield curve, the coefficient on the yield spread is expected to be positive.

*Firm size.* Firm size is measured as the natural log of the market value of total assets in constant 1987 dollars. The market value of total assets is deflated by the U.S. GNP deflator. The flotation cost hypothesis maintains that smaller firms tend to have smaller dollar amount of debt issues and thus require more time to amortize the higher proportional flotation costs. This requires the coefficient on firm size to be negative, all else being equal. However, if smaller firms have greater information asymmetry and thus would issue shorter-term debt (Guedes and Opler, 1996), then firm size could be positively related to bond maturity.

*Pre-issue leverage ratio.* This variable is defined as the ratio of a firm's current liabilities and long-term debt to the market value of assets prior to the bond issue. Holding the issue-size ratio constant, a firm's post-issue leverage ratio increases with its pre-issue leverage ratio. Diamond (1991) argues that firms with higher leverage would issue longer-term debt because of their higher liquidity risk. More recently, Leland and Toft (1996) model a firm's optimal capital structure while considering the tradeoff between the tax advantage of debt and bankruptcy and agency costs of debt. Their simulation results show that the leverage ratio that maximizes firm value is larger for debt with longer maturity. Hence, we expect a positive relation between pre-issue leverage and bond maturity, holding issue size constant.

*Call provision and industry classification.* Dummy variables are introduced for bonds' callability and firms' industry classification. The call dummy equals one if the bond is callable, and zero otherwise. The financial- (utility-) firm dummy equals one if a firm belongs to the financial (utility) industry, and zero otherwise.

The fact that callable bond issuers are often prohibited from exercising the call feature for a number of years rules out very short-term bonds with the call feature (Mitchell, 1991). This suggests that call provision is usually associated with long-term bonds. King and Mauer (2000) document that, for their sample of 1642 called bonds during the period 1975–1994, the median original bond maturity is 30 years. We therefore expect the coefficient on the call dummy to be positive.

The industry dummies reveal the effect of idiosyncratic features of the industry on debt maturity. Financial firms are expected to issue shorter-term bonds for two reasons. First, Flannery (1986) attributes industry differences on debt maturity to differential information asymmetry across industries. He suggests that industries characterized by greater information asymmetries (e.g., financial companies whose portfolios are not well documented externally compared to industrial companies) tend to issue shorter-term debt. Second, Barnea, Haugen and Senbet (1980) and Flannery (1994) argue that firms choose short-term financing as a way to reduce shareholders' incentives to take excessive risk. Since financial firms encounter numerous opportunities for asset substitution (e.g., undertaking low-value and high-risk investments) and their assets are difficult for investors to evaluate, their probability of sub-optimal investment is high. If financial firms shorten debt maturity to counter this phenomenon, the coefficient for the financial-firm dummy will be negative.

Smith (1986) provides an argument for industry-specific debt maturities in terms of the extent of regulation. According to Smith, regulated firms (e.g., utility firms) have less discretion over future investment decisions and hence, they are subject to a smaller adverse effect (agency cost) from issuing long-term debt. Regulated firms will, therefore, issue debt with longer term to maturity. Under this scenario, the coefficient on the utility-firm dummy is expected to be positive. In addition, as argued by Flannery (1986), utility firms are subject to less information asymmetry because they are required by regulators to document their operations. Hence, they are expected to issue longer-term debt. A positive coefficient on the utility-firm dummy would provide support for both Smith's agency cost and Flannery's asymmetric information hypotheses.

*Issue-size ratio.* The issue-size ratio $S$ measures a firm's incremental leverage. Holding pre-issue leverage constant, a firm's post-issue leverage increases with its issue size. Diamond (1991) and Leland and Toft (1996) argue that a firm's leverage is positively related to its debt maturity. We therefore expect the coefficient on $S$ in the bond-maturity equation to be positive.

***C.2 The issue-size equation.*** The explanatory variables in equation (3) include $X_s$ and bond maturity $M$. Vector $X_s$ includes variables that proxy for growth opportunities, firm size, liquidation risk, pre-issue leverage, profitability, intangible assets, average tax rate, and industry classification.

*Growth opportunity.* A firm's market-to-book ratio $(M/B)$ will again be used to measure its growth opportunities. Myers (1977) and Mauer and Ott (2000) argue that, when a firm issues new debt to partially finance the growth options, shareholders' benefits from exercising the growth option increase with the amount of new debt issued. This is because the increase in the firm's debt ratio erodes the old bondholders' position, and shareholders would thus have less incentive to underinvest. This suggests a positive relation between growth opportunities and issue size.

*Firm size.* Firm size is measured as the natural log of the market value of total assets in constant 1987 dollars. Titman and Wessels (1988) indicate that smaller firms incur higher issue costs than larger firms for both equity and debt, but this issue-cost disadvantage for smaller firms is less severe for new debt issues. This suggests that smaller firms may be more leveraged than larger firms, and the coefficient on firm size should be negative in the issue-size equation.

*Liquidation risk.* Moody's bond rating ($A_{aa} = 1$ to $C = 24$) is used to proxy for a firm's liquidation risk. If firms with smaller liquidation risk issue more debt because of their greater debt capacity (Titman and Wessels, 1988), we expect the coefficient on bond rating to be negative.

*Pre-issue leverage ratio.* If a firm maintains an optimal leverage ratio, the amount of new debt issue would depend on the direction of the firm's deviation from its desired debt level. In this case, the relation between pre-issue leverage and issue size is ambiguous.

*Profitability.* We use return on assets (ROA) to proxy for a firm's profitability. ROA is defined as the ratio of a firm's net income to its book value of total assets. Since a firm's debt capacity is likely to increase with its profitability, and profitable firms generally have high tax benefits of debt, a higher ROA may lead to greater issue size and thus a positive coefficient on ROA. However, Myers (1984) argues that firms prefer acquiring capital, first from retained earnings, second by issuing debt, and last by issuing new equity. Under this scenario, more profitable firms with higher retained earnings would have smaller debt issues, and the coefficient on ROA should appear with a negative sign.

*Intangible-assets ratio.* This variable is defined as the ratio of a firm's intangible assets to its book value of total assets. Intangible assets include goodwill, patents, copyrights and trademarks, and other long-term assets that do not have a physical from or substance. Managers in firms with higher proportions of intangible-assets may have greater incentives to consume excessive perquisites, because monitoring the capital outlays of such firms is more difficult. Titman and Wessels (1988) suggest that these firms may choose higher debt levels so that bondholders can closely monitor and limit managers' consumption of perquisites. This implies a positive coefficient on the intangible-assets ratio in the issue-size equation.

On the other hand, Myers and Majluf (1984) argue that issuing debt secured by property (collateralizable) alleviates the adverse selection problem resulting from information asymmetry between managers and outsiders. Hence, firms with greater collateralizable assets are expected to issue more debt. Under this scenario, a negative relation will hold between a firm's intangibles and the size of its debt issue.

*Average tax rate.* Average tax rate is calculated as the ratio of a firm's total taxes (including all income taxes paid to federal, state, and non-U.S. governments) to the firm's pretax income. The higher the tax-rate, the greater the incentive for firms to issue debt in order to enjoy the debt tax shield. Hence, we expect the coefficient on average tax rate to be positive.[6]

*Industry classification.* It is well established that firms' capital structure varies across industries. We use the financial- and the utility-firm dummies to control for the industry effect.

*Bond maturity.* Because of the interdependent nature of debt maturity and leverage, we include bond maturity as an explanatory variable in the issue-size (incremental leverage) equation. Diamond (1991) and Leland and Toft (1996) argue that debt maturity is positively related to leverage. We therefore expect the sign of the bond-maturity coefficient to be positive.

## IV. Data sources and sample statistics

Data on debt issue date, issue size, maturity date, Moody's rating, call and sinking fund provision, coupon rate, CUSIP numbers and industry classification are obtained from the Securities Data Company (SDC) for the period of 1973–1994. When a bond issue reported by the SDC is doubtful, we check Moody's Bond Record to ensure data accuracy. Firms' financial data including book value of assets, market value of assets, leverage ratio, earnings, return on assets, average tax rate and intangible assets are extracted from the COMPUSTAT Industrial Annual File. The GNP deflators, monthly 6-month Treasury bill rates and 10-year Treasury bond rates are obtained from the CITIBASE.

The following sets of observations are excluded from the sample: non-U.S. debt, serial issues containing bonds maturing on various dates, simultaneous issues of multiple-type securities (e.g., common stock, preferred stock and warrants), convertible issues, issues denominated in currencies other than the U.S. dollar, and floating rate issues.[7] With the above criteria, the sample contains 4825 bond issues. For firms that have multiple bond issues in the same fiscal year, we keep the observation of the first issue and exclude other issues that occurred within the same fiscal year to alleviate potential problems of residual serial correlation,[8] although some useful information may be lost in this way. After this exclusion, we have 3414 observations in our sample, of which we have complete information to estimate the single-equation debt maturity model for 1632 observations.[9] A total of 666 different issuing firms represent the 1632 bond issues. We group firms into industrial, financial and utility firms according to the classification guideline used by the SDC.[10] Firms with Standard Industrial Classification (SIC) codes between 6000 and 6799 are classified as financial firms. Utility firms are those whose SIC codes are 4612 to 4619, 4811, 4813, 4911–4941, or 4961–4971. Industrial firms' SIC codes are from 0111 to 8999, excluding those SIC codes used for financial and utility firms. Out of the 1632 bond issues, 940 issues are from industrial firms, 269 issues from financial firms, and 423 issues from utility firms.

Table 1 reports the descriptive statistics for the entire sample. The mean and median bond maturity at issuance are 14.45 years and 10 years, respectively. The statistics for issue size and market value of assets are in constant 1987 dollars. The average issuer in the sample has a market value of \$11.78 billion, an issue size of \$133.42 million, a pre-issue leverage ratio of 29.93%, and a market-to-book ratio of 1.21. Table 2 reports the means and medians of selected variables for industrial, financial and utility firms, respectively. As expected, bonds issued by utility firms have the longest maturity. The means of bond maturity for the industrial, financial, and utility firms are 13.06 years, 9.64 years, and 20.63 years, respectively. Tests on means and medians indicate that the differences in bond maturity across industries are statistically significant. Table 2 also indicates that on average, the financial firms are much larger than the industrial and utility firms. The means of the

*Table 1.* Descriptive statistics for the entire bond-issue: 1973–1994

| Variable | Mean | Std. Dev. | Minimum | Median | Maximum | No. of Obs. |
|---|---|---|---|---|---|---|
| Bond maturity (in years) | 14.45 | 8.70 | 0.30 | 10.00 | 40.00 | 1632 |
| Issue size (\$million, in 1987 dollars) | 133.42 | 98.67 | 4.10 | 104.60 | 1077.37 | 1632 |
| Issue-size ratio (%) | 5.52 | 7.88 | 0.01 | 2.99 | 87.90 | 1632 |
| Market value of assets (\$billion, in 1987 dollars) | 11.78 | 21.95 | 0.05 | 4.66 | 210.52 | 1632 |
| Pre-issue leverage ratio (%) | 29.93 | 15.12 | 1.21 | 28.16 | 92.53 | 1632 |
| Market-to-book ratio ($M/B$) | 1.21 | 0.44 | 0.72 | 1.07 | 7.26 | 1632 |
| Earnings change (%) | −0.91 | 12.77 | −220.95 | 0.20 | 143.33 | 1632 |
| Bond rating | 8.59 | 4.69 | 1 | 8 | 21 | 1632 |
| Yield spread (%) | 1.91 | 1.13 | −2.28 | 2.10 | 3.64 | 1632 |
| Call dummy | 0.64 | 0.47 | 0 | 1 | 1 | 1632 |
| Financial-firm dummy | 0.16 | 0.37 | 0 | 0 | 1 | 1632 |
| Utility-firm dummy | 0.26 | 0.43 | 0 | 0 | 1 | 1632 |
| Return on assets (ROA) (%) | 6.37 | 5.54 | −23.16 | 6.21 | 35.84 | 1632 |
| Intangible-assets ratio (%) | 7.12 | 9.58 | 0.00 | 2.97 | 71.13 | 676 |
| Average tax rate | 0.35 | 0.70 | −7.56 | 0.36 | 3.75 | 1625 |

*Notes:* Issue-Size Ratio is the ratio of a firm's issue proceeds to its book value of total assets; Market Value of Assets is measured as the book value of assets minus the book value of equity plus the market value of equity; Pre-Issue Leverage Ratio is the ratio of a firm's debt to its market value of assets prior to the bond issue; Market-to-Book Ratio is the ratio of the market value of a firm's assets to the book value of its assets; Earnings Change is the ratio of a firm's change in earnings per share from year $t$ to year $t+1$ to its stock price in year $t$; Bond Rating is Moody's bond rating ($A_{aa} = 1$ to $C = 24$); Yield Spread is the yield on ten-year government bond minus the yield on six-month government security; Call Dummy equals 1 if the issue is callable, and zero otherwise; Finance (Utility) Firm Dummy equals 1 if the issuer is a finance (utility) firm, and zero otherwise; Return on Assets is the ratio of a firm's net income to its book value of total assets; Intangible-Assets Ratio is the ratio of a firm's intangible assets to its book value of total assets; Average Tax Rate is the ratio of a firm's total taxes (including all income taxes paid to federal, state, and non-U.S. governments) to the firm's pretax income.

*Table 2.* Means and medians of variables for the bond-issue sample by sector: 1973–1994

| | Industrial Firms | | Financial Firms | | Utility Firms | |
|---|---|---|---|---|---|---|
| Variable | Mean | Median | Mean | Median | Mean | Median |
| Bond maturity (in years) | 13.06<br>(940) | 10.00<br>(940) | 9.64***<br>(269) | 10.00***<br>(269) | 20.63***<br>(423) | 30.00***<br>(423) |
| Issue size ($million, in 1987 dollars) | 148.07<br>(940) | 117.65<br>(940) | 122.47***<br>(269) | 103.45***<br>(269) | 107.85***<br>(423) | 92.27***<br>(423) |
| Issue-size ratio (%) | 7.47<br>(940) | 3.99<br>(940) | 1.34***<br>(269) | 0.61***<br>(269) | 3.84***<br>(423) | 2.98***<br>(423) |
| Market value of assets ($billion, in 1987 dollars) | 8.93<br>(940) | 3.85<br>(940) | 32.45***<br>(269) | 17.86***<br>(269) | 4.98***<br>(423) | 3.11**<br>(423) |
| Pre-issue leverage ratio (%) | 27.46<br>(940) | 24.73<br>(940) | 23.44***<br>(269) | 16.75***<br>(269) | 39.55***<br>(423) | 40.96***<br>(423) |
| Market-to-book ratio ($M/B$) | 1.33<br>(940) | 1.20<br>(940) | 1.02***<br>(269) | 1.00***<br>(269) | 1.06***<br>(423) | 1.03***<br>(423) |
| Earnings change (%) | −1.54<br>(940) | 0.06<br>(940) | 0.49**<br>(269) | 0.78**<br>(269) | −0.39*<br>(423) | 0.19<br>(423) |
| Bond rating | 9.35<br>(940) | 8<br>(940) | 7.64***<br>(269) | 8***<br>(269) | 7.53***<br>(423) | 7<br>(423) |
| Yield spread (%) | 1.95<br>(940) | 2.14<br>(940) | 2.01<br>(269) | 2.14<br>(269) | 1.75***<br>(423) | 1.96***<br>(423) |
| Call dummy | 0.63<br>(940) | 1<br>(940) | 0.39***<br>(269) | 0[a]<br>(269) | 0.83***<br>(423) | 1[a]<br>(423) |
| Return on assets (ROA) (%) | 7.83<br>(940) | 7.85<br>(940) | 1.36***<br>(269) | 1.02***<br>(269) | 6.32***<br>(423) | 6.42***<br>(423) |
| Intangible-assets ratio (%) | 8.61<br>(536) | 5.00<br>(536) | 0.89***<br>(109) | 0.77***<br>(109) | 3.34***<br>(31) | 1.95***<br>(31) |
| Average tax rate | 0.40<br>(937) | 0.38<br>(937) | 0.23***<br>(265) | 0.26***<br>(265) | 0.32*<br>(423) | 0.33***<br>(423) |

*Notes:* The numbers of observations are in parentheses. The variables are defined in Table 1.
***, **, * The difference between this mean (median) and the mean (median) of the industrial firms is statistically significant at the 1%, 5% and 10% level, respectively (two-tailed test).
[a]The median test does not apply to this variable.

market value of assets for the industrial, financial and utility firms are $8.93 billion, $32.45 billion and $4.98 billion, respectively, and their medians are $3.85 billion, $17.86 billion and $3.11 billions respectively. Despite the large difference in market value across industries, the amount of issue size has less variation. The average issue size ranges from $107.85 million for utility firms to $148.07 million for industrial firms. Moreover, consistent with our expectation that the call feature is associated with longer maturity bonds, the percentage of bonds that are callable is 83% for the utility firms, which is much higher than the 63% and 39% for the industrial firms and financial firms respectively.

Table 3 reports correlations between the variables used in the regression analysis. The correlation between the market-to-book ratio and the pre-issue leverage ratio is −0.38,

*Table 3.* Correlation matrix of selected variables for the entire bond-issue sample: 1973–1994

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Bond maturity | | | | | | | | | | | | | |
| 2. Log (market value of assets) | −0.1006 | | | | | | | | | | | | |
| | (0.0000) | | | | | | | | | | | | |
| 3. Issue-size ratio | −0.0510 | −0.6613 | | | | | | | | | | | |
| | (0.0395) | (0.0000) | | | | | | | | | | | |
| 4. Pre-issue leverage ratio | 0.1182 | −0.2436 | 0.2379 | | | | | | | | | | |
| | (0.0000) | (0.0000) | (0.0000) | | | | | | | | | | |
| 5. Market-to-book ratio ($M/B$) | −0.0989 | 0.0533 | 0.1183 | −0.3787 | | | | | | | | | |
| | (0.0001) | (0.0314) | (0.0000) | (0.0000) | | | | | | | | | |
| 6. Earnings change | 0.0130 | 0.0626 | −0.0352 | −0.0065 | 0.0324 | | | | | | | | |
| | (0.6003) | (0.0114) | (0.1557) | (0.7943) | (0.1902) | | | | | | | | |
| 7. Bond rating | −0.1920 | −0.4744 | 0.5679 | 0.3330 | −0.0621 | −0.0396 | | | | | | | |
| | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0121) | (0.1101) | | | | | | | |
| 8. Yield spread | −0.0920 | 0.0108 | 0.0383 | −0.0595 | 0.1102 | 0.0328 | 0.1974 | | | | | | |
| | (0.0002) | (0.6624) | (0.1219) | (0.0163) | (0.0000) | (0.1858) | (0.0000) | | | | | | |
| 9. Call dummy | 0.3679 | −0.3523 | 0.2425 | 0.1824 | −0.1508 | −0.0280 | 0.0133 | −0.1728 | | | | | |
| | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.2586) | (0.5920) | (0.0000) | | | | | |
| 10. Financial-firm dummy | −0.2461 | 0.4165 | −0.2354 | −0.1909 | −0.1942 | 0.0488 | −0.0901 | 0.0398 | −0.2319 | | | | |
| | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0486) | (0.0003) | (0.1083) | (0.0000) | | | | |
| 11. Utility-firm dummy | 0.4193 | −0.1622 | −0.1260 | 0.3763 | −0.1987 | 0.0238 | −0.1343 | −0.0841 | 0.2295 | −0.2628 | | | |
| | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.3358) | (0.0000) | (0.0007) | (0.0000) | (0.0000) | | | |
| 12. Intangible-assets ratio | −0.1144 | −0.0933 | 0.1974 | 0.0358 | 0.1854 | −0.0217 | 0.1393 | 0.0192 | −0.0725 | −0.2855 | −0.0866 | | |
| | (0.0029) | (0.0152) | (0.0000) | (0.3524) | (0.0000) | (0.5727) | (0.0003) | (0.6176) | (0.0597) | (0.0000) | (0.0244) | | |
| 13. Return on assets | 0.1068 | −0.1240 | 0.0735 | −0.2995 | 0.4909 | −0.1301 | −0.2664 | −0.1209 | 0.1707 | −0.4022 | −0.0055 | 0.1195 | |
| | (0.0000) | (0.0000) | (0.0030) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.8250) | (0.0019) | |
| 14. Average tax rate | 0.0121 | −0.0438 | 0.0397 | −0.0241 | 0.0387 | −0.0093 | −0.0270 | −0.0234 | 0.0559 | −0.0762 | −0.0235 | 0.0404 | 0.0383 |
| | (0.6273) | (0.0776) | (0.1097) | (0.3318) | (0.1185) | (0.7067) | (0.2774) | (0.3450) | (0.0242) | (0.0021) | (0.3431) | (0.2948) | (0.1224) |

*Note:* Numbers in the first row correspond to numbers in Column 1. The $p$ values for the null of zero correlation are in parentheses. The variables are defined in Table 1.

indicating that firms with greater growth options use less leverage. As suggested by Stohs and Mauer (1996), this negative correlation may imply that management of debt maturity structure may be of little importance to firms with large amounts of growth options, because such firms have little debt. Second, the large negative correlation between the log of market value of assets and the issue-size ratio (−0.66) suggests that larger firms tend to have smaller issue-size ratios. Third, similar to Stohs and Mauer (1996), we find that the log of market value of assets is strongly negatively related to bond rating (correlation of −0.47). This suggests that larger firms tend to have higher credit quality.

## V. Empirical results

We perform the empirical tests in the following order. First, we estimate the bond maturity equation under the single-equation framework using OLS to replicate the existing studies such as Barclay and Smith (1995), Guedes and Opler (1996) and Stohs and Mauer (1996), among others. Second, we estimate the bond maturity and issue size equations jointly within a simultaneous-equations framework using 2SLS. Third, we contrast these two sets of results to ascertain the sensitivity of the findings to the estimation framework. Finally, as a robustness test, we examine the determinants of debt maturity with a balance-sheet approach for the bond-issuing firms in our sample.

### *A. Single-equation estimation results with the incremental approach*

***A.1 The OLS results for the entire sample.*** Column 3 of Table 4 reports the results of the OLS estimation of the bond-maturity equation for the entire sample. Reported $t$-statistics are based on White's (1980) heteroskedasticity-consistent standard errors and are adjusted for serial correlations among observations from the same firm.[11] We find that the coefficient on growth opportunities ($M/B$) is negative and significant at the 5% level. This supports the underinvestment hypothesis based on Myers (1977) and corroborates the findings of Barclay and Smith (1995) and Guedes and Opler (1996). The crux of Myers's argument is that, growth in investment opportunities intensifies the conflict between shareholders and bondholders over whether to adopt a new investment project, and firms shorten debt maturity to alleviate this problem.

Similar to Barclay and Smith (1995), Guedes and Opler (1996) and Stohs and Mauer (1996), our results fail to support the tax hypothesis that purports a positive relation between debt maturity and the slope of the yield curve. The coefficient on the yield spread is insignificant for the all-firm sample, demonstrating that a widening of the yield spread between short and long-term debt does not prompt firms to issue longer-term debt in order to take advantage of the tax shields.

The lack of significance of the firm-size variable is in discord with the flotation cost hypothesis, according to which smaller firms are more likely to be associated with longer-term debt. However, it is likely that firm size also proxies for the extent of asymmetric information, which moves inversely with size (Guedes and Opler, 1996), and the

*Table 4.* Ordinary-least-squares single-equation regressions of bond maturity on explanatory variables: 1973–1994

| Explanatory Variables (Hypotheses) | Predicted Sign | All Firms | Industrial Firms | Financial Firms | Utility Firms |
|---|---|---|---|---|---|
| Intercept | | 11.8340***<br>(7.29) | 13.6312***<br>(6.37) | 5.4772<br>(0.61) | −8.043<br>(−1.04) |
| Issue-size ratio | + | 4.2454<br>(1.64) | 4.1162*<br>(1.72) | −7.5775<br>(−0.66) | 16.3075<br>(0.77) |
| Market-to-book ratio ($M/B$)<br>(Under investment) | − or + | −0.9948**<br>(−2.42) | −1.5369***<br>(−3.38) | 6.0888<br>(0.72) | 6.3517<br>(1.42) |
| Log (Market value of assets)<br>(Flotation cost) | − | 0.2644<br>(1.22) | 0.2730<br>(0.93) | −0.4899<br>(−1.19) | 1.6529***<br>(3.08) |
| Bond rating<br>(Liquidation risk) | + | −0.0127<br>(−0.08) | 0.1409<br>(0.63) | 0.1096<br>(0.32) | −0.1849<br>(−0.46) |
| Bond rating squared<br>(Liquidation risk) | − | −0.0140*<br>(−1.86) | −0.0142<br>(−1.55) | −0.0056<br>(−0.31) | −0.0339<br>(−1.54) |
| Pre-issue leverage ratio | + | −1.9721<br>(−1.26) | −6.6826***<br>(−2.90) | −2.6859<br>(−1.20) | 17.6216**<br>(2.07) |
| Yield spread<br>(Tax) | + | 0.1400<br>(0.83) | 0.0503<br>(0.26) | −0.2149<br>(−0.68) | 1.0101**<br>(2.50) |
| Earnings change<br>(Asymmetric information) | − | 0.8711<br>(0.65) | 0.1198<br>(0.06) | 0.2493<br>(0.18) | −0.7064<br>(−0.19) |
| Call dummy | + | 5.2263***<br>(10.03) | 3.5564***<br>(5.96) | 3.0284***<br>(3.65) | 12.9126***<br>(10.40) |
| Financial-firm dummy<br>(Asymmetric information or under investment) | − | −3.3769***<br>(−5.23) | | | |
| Utility-firm dummy<br>(Asymmetric information or under investment) | + | 6.0771***<br>(8.75) | | | |
| $R^2$ | | 0.2931 | 0.0968 | 0.1294 | 0.3105 |
| No. of observations | | 1,632 | 940 | 269 | 423 |

*Notes*: The variables are defined in Table 1. Reported $t$-statistics (in parentheses) are based on heteroskedasticity-consistent standard errors and are adjusted for serial correlations among observations from the same firm.
***, **, * Statistically significant at the 1%, 5% and 10% level, respectively (two-tailed test).

coefficient on firm size reflects the net effect of flotation cost and asymmetric information on debt maturity.

The bond rating variable and the square of bond rating are used to test the liquidation risk hypothesis. The hypothesized nonmonotonic relation between a firm's liquidation risk and debt maturity implies a positive coefficient on bond rating, and a negative coefficient on the bond rating squared. Table 4 indicates that the coefficient on bond rating is negative but insignificant, and the coefficient on the square of bond rating is significantly negative. Although this result is inconsistent with Diamond's (1991) prediction about the effect of liquidation risk on debt maturity, it does suggest that this effect is nonmonotonic in nature.

We also find that the coefficient on the firm-quality variable (earnings change) is insignificant. Similar to what Guedes and Opler (1996) conclude, this result does not support the asymmetric information hypothesis, according to which high-quality firms issue shorter-term debt. Note that although Barclay and Smith (1995) find that debt maturity is negatively related to earnings change, they question the economic significance of this variable.

To investigate possible behavioral differences across industry lines, we examine dummy variables for the financial and utility firms in the regression. According to Flannery (1986), information asymmetry is more severe for financial firms than for industrial firms, which are, in turn, subject to a greater degree of information asymmetry than utility firms. Consequently, financial (utility) firms are expected to issue shorter- (longer-) term debt than industrial firms. Consistent with this view, the coefficients on the financial- and utility-firm dummies are negative and positive, respectively, and both coefficients are statistically significant at the 1% level.

Because the assets of financial firms are difficult for investors to evaluate, the probability of asset substitution is high for these companies. The negative coefficient on the financial-firm dummy also supports the prediction of Barnea, Haugen and Senbet (1980) and Flannery (1994) that firms choose short-term financing as a way to reduce shareholders' incentives to take excessive risk. Moreover, the positive coefficient on the utility-firm dummy supports the prediction of Smith (1986) that debt maturity for regulated firms (e.g., utility firms) is longer because they are subject to a smaller agency cost from issuing long-term debt.

As expected, the coefficient on the call dummy is significantly positive, indicating that call provision is associated with longer-term bonds. In addition, the coefficients on the issue-size ratio and the pre-issue leverage ratio are statistically insignificant. This is in contrast to the prediction of Diamond (1991) and Leland and Toft (1996) that leverage is positively related to debt maturity.

In summary, our single-equation OLS results for the whole sample are consistent with the underinvestment hypothesis and provide mixed support for the asymmetric information hypothesis. However, the findings are inconsistent with the tax, flotation costs, and liquidation risk hypotheses.

***A.2 Sample disaggregation by industry classification.*** Idiosyncratic features of different economic sectors may lead to dissimilar debt maturity behavior across industries. Under this condition, pooling of firms from different industries in one sample may distort the testing of the hypotheses. Hence, we estimate the model also for the industrial, financial and utility firms separately.

Because the samples in Barclay and Smith (1995), Guedes and Opler (1996), and Stohs and Mauer (1996) mainly comprise industrial firms,[12] it is more appropriate to compare the results from our industrial-firm subsample to their findings. Column 4 of Table 4 shows that the results for the industrial-firm sample are generally similar to those for the full sample. The coefficient on $M/B$ is significantly negative, providing strong support for the underinvestment hypothesis. It is noteworthy that, in spite of the model and data differences, our result on the underinvestment hypothesis is in accord with Barclay and Smith (1995) and Guedes and Opler (1996).

Column 5 of Table 4 reports the results for the financial-firm sample. Unlike the results based on the entire sample and the industrial firms, the positive but insignificant coefficient on $M/B$ manifests no support for the underinvestment hypothesis. Rejection of the asymmetric information, liquidation risk, tax, and flotation costs hypotheses remains in effect as for the industrial-firm sample.

The results for the utility firms are reported in Column 6 of Table 4. Similar to the financial-firm sample, the coefficient on $M/B$ is positive and insignificant, rejecting the underinvestment hypothesis. In addition, the findings for the utility firms show three main differences from those based on the industrial and the financial firms. First, the coefficient on firm size is significantly positive, indicating that larger utility firms issue longer-term debt. This is consistent with the scenario that larger firms are subject to less asymmetric information and thus would issue longer-term debt. Second, the coefficient on yield spread is positive and significant at the 5% level, providing support for the tax hypothesis. Third, the coefficient on the pre-issue leverage ratio is significantly positive, indicating that utility firms use maturity and leverage in a complementary fashion to achieve their desired capital structure. This finding is in accord with Diamond (1991) and Leland and Toft (1996).

In brief, the most interesting results from the disaggregate samples are the support for the underinvestment hypothesis for the industrial-firm sample, and the rejection of this hypothesis for the financial-firm and the utility-firm samples. Unlike the case for the aggregate sample, the tax hypothesis does receive support but only from the utility firms. Differences in results across industries highlight the importance of sample disaggregation in making reliable inferences.

### *B. System-based results with the incremental approach*

The single-equation results in Table 4 lend some support to the underinvestment, the asymmetric information and the tax hypotheses on firms' debt-maturity choice. It is interesting to investigate whether these results still hold under a simultaneous-equations framework that considers debt maturity and leverage decisions concurrently. To this end, the simultaneous-equations model in equations (2) and (3) is estimated for the whole sample and for the industry subsamples using 2SLS. Table 5 reports the 2SLS results. Reported $t$-statistics are based on heteroskedasticity-consistent standard errors and are adjusted for serial correlations among observations from the same firm.

Several results are especially interesting. First, it is conspicuous that the negative relation between a firm's debt maturity and its growth opportunities is no longer valid. Indeed, the coefficient on $M/B$ is statistically insignificant for the whole sample as well as for all the subsamples. These findings suggest that the underinvestment hypothesis garners support mainly from the single-equation model estimated with OLS and industrial-firm data. This support does cease to exist in the system-based model, estimated with the consistent 2SLS procedure. The differential impact of $M/B$ on the debt-maturity decision under the single-equation and the system-based models is a major finding that distinguishes our study from the existing research on corporate debt maturity structure. Our 2SLS results corroborate the findings of Stohs and Mauer (1996) and Scherr and Hulburt (2001). Under

*Table 5.* Two-stage least squares regressions of bond maturity and issue-size ratio on explanatory variables: 1973–1994

| | All Firms | | Industrial Firms | | Financial Firms | | Utility Firms | |
|---|---|---|---|---|---|---|---|---|
| Explanatory Variable | Bond Maturity | Issue-Size Ratio | Bond Maturity | Issue-Size Ratio | Bond Maturity | Issue-Size Ratio | Bond Maturity | Issue-Size Ratio |
| Intercept | 31.0207*** | 0.0276 | 31.9601*** | 0.0573 | −6.4417 | 0.0651 | −1.6361 | 0.0454 |
| | (2.72) | (−0.63) | (2.70) | (−1.08) | (−0.36) | (1.62) | (−0.05) | (1.00) |
| Bond maturity | | 0.0016 | | 0.0007 | | −0.0006 | | 0.0000 |
| | | (1.03) | | (0.34) | | (−1.07) | | (0.06) |
| Issue-size-ratio | −100.1619 | | −94.3688 | | 450.6791 | | −218.7184 | |
| | (−1.44) | | (−1.48) | | (1.67) | | (−0.88) | |
| Market-to-book ratio ($M/B$) | 0.8653 | 0.0327*** | 0.6947 | 0.0357*** | −5.5528 | −0.0297 | 30.4873 | 0.0309 |
| | (0.57) | (3.17) | (0.45) | (3.04) | (−0.38) | (−0.83) | (1.61) | (1.06) |
| Log (Market value of assets) | −3.1102 | −0.0318*** | −3.3652 | −0.0371*** | 1.8784 | −0.0048*** | −3.0115 | −0.0187*** |
| | (−1.55) | (−9.46) | (−1.54) | (−9.05) | (1.21) | (−6.24) | (−0.58) | (−7.28) |
| Bond rating | −1.3895 | 0.0051*** | −1.3764 | 0.0039*** | 2.0690 | −0.0001 | −4.4686** | 0.0018 |
| | (−1.38) | (4.75) | (−1.33) | (3.34) | (1.53) | (−0.56) | (−2.28) | (1.27) |
| Bond rating squared | 0.0762 | | 0.0721 | | −0.1093 | | 0.2126** | |
| | (1.23) | | (1.22) | | (−1.67) | | (2.13) | |
| Pre-issue leverage ratio | 3.6738 | 0.1163*** | 3.6340 | 0.1521*** | −7.9293* | 0.0061 | 42.5361 | 0.0260 |
| | (0.68) | (3.67) | (0.48) | (3.16) | (−1.70) | (1.37) | (1.58) | (0.49) |
| Yield spread | 0.3951 | | 0.6200* | | 0.0420 | | −0.1113 | |
| | (1.40) | | (1.83) | | (0.07) | | (−0.04) | |
| Earnings change | −0.3538 | | 0.4937 | | −1.1144 | | 4.0530 | |
| | (−0.15) | | (0.16) | | (−0.41) | | (0.14) | |
| Call dummy | 3.5107*** | | 3.1121*** | | 4.4112** | | 11.0594** | |
| | (4.02) | | (3.19) | | (2.28) | | (2.34) | |
| Financial-firm dummy | −2.2656** | 0.0242* | | | | | | |
| | (−2.15) | (1.65) | | | | | | |
| Utility-firm dummy | −0.1570 | −0.3346** | | | | | | |
| | (−0.07) | (−3.91) | | | | | | |
| Return on assets (ROA) | | 0.0974 | | 0.0953 | | 0.4272** | | 0.1931* |
| | | (1.02) | | (0.97) | | (2.20) | | (1.90) |
| Intangible-assets ratio | | 0.0897 | | 0.0842 | | −0.1706* | | 0.1432* |
| | | (1.39) | | (1.23) | | (−1.97) | | (2.03) |
| Average tax rate | | 0.0005 | | 0.0008 | | −0.0006 | | −0.0516 |
| | | (0.28) | | (0.46) | | (−0.63) | | (−1.49) |
| $F$-statistics | 7.16 | 24.22 | 3.31 | 22.69 | 4.28 | 15.71 | 12.49 | 12.18 |
| $P$ Value | 0.0000 | 0.0000 | 0.0007 | 0.0000 | 0.0003 | 0.0000 | 0.0000 | 0.0000 |
| No. of observations | 676 | 676 | 536 | 536 | 109 | 109 | 31 | 31 |

*Notes:* The variables are defined in Table 1. Reported $t$-statistics (in parentheses) are based on heteroskedasticity-consistent standard errors and are adjusted for serial correlations among observations from the same firm.
***, **, * Statistically significant at the 1%, 5% and 10% level, respectively (two-tailed test).

a single-equation framework, these authors find that the coefficient estimate on $M/B$ is either insignificant or significantly positive after including leverage in their debt-maturity regressions. Based on their analysis of the correlation between leverage and the $M/B$ ratio, Stohs and Mauer explain that firms with large growth opportunities may have little leverage, and, therefore, little incentive to use debt maturity structure to alleviate the underinvestment problem.

More recently, Mauer and Ott (2000) model firms' debt maturity and leverage decisions in a setting in which the firms exercise growth options endogenously and plan to maintain target leverage ratios through time. They show that shortening debt maturity can no longer alleviate the underinvestment problem once leverage is held constant. This is because as debt maturity is shortened, shareholders choose to default sooner and thus expected bankruptcy costs increase. This will in turn reduce expected tax shields because firms may lose them in bankruptcy. The first-best strategy that maximizes total firm value requires that the firm exercise the growth options sooner to offset the larger expected bankruptcy costs and lower expected tax shields. However, because shareholders ignore bankruptcy costs when making their exercise decision on the growth options, the conflicts between shareholders and bondholders may intensify when debt maturity shortens. The lack of a negative relation between growth opportunities ($M/B$) and debt maturity is consistent with the model's implication. It suggests that the extant studies may overestimate the importance of this variable, and the corresponding agency costs, in determining firms' debt-maturity choices. The contrast in results between the single-equation and the system-based models highlights the importance of considering simultaneity in estimating the bond-maturity and issue-size regressions.

Second, the coefficient on $M/B$ in the issue-size regression is significantly positive at the 1% level for the whole sample and the industrial-firm sample, lending support to the argument of Myers (1977) and Mauer and Ott (2000) that shareholders' benefits from exercising the growth options increase with the amount of new debt issued. Issuing new debt to finance the firm's growth opportunities erodes the position of old bondholders. This in turn reduces shareholders' incentive to underinvest. The notable point here is that it is the leverage, rather than the bond maturity, that is used by industrial firms as the vehicle of response to changes in growth opportunities. It follows that excluding the leverage decision from the model misplaces the focus on the wrong variable (debt maturity) as the instrument of response and is likely to distort both the magnitude and significance of the effect of growth opportunities. Note that the coefficient on $M/B$ is insignificant for the financial firms and the utility firms, implying an absence of a relation between growth opportunities and issue size for these companies. The dissimilar patterns of the effect of growth opportunity on debt maturity across industries are strong indications of the need to disaggregate the sample.

Third, unlike the single-equation case, there is support from the industrial-firm sample for the tax hypothesis with the 2SLS estimation. The coefficient on yield spread is positive at the 10% level for the industrial firms, while it is insignificant for the financial and utility firms. Fourth, as in the single-equation case, the coefficient on bond rating is insignificant for the industrial- and the financial-firm samples in the bond-maturity regression. Dissimilar to the single-equation estimation, the coefficients on bond rating and bond rating squared for the utility firms are significantly negative and positive, respectively. These results fail to support the liquidation risk hypothesis. Fifth, the significantly negative coefficient on the financial-firm dummy provides limited support for the asymmetric information hypothesis. Also as expected, the coefficient on the call dummy in the bond-maturity regression is significantly positive for all the samples, suggesting that the call feature is associated with longer-term bonds. Sixth, the coefficient on the log of market value of assets in the issue-size regression is significantly negative for all the samples. This is consistent with Titman and Wessels' (1988) suggestion that smaller firms are more leveraged because of their higher costs of selling equity.

Some other results on the issue-size equation are also worth mentioning. Table 5 shows that the coefficient on bond rating is significantly positive for the industrial firms, indicating that riskier industrial firms have larger debt issues. Results also indicate that the coefficient on the profitability measure (ROA) is significantly positive for the financial and utility firms. This effect may be due to greater debt capacity of more profitable firms. We also find that the coefficient on the intangible-assets ratio for the financial firms is significantly negative, indicating that financial firms with greater collateralizable assets issue more debt. This is consistent with Myers and Majluf's (1984) argument that issuing debt secured by collateralizable assets alleviates the adverse selection problem resulting from information asymmetry between managers and outsiders. However, the coefficient on the intangible-assets ratio is significantly positive for the utility firms. This supports the view that utility firms with higher intangible assets (less collateral value of assets) issue greater amount of debt so that intensified monitoring from bondholders would alleviate managers' incentive to consume excessive perquisites. Moreover, the coefficients on the financial- and utility-firm dummies in the issue-size equation are significantly positive and negative, respectively. This suggests that, compared with their industrial counterparts, financial firms tend to issue greater amount of debt (to be more levered), while utility firms do the opposite. The positive coefficient on the financial-firm dummy is consistent with the idiosyncrasies of the banking firms as they borrow most of their funds and are required to hold only a small equity in proportion to their assets.

We note that neither the coefficient on the issue-size ratio in the debt-maturity regression nor the coefficient on bond maturity in the issue-size regression is statistically significant, contrary to our expectation that both coefficients should be positive. This puzzling result could be due to the omission of other regressors that are correlated to the issue-size ratio or bond maturity, and/or due to measurement errors in the proxies employed. This suggests that it is important to examine the robustness of our results with additional tests.

We also note that the number of observations used in our whole-sample 2SLS estimation is much smaller than that of the single-equation model because for some companies we do not have data on the additional explanatory variables included in the issue-size equation. To examine whether the differential results from the single-equation and the simultaneous-equations models are due to sample differences, we also estimate the OLS regression for the debt-maturity equation using the sample for the system-based estimation. The result from this regression is qualitatively the same as that for the full sample. This suggests that the dissimilarity between the OLS and 2SLS results is not due to sample differences but rather due to the interdependence between debt maturity and leverage decisions, which is ignored in the single-equation model.

Overall, Table 5 shows that the 2SLS results fail to support the underinvestment hypothesis for any of the subsamples. The similarity in results between the industrial-firm and the all-firm samples suggests that industrial firms are driving the whole-sample results. The industrial-firm sample provides support for the tax hypothesis. However, our 2SLS results for the financial- and utility-firm subsamples are not consistent with any of the hypotheses on debt maturity. In addition, the system-based model produces some interesting results on leverage. Most importantly, we find that it is the leverage decision, and not the maturity decision, that is used as a tool by firms to respond to changes in growth opportunities. Our industrial-firm result is consistent with the prediction of Myers (1977) and Mauer and Ott (2000) that firms tie the additional borrowing to their incremental investment to alleviate the underinvestment problem.

So far, we have defined debt maturity using the incremental approach. To ascertain whether our conclusions are robust to different measures of debt maturity, we examine our hypotheses in the next section with a balance-sheet approach that is similar to the one in Barclay, Marx and Smith (2001).

### *C. Robustness tests with the balance-sheet approach*

As in Barclay, Marx and Smith (2001), we measure debt maturity as the percentage of the firm's total debt that matures in more than three years, and we measure leverage as the ratio of the book value of total debt to the market value of total assets. To directly compare with our results under the incremental approach, the tests in this section are for the same debt-issuing firms included in our incremental-approach analysis. For each firm, we extract its financial data from the Compustat Industrial Annual File for the period of 1973–1994. Our final balance-sheet-approach sample includes a panel data set of 6407 firm-year observations, representing 425 different companies.

To facilitate the comparison with the results in Barclay, Marx and Smith (2001), we use a set of variables similar to theirs to explain firms' decision on debt maturity and leverage. In particular, the explanatory variables for the debt-maturity equation include the leverage ratio, $M/B$, the natural log of market value of assets, asset maturity, and a commercial-paper dummy; the explanatory variables for the leverage equation include debt maturity, $M/B$, the natural log of market value of assets, return on assets, the intangible-assets ratio, average tax rate, and a dummy variable for net operating loss (NOL) carryforwards.[13] Variables debt maturity, leverage ratio, $M/B$, the log of market value of assets, return on assets, intangible-assets ratio, and average tax rate have been defined and discussed earlier. Asset maturity is the weighted average of current assets divided by the cost of goods sold, and net property, plant and equipment divided by depreciation and amortization, where the weights are the relative sizes of current assets and net property, plant and equipment. Myers (1977) suggests that firms match the maturities of their assets and liabilities to alleviate the agency cost of underinvestment. We therefore expect the coefficient on asset maturity to be positive in the debt maturity regression. The commercial paper dummy equals one if a firm has commercial paper programs, and zero otherwise. We expect firms with commercial paper programs have more short-term debt (Barclay et al., 2001). The NOL carryforwards dummy equals one for firms with net operating loss carryforwards, and zero otherwise. If firms with NOLs have low tax benefits of debt, we expect a negative coefficient on the NOL dummy in the leverage-ratio regression.

*Table 6.* Descriptive statistics for the balance-sheet-approach sample: 1973–1994

| Variable | Mean | Std. Dev. | Minimum | Median | Maximum | No. of Obs. |
|---|---|---|---|---|---|---|
| Debt maturity (%) | 42.08 | 19.57 | 0.00 | 41.58 | 92.75 | 6407 |
| Leverage ratio (%) | 26.84 | 15.38 | 0.00 | 24.55 | 83.07 | 6407 |
| Market value of assets ($billion, in 1987 dollars) | 4.37 | 8.42 | 0.01 | 1.78 | 122.47 | 6407 |
| Market-to-book ratio ($M/B$) | 1.27 | 0.49 | 0.33 | 1.13 | 5.78 | 6407 |
| Asset maturity | 8.03 | 8.57 | 0.25 | 5.10 | 108.80 | 6407 |
| Commercial paper dummy | 0.22 | 0.41 | 0.00 | 0.00 | 1.00 | 6407 |
| Return on assets (%) | 8.57 | 9.15 | −248.12 | 8.54 | 59.30 | 6407 |
| Intangible-assets ratio (%) | 3.73 | 7.35 | 0.00 | 0.38 | 78.48 | 5619 |
| Average tax rate | 0.35 | 1.17 | −75.60 | 0.39 | 24.75 | 6406 |
| NOL carryforwards dummy | 0.18 | 0.39 | 0.00 | 0.00 | 1.00 | 6407 |

*Notes:* Debt Maturity is the percentage of a firm's total debt that has a maturity of more than three years; Leverage Ratio is the ratio of a firm's debt to its market value of assets; Market Value of Assets is measured as the book value of assets minus the book value of equity plus the market value of equity; Market-to-Book Ratio is the ratio of the market value of a firm's assets to the book value of its assets; Asset Maturity is the weighted average of current assets divided by the cost of goods sold, and net property, plant and equipment divided by depreciation and amortization, while the weights are the relative sizes of current assets and net property, plant and equipment; Commercial Paper Dummy equals one for firms with commercial paper programs, and zero otherwise; Return on Assets is the ratio of a firm's net income to its book value of total assets; Intangible-Assets Ratio is the ratio of a firm's intangible assets to its book value of total assets; Average Tax Rate is the ratio of a firm's total taxes (including all income taxes paid to federal, state, and non-U.S. governments) to the firm's pretax income; and NOL Carryforwards Dummy equals one for firms with net operating loss carryforwards, and zero otherwise.

Table 6 reports descriptive statistics for this balance-sheet approach sample, and Table 7 tabulates the correlation matrix of selected variables. Again, similar to what Stohs and Mauer (1996) find, $M/B$ is strongly negatively related to the leverage ratio (correlation of −0.48). Moreover, the correlation between debt maturity and asset maturity is 0.51, suggesting that firms match the maturities of their assets and liabilities to a considerable degree.

Table 8 presents the following four sets of regression results using the balance-sheet approach: (1) pooled OLS single-equation regressions in which debt maturity and the leverage ratio are not included as regressors (Columns 2 and 3), (2) pooled OLS single-equation regressions in which debt maturity and leverage are included as regressors (Columns 4 and 5), (3) random-effects 2SLS regressions (Columns 6 and 7), and (4) fixed-effects 2SLS regressions (Columns 8 and 9). Except for the fixed-effects 2SLS regressions, reported $t$-statistics (or $z$-statistics) are based on heteroskedasticity-consistent standard errors.[14] Because the OLS single-equation regressions may produce biased and inconsistent estimates, we make inferences mainly from the results that are confirmed by both the random-effects and the fixed effects 2SLS estimates.

Similar to Barclay and Smith (1995) and Guedes and Opler (1996), $M/B$ is significantly negatively related to debt maturity in the OLS single-equation regression that excludes the leverage ratio as a regressor. However, this coefficient becomes significantly positive once the leverage ratio is included. This result again corroborates Stohs and Mauer's (1996) finding that when leverage is controlled for, the coefficient on $M/B$ is significantly positive in the pooled OLS regression. The coefficient on $M/B$ continues to be significantly positive

*Table 7.* Correlation matrix of selected variables for the balance-sheet-approach sample: 1973–1994

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Debt maturity | | | | | | | | | |
| 2. Log (Market value of assets) | −0.0485 | | | | | | | | |
| | (0.0001) | | | | | | | | |
| 3. Leverage ratio | 0.5882 | −0.2622 | | | | | | | |
| | (0.0000) | (0.0000) | | | | | | | |
| 4. Market-to-book ratio ($M/B$) | −0.2386 | 0.1959 | −0.4802 | | | | | | |
| | (0.0000) | (0.0000) | (0.0000) | | | | | | |
| 5. Asset maturity | 0.5130 | 0.0342 | 0.3688 | −0.1596 | | | | | |
| | (0.0000) | (0.0063) | (0.0000) | (0.0000) | | | | | |
| 6. Commercial paper dummy | −0.0251 | 0.3584 | −0.1974 | 0.2239 | −0.0258 | | | | |
| | (0.0446) | (0.0000) | (0.0000) | (0.0000) | (0.0389) | | | | |
| 7. Intangible-assets ratio | −0.0154 | −0.0088 | 0.0120 | 0.1493 | −0.2242 | 0.1489 | | | |
| | (0.2485) | (0.5099) | (0.3675) | (0.0000) | (0.0000) | (0.0000) | | | |
| 8. Return on assets | −0.2330 | 0.1069 | −0.4786 | 0.3037 | −0.0895 | −0.0177 | −0.0333 | | |
| | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.1559) | (0.0126) | | |
| 9. Average tax rate | −0.0016 | 0.0183 | −0.0352 | 0.0203 | −0.0138 | 0.0156 | 0.0110 | 0.0667 | |
| | (0.8950) | (0.1428) | (0.0048) | (0.1046) | (0.2694) | (0.2117) | (0.4083) | (0.0000) | |
| 10. NOL carryforwards dummy | 0.3710 | −0.0582 | 0.3065 | −0.1343 | 0.5330 | 0.0619 | −0.0899 | −0.2007 | −0.0365 |
| | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0035) |

*Note:* Numbers in the first row correspond to numbers in Column 1. The $p$-values for the null of zero correlation are in parentheses. The variables are defined in Table 6.

*Table 8.* Regression results with the balance-sheet approach: 1973–1994

| | OLS Single-Equation Pooled Regressions | | OLS Single-Equation Pooled Regressions | | Random-Effects 2SLS Regressions | | Fixed-Effects 2SLS Regressions | |
|---|---|---|---|---|---|---|---|---|
| Explanatory Variable | Debt Maturity ($t$-statistics) | Leverage Ratio ($t$-statistics) | Debt Maturity ($t$-statistics) | Leverage Ratio ($t$-statistics) | Debt Maturity ($z$-statistics) | Leverage Ratio ($z$-statistics) | Debt Maturity ($z$-statistics) | Leverage Ratio ($z$-statistics) |
| Intercept | 0.4112*** (52.65) | 0.4387*** (71.10) | 0.1597*** (14.76) | 0.2731*** (33.83) | 0.1995*** (10.36) | 0.1289*** (8.11) | 0.2628*** (12.37) | −0.1075* (1.93) |
| Debt maturity | | | | 0.3338*** (30.30) | | 0.6500*** (20.49) | | 1.1545*** (9.64) |
| Leverage ratio | | | 0.6444*** (28.05) | | 0.5870*** (12.99) | | 0.4873*** (9.32) | |
| Market-to-book ratio ($M/B$) | −0.0640*** (−12.96) | −0.1073*** (−12.61) | 0.0142** (2.45) | −0.0838*** (−11.62) | 0.0176*** (2.58) | −0.0712*** (−18.12) | −0.0003 (−0.03) | −0.0459*** (−5.43) |
| Log (Market value of assets) | −0.0065*** (−3.98) | −0.0149*** (−13.02) | 0.0060*** (3.96) | −0.0164*** (−16.19) | 0.0261*** (10.36) | −0.0207*** (−12.99) | 0.0451*** (13.17) | −0.0446*** (−7.53) |
| Asset maturity | 0.0112*** (20.95) | | 0.0076*** (16.32) | | 0.0035*** (8.61) | | 0.0014*** (3.12) | |
| Commercial paper dummy | 0.0193*** (3.87) | | 0.0281*** (6.14) | | 0.0043 (0.94) | | −0.0063 (−1.37) | |
| Return on assets | | −0.5098*** (−5.79) | | −0.4332*** (−5.78) | | −0.2999*** (−17.91) | | −0.2441*** (−9.98) |
| Intangible-assets ratio | | 0.1469*** (5.28) | | 0.1132*** (4.95) | | 0.0320 (1.32) | | −0.1711*** (−2.89) |
| Average tax rate | | −0.0051** (−2.10) | | −0.0056*** (−2.74) | | −0.0035* (−1.91) | | −0.0020 (−0.80) |
| NOL carryforwards dummy | | 0.0805*** (15.53) | | 0.0246*** (5.49) | | −0.0258*** (−4.61) | | −0.0326*** (−3.94) |
| $R^2$ | 0.2910 | 0.4130 | 0.4560 | 0.5620 | 0.4089 | 0.5060 | 0.2750 | 0.4450 |
| No. of observations | 6407 | 5618 | 6407 | 5618 | 5618 | 5618 | 5618 | 5618 |

*Notes:* The variables are defined in Table 6. Except for the fixed-effects 2SLS regressions, reported $t$-statistics or $z$-statistics (in parentheses) are based on heteroskedasticity-consistent standard errors.
***, **, * Statistically significant at the 1%, 5% and 10% level, respectively (two-tailed test).

in our random-effects 2SLS regression of debt maturity, while it ceases to be significant in the fixed-effects 2SLS regression. These results support Mauer and Ott's (2000) prediction that once leverage is held constant, shortening debt maturity can no longer reduce the agency cost of underinvestment. However, they contradict the results of Barclay, Marx and Smith (2001). The latter authors find that the coefficient on $M/B$ is significantly negative in their 2SLS regression of debt maturity. Table 8 also shows that the coefficient on $M/B$ is significantly negative in the leverage regression for all the four models suggesting that firms can reduce the agency cost of underinvestment by reducing their leverage. This result shows once more that it is the leverage, rather than the debt maturity, that is used by firms as the vehicle to alleviate the underinvestment problem. These findings suggest that our conclusion on the effect of $M/B$ is very robust to different measures of debt maturity.

Table 8 shows that most of the coefficients on other variables have the expected signs. The coefficient on the leverage ratio in the debt-maturity regression and the coefficient on debt maturity in the leverage-ratio regression are both significantly positive.[15] This is consistent with the prediction of Diamond (1991) and Leland and Toft (1996). The positive coefficient on the log of market value of assets in the 2SLS debt maturity regressions is consistent with the scenario that larger firms have less asymmetric information and thus have greater long-term debt. There is also strong evidence that firms match the maturities of their assets and liabilities, confirming the results of Stohs and Mauer (1996). Moreover, the significantly negative coefficient on the firm-size variable in the leverage-ratio regression is consistent with the view that smaller firms are more leveraged than larger firms due to their higher costs of selling equity (Titman and Wessels, 1988). Results also indicate that more profitable firms (with higher ROAs) tend to have less leverage, supporting Myers' (1984) argument that more profitable firms have greater retained earnings and would like to use their retained earnings first to finance new investments. Furthermore, the significantly negative coefficient on the NOL carryforwards dummy support the notion that firms with NOL carryforwards have less tax benefits of debt and thus are less leveraged.

## VI. Conclusions

Decisions concerning debt maturity and leverage are important aspects of a firm's capital structure. This paper examines the determinants of corporate debt maturity for a sample of bond issuers over the period of 1973–1994. Most previous empirical studies either ignore the effect of leverage on debt maturity or treat leverage as an exogenous explanatory variable. Our paper incorporates the interdependent nature of the relation between maturity and leverage, and estimates a simultaneous-equations model on the two decision variables using 2SLS. To compare our results with previous studies and to assess the importance of the system-based model, we also estimate a single-equation model on debt maturity using OLS. Our empirical analysis employs both an incremental approach and a balance-sheet approach to test a variety of important theories on debt maturity. In the incremental approach, debt maturity is defined as the maturity of bonds at issuance. In the balance-sheet approach, debt maturity is measured as the percentage of a firm's total debt that matures in more than three years.

Our single-equation OLS results under the incremental approach are by and large in accord with the findings reported by many existing studies on the determinants of corporate debt maturity. In particular, consistent with the underinvestment hypothesis, we find that industrial firms with more growth opportunities tend to issue shorter-term bonds. However, the results from our simultaneous-equations model show that once issue size (incremental leverage) is incorporated into the model, the negative relation between firms' growth opportunities and debt maturity disappears. This result is confirmed by our 2SLS estimation under the balance-sheet approach. These findings lend support to the prediction of Mauer and Ott (2000) that, once leverage is held constant, shortening debt maturity can no longer reduce the agency cost of underinvestment.

In addition, our 2SLS results indicate that an increase in growth opportunities leads to an increase in issue size for the industrial firms. This finding supports the prediction of Myers (1977) and Mauer and Ott (2000) that the shareholders' benefits from exercising the growth options increase with the amount of new debt issued. Moreover, our results under the balance-sheet approach indicate that firms with greater growth options have less debt, supporting Myers' (1977) implication that firms with greater growth opportunities should be less leveraged to reduce the agency cost of underinvestment. These findings suggest that the effect of growth opportunities on capital structure manifests itself in the leverage decision, rather than debt maturity. The lack of a negative effect of growth opportunities on debt maturity in the system-based model constitutes an indication that the support for the underinvestment hypothesis on debt maturity is overstated in the existing literature.

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## Notes

1. The weighted-average maturity of a firm's liability items is a more precise measure of debt maturity than the ones defined as the proportions of long- or short-term debt. However, it is difficult to construct the weighted-average measure because detailed information about a firm's liability structure is very time-consuming to collect and is often unavailable.
2. Recently, in a working paper, Barclay, Marx and Smith (2001) use a balance-sheet approach to empirically examine corporate debt maturity and leverage simultaneously.
3. The maturity for a bond with sinking fund provisions is the average life of the bond after being adjusted for any redemption following the sinking fund scheduled. The sinking fund adjusted bond maturity is obtained from the Securities Data Company. Stohs and Mauer (1996) find that adjusting the maturity of debt for sinking fund provisions has a significant impact on debt maturity measures.

4. Because a firm's total debt equals its pre-issue debt amount plus the new debt issued, and the pre-issue debt amount is exogenous at the time of the new debt issue, our simultaneous-equations model treats issue size as an endogenous variable and the pre-issue leverage as an exogenous variable.
5. See Greene (1997).
6. A better measure of the effect of tax on a firm's leverage is the firm's marginal tax rate. Here we assume that average tax rate is a good proxy for marginal tax rate.
7. We exclude convertible debt issues because they may have different behavior from non-convertible debt issues. We also exclude debt with floating coupon rates because it is difficult to determine their maturity.
8. Residual serial correlation makes least-squares estimates inefficient.
9. The number of observations with complete information drops to 676 for the estimation of the simultaneous-equation model because the issue-size equation requires additional variables.
10. Detailed industry classification can be found on page 1.4.2 of Securities Data Company Financial Database System Mini Manual, 1994.
11. Heteroskedasticity-consistent standard errors are used because conventional standard errors computed under the assumption of homoscedastic disturbances may be quite far from the appropriate values and may lead to invalid $t$-statistics for the estimated coefficients. Here we use the algorithm developed by Rogers (1993) to adjust for serial correlations in estimating White's heteroskedasticity-consistent standard errors.
12. The samples in Barclay and Smith (1995) and Guedes and Opler (1996) also include utilities firms.
13. Our proxy variables differ from those of Barclay, Marx and Smith (2001) in the following ways. First, Barclay et al. use the log of real sales instead of log of market value of assets to measure firm size. Second, they use marginal tax rate instead of average tax rate to measure firms' propensity to lower tax payment with increased leverage. Third, they use the ratio of operating income to the book value of total assets to measure profitability, while our profitability measure is the ratio of net income to the book value of total assets. Fourth, they use the tangible-assets ratio versus our intangible-assets ratio to measure asset tangibility. Fifth, they include a regulation dummy to examine the effects of regulation on debt maturity (it is insignificant in their 2SLS debt-maturity regression). Although we do not use such a dummy variable, we find that adding the financial- and utility-firm dummies do not change the results on other variables.
14. We are not aware of any algorithm that is available to estimate heteroskedasticity-consistent standard errors for fixed-effects 2SLS regressions.
15. In their 2SLS estimation of the determinants of leverage and debt maturity, Barclay, Marx and Smith (2001) find that the sign of the coefficient on leverage in the debt-maturity equation is opposite to the sign of the coefficient on debt maturity in the leverage equation.

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