THE JOURNAL OF FINANCE • VOL. LI, NO. 1 • DECEMBER 1996

# The Determinants of the Maturity of Corporate Debt Issues

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**ABSTRACT**

We document the determinants of the term to maturity of 7,369 bonds and notes issued between 1982 and 1993. Our main finding is that large firms with investment grade credit ratings typically borrow at the short end and at the long end and of the maturity spectrum, while firms with speculative grade credit ratings typically borrow in the middle of the maturity spectrum. This pattern is consistent with the theory that risky firms do not issue short-term debt in order to avoid inefficient liquidation, but are screened out of the long-term debt market because of the prospect of risky asset substitution.

TRADITIONALLY, CAPITAL STRUCTURE RESEARCH has focused on how much of a firm's future cash flows should be paid out to debtholders instead of equityholders. An equally important issue is *when* future cash flows should be paid out to debtholders. A firm that finances its projects with short-term debt risks serious financial difficulty if the debt cannot be extended. Similarly, a firm that finances its activities with long-term debt can sacrifice profits by needlessly risking mismanagement of resources after cash flows are returned from investments, but before they are due to debtholders.

This study investigates the factors that firms consider when choosing the maturity of their liabilities. We document the determinants of the maturity of 7,368 public debt issues made by U.S. corporations between 1982 and 1993. Our empirical tests are based on existing theoretical models that relate the maturity of a firm's borrowings to the riskiness of its cash flows, the time until investments pay off, the quality of information held by outsiders, the expected

* Guedes is from Universidade Catolica Portuguesa. Opler is from Ohio State University. We thank an anonymous referee, Sugato Bhattacharya, Bob Connolly, Vidhan Goyal, Jean Helwege, David Hirshleifer, Simon Kwan, Ken Lehn, Craig Lewis, David Mauer, David Mayers, Richard McEnally, Bernadette Minton, Karlyn Mitchell, Harold Mulherin, Krishna Palepu, John Persons, Lee Pinkowitz, Avri Ravid, Richard Ruback, Paul Schultz, René Stulz, Sheridan Titman, Peter Tufano, Rex Thompson, Ralph Walkling, Karen Wruck, Marc Zenner, and seminar participants at the 1995 American Finance Association (AFA) Meetings, the 1994 Financial Management Association (FMA) Meetings, Harvard Business School, the University of Michigan, the University of North Carolina, Ohio State University, and the University of Pittsburgh for helpful comments. Conversations with Roberts W. Brokaw III and Leland Crabbe of Merrill Lynch, Bob Cavanaugh of JC Penney, Peter Klosowicz of Deutsche Morgan Grenfell, and Gregg Koser of Electronic Data Systems (EDS) were of great help in writing this article. The second author benefitted from research support from the Charles A. Dice Center for Financial Economics at Ohio State University.

marginal tax rate, and the potential for conflict of interest between bondholders and equityholders.

Previous empirical studies of the debt maturity choice include Barclay and Smith (1995) and Stohs and Mauer (1994). While informative, these studies leave much unexplained. Barclay and Smith (1995) show that the term to maturity of a firm's debt rises with credit quality and size, and falls with growth opportunities. Their results are broadly consistent with Myers' (1977) view that firms should shorten debt maturity when contracting costs rise. In a related article, Stohs and Mauer (1994) find that long-term debt is most likely to be used by larger, less risky firms with relatively poor growth opportunities.[1]

We depart from earlier studies by examining the maturity of *incremental* debt issues rather than the maturity of all liabilities on a firm's balance sheet. It is our view that some questions about the determinants of debt maturity are better answered by the incremental approach and some by the balance sheet approach. In particular, the incremental approach is well-suited to test theories that rely on state variables that fluctuate substantially over time. For example, it is difficult to test signalling models of maturity choice using the average maturity of outstanding debt issues because these models rely on transient informational asymmetry between managers and investors. Similar arguments can be made about theories that rely on a firm's tax position and its liquidity risk. On the other hand, the incremental approach is not well-suited to test theories that relate the properties of a firm's asset mix to the maturity of its liabilities because new debt issues may have a maturity that is far from the average maturity of a firm's assets.

Another advantage of the incremental approach is that it can identify the determinants of financing choices at all points of the maturity spectrum. This allows us to characterize which types of firms inhabit various parts of the debt maturity spectrum more precisely than can be done using cross-sectional debt maturity information from the COMPUSTAT tapes.[2]

Our main finding is that large firms with investment grade credit ratings typically borrow at the short end and at the long end of the maturity spectrum, while firms with speculative grade credit ratings typically borrow in the middle of the maturity spectrum. This result is consistent with the theory that speculative grade firms issue debt with the longest possible term in order to avoid the risk of costly premature liquidation. However, these firms are not able to borrow as long-term as they would like because they are screened out of the long-bond market by moral hazard problems that arise when the re-

[1] Other studies are also consistent with these findings. Mitchell (1991) finds that smaller firms and those with convertible debt are more likely to issue bonds with a maturity of less than ten years. Morris (1991) examines 140 companies in 1985 and finds that debt maturity rises with size, leverage, liquidity, and asset maturity. Titman and Wessels (1988) find that maturity rises with firm size.

[2] Morris (1991) discusses the difficulty of hand-collecting precise information on the maturity of a firm's liabilities. Maturity measures obtained from COMPUSTAT lump all debt with a maturity longer than five years together.

quired rate of return induces risk-shifting (Diamond (1991a)). Consequently, we would expect to find high credit risk firms issuing in the middle of the maturity spectrum and low credit risk firms issuing at the very long end of the maturity spectrum (and at the short-end because it is not as risky for them). We also find that firms which have above average growth prospects are most likely to issue at the short end of the maturity spectrum. This fact, coupled with a tendency of firms in our sample to match the maturity of assets and liabilities, supports Myers' (1977) view that firms can control the agency problems of debt by shortening debt maturity.

The remainder of this article presents our empirical hypotheses (Section I), the empirical implementation (Section II), and results (Section III). Section IV summarizes our findings and suggests future directions for empirical research on debt maturity choice.

## I. Theory and Empirical Hypotheses

### *A. Liquidity Risk and Screening*

The risk of not being able to refund debt because of deterioration in financial or economic conditions can motivate firms to lengthen the maturity of their debt. In Sharpe (1991), Diamond (1991a), and Titman (1992), bad news about a borrower may arrive at the refinancing date, causing investors not to extend credit or to raise the default premium on new debt. Diamond refers to liquidity risk as the risk of a borrower being forced into inefficient liquidation because refinancing is not available. Even if this extreme outcome is not realized, short-term debt can still cause a loss of project rents if it has to be refinanced at an overly high interest rate because of credit market imperfections (Froot, Scharfstein, and Stein (1993)). Firms may also experience deadweight indirect costs of financial distress (e.g., loss of customers and distraction of management) when they lose access to attractively priced credit.

While liquidity risk gives some firms an incentive to borrow long-term, they may not be able to do so because the rate of return required to compensate investors for bearing long-term credit risk can induce substitution into risky low-quality projects (Diamond (1991a), Stiglitz and Weiss (1981)). Thus, low quality firms can be screened out of the long-term debt market, and only stable firms with high credit quality (e.g., large firms) may end up being able to borrow in the long-term credit market. This possibility mirrors the history of the corporate bond market, where firms with speculative grade ratings have often been unable to issue long-term debt (Rizzi (1994)). Empirically, we proxy for credit quality using a dummy variable for whether a firm's issues are investment grade (S&P rating of BBB or higher). Another proxy for credit quality is the volatility of cash flows in a firm's industry.[3] Finally, we use firm

[3] This is defined as the standard deviation of year-to-year growth in earnings before interest, taxes, and depreciation divided by total assets (COMPUSTAT Data Item 13/Data Item 6) for all sample firm-years within a 3-digit SIC industry.

size as a proxy for credit risk. Queen and Roll (1987) find that larger firms are much more likely to survive in the long run than smaller firms.

### B. Agency Costs of Debt

The agency costs of debt may also influence corporate debt maturity. Myers (1977) argues that short-term debt reduces the potential for underinvestment caused by debt overhang because lenders and borrowers recontract before growth options are exercised. In the same vein, Barnea, Haugen, and Senbet (1980) take the position that short-term debt reduces the incentive for risky asset substitution because short-term bond prices are relatively insensitive to shifts in risk of the underlying assets. This view of debt maturity, called the agency cost or contracting cost perspective, suggests that firms whose value derives to a large extent from investment opportunities that are particularly sensitive to the degree of management effort and talent (e.g., creation and exploitation of risky growth opportunities as opposed to harvesting assets-in-place) have an incentive to borrow short-term.[4] In contrast, the liquidity risk hypothesis predicts that firms with risky growth opportunities have an incentive to finance themselves with long-term debt to avoid the threat of inefficient liquidation. Empirically, we measure the extent of management discretion over a firm's investment policy with the market-to-book ratio of a firm's assets, a regulated utility dummy, and the R&D to sales ratio. Firms with higher R&D spending are more likely to grow by introducing new products in the future.[5] Similarly, firms with high market-to-book ratios are likely to have good growth opportunities in the sense that expected future cash flows are large relative to past capital expenditures (Smith and Watts (1992)). We employ the utility dummy because managers of these firms have considerably less discretion in their choice of investment opportunities due to regulatory constraints.

Asset maturity (i.e., the time pattern of cash flows generated from a firm's assets) also plays an important role in agency theories of debt maturity. Myers (1977) argues that firms schedule debt repayments to match the decline in value of assets in place as a way to lower the agency costs of debt. Thus, firms with more long-term assets in place can support more long-term debt. Maturity matching allows firms to extend debt maturity without significantly increasing the agency costs of debt.[6] For our empirical tests, we define asset maturity as (gross PP&E/Assets) multiplied by (gross PP&E/Depreciation) where PP&E

[4] Another view, not tested here, is that debt maturity choice can reduce agency conflict between managers and equityholders. Long-term debt is almost always junior to short-term debt. Hart and Moore (1995) show that a firm can select an optimal amount of junior and senior debt to offset management's incentive to invest in unprofitable projects.

[5] The liquidity risk perspective, in contrast, argues that firms with long-term projects requiring on-going managerial discretion prefer to buy insurance against liquidity risk in the form of long-term debt. This perspective suggests a positive association between debt maturity and R&D expense, especially given that R&D-intensive firms appear to lose disproportionate value in financial distress (Opler and Titman (1994)).

[6] Using similar logic, Diamond (1991a) argues that liquidity risk is reduced by financing long-term assets with long-term debt.

stands for property, plant, and equipment and the depreciation charge is from the most recent year before a debt issue.[7] The intuition underlying this measure is that longer maturity assets will be depreciated at a slower rate. This measure is very crude, given that allowable depreciation lives are determined by the tax authorities. While these lives should correspond to actual economic lifetimes of plant and equipment, the connection may be noisy. In addition, assets that are not on the books, such as human capital, are ignored by this measure.

Our measures of firm size and business risk also allow us to test the agency cost theory of debt maturity. Because smaller firms with higher business risk are also more likely to experience ratings downgrades they are also more subject to the agency costs of debt. Thus, the agency cost perspective suggests that borrowers in riskier businesses have an incentive to lower agency costs by shortening maturity.

### *C. Tax Benefits*

The tax implications of the debt maturity choice have been explored in a series of theoretical articles. Mauer and Lewellen (1987), Emery, Lewellen, and Mauer (1988) and Brick and Palmon (1992) emphasize the *tax-timing option* in long-term debt contracts resulting from the opportunity to mark debt to market by repurchasing and reissuing it. With a convex corporate tax function, an increase in interest rate volatility reduces the present value of the debt tax shields from short-term financing, while the present value of tax shields from long-term financing remain unchanged. Thus long-term debt is attractive when interest rates are volatile and the firm expects a stream of taxable earnings.[8] We test this prediction using the standard deviation of monthly 20-year Treasury bond returns over the past 3 months as a proxy for interest rate volatility.[9]

Brick and Ravid (1985) show how different time patterns of interest payments affect the combined taxes paid by borrowers and lenders. They argue that borrowers seek to accelerate interest payments to maximize the present value of interest tax shields, while lenders seek to slow down interest payments to minimize the present value of their tax liabilities. The upshot is that a maturity strategy that accelerates interest payments is more costly to the borrower, on a before-tax basis, than a maturity strategy that slows down

[7] This measure implicitly assumes that other balance sheet items have a zero maturity. Thus, we also defined asset maturity as (Inventory/Assets) (Average days in inventory) + (Receivables/Assets) (Average days receivables in inventory) + (Net PP&E/Assets) (Net PP&E/Depreciation). Our results did not change when we used this measure.

[8] Lewis (1990) shows that conclusions regarding the sensitivity of debt maturity choice to a firm's tax position are not robust to changing assumptions of models in this area. In a general setting, he argues that taxes are irrelevant to maturity choice.

[9] As argued by Titman (1992), interest rate volatility also influences the liquidity risk of short-term debt. A high default-free interest rate at the refinancing date distorts managerial preferences toward high-risk projects and may result in an inefficient investment and liquidation policy.

interest payments, since a premium has to be paid to lenders to induce them to accept a larger tax bill. One implication of the Brick and Ravid model is that borrowers prefer long-term debt when the term structure of interest rates is upward sloping because the present value of interest tax shields is highest then. The Brick and Ravid model also implies that borrowers will only extend the maturity of their borrowings in an upward sloping term structure environment when the benefits of debt tax shields are significant—that is when the firm expects unshielded income. Thus, we hypothesize that debt maturity is positively related to the marginal tax rate of issuers. We proxy for the expected effective marginal tax rate with the ratio of taxes paid to assets and the ratio of tax loss carryforwards to sales.[10] We test the hypothesis that firms with positive expected taxes will issue longer-term debt when the term structure is positive by interacting the ratio of income taxes paid to assets with a dummy variable that indicates whether the term premium is above its sample median (2.5 percentage points).[11,12]

### *D. Asymmetric Information*

Another class of models studies debt maturity decisions when borrowers have private information about their credit quality (see Flannery (1986), Robbins and Schatzberg (1986), Kale and Noe (1990), and Diamond (1993)). These models can be categorized as either adverse selection or signalling models depending on whether a separating equilibrium is possible. In *signalling* models, investors infer private information held by borrowers from the debt maturity choice. Because short-term debt is less sensitive to underpricing, firms that have underpriced liabilities choose to issue debt of a shorter term to maturity (and vice-versa for firms with overpriced liabilities).[13]

In *adverse selection* models, private information is not revealed, and maturity is chosen to minimize the effect of private information on financing costs. The key insight of adverse selection models is that asymmetric information induces a bias toward short-term debt. This bias arises because borrowers with favorable inside information avoid locking in their financing costs with long-

[10] In unreported regressions, we also examined the relation between debt maturity and investment tax credits/assets, depreciation/assets, and deferred taxes/assets (measures of expected debt and non-debt tax shields). The results of these regressions do not change our conclusions about the relative importance of tax explanations of debt maturity choice.

[11] As a practical matter, the term premium is almost always positive in our sample. There is only one month in our sample period when the term premium is negative. Thus, our tests focus on whether the maturity of new debt issues is influenced by the *steepness* of the yield curve.

[12] The Brick and Ravid model does not imply that the term premium is systematically related to the maturity of new issues for nontaxpaying firms. There may be other reasons, of course, why the term premium may influence the maturity of new debt. For example, in the presence of a high term premium, low rated firms may prefer to finance with short-term debt to avoid the asset-substitution/screening problem of Stiglitz and Weiss (1981), which is most severe in high interest rate environments.

[13] The results of these models may be sensitive to the set of available financing opportunities. A firm that has underpriced liabilities might not want to issue debt at all or might, instead, choose to collateralize an issue or use project financing.

term debt, since they expect to be able to borrow under more favorable terms later.[14]

We test signalling models by observing whether the maturity of debt issues predicts unexpected changes in future firm performance. For instance, the Flannery (1986) model would suggest that firms which issue short-term debt are more likely to experience positive stock returns at issue announcement, subsequent bond rating upgrades, and unexpected increases in earnings.[15,16]

We test adverse selection models by relating the term-to-maturity of new debt issues to firm size because the market typically possesses more information about larger firms. We also test the class of adverse selection models of maturity choice using past stock returns as a predictor of debt maturity. Lucas and McDonald (1990) argue that firms will usually wait to issue securities if they expect an increase in their share price because of good news, but will not wait until bad news is released. Consequently, one would usually expect a stock price runup prior to the issue of an informationally disadvantaged security like equity or long-term debt.

## II. Empirical Implementation

### *A. The Empirical Approach*

In the previous section we reviewed theories which suggest that taxation, agency costs, liquidity risk, screening, and signalling are important determinants of corporate debt maturity. We test these theories by investigating whether the maturity of new corporate debt issues can be explained by proxies for theoretically important firm characteristics. The main empirical predictions and predicted signs on proxy variables discussed in the last section are summarized in Table I.

In reality, the term to maturity of debt is chosen not in isolation but along with a variety of other debt features including sinking funds, call provisions, and conversion rights. A general framework for analyzing debt maturity would relate theories of capital structure choice (e.g., agency costs of debt) to joint configurations of debt attributes such as term to maturity, amount of collat-

[14] Goswami, Noe, and Rebello (1995) note that the bias toward short-term debt financing may be reversed if information asymmetry concerns long-term cash flows. They show that maturity choice depends on rollover risk, on whether dividend payments are restricted, and on the dates at which informational asymmetry is highest.

[15] We also test for a relation between maturity and future stock returns. In an efficient market one would expect that signals in maturity would be immediately incorporated into the stock price. In practice, this may not be the case when the market has not fully learned to interpret signals. For example, Loughran and Ritter (1995) find that firms which issue equity experience prolonged share price declines as the market adjusts to poor subsequent earnings. This evidence is consistent with the view that information is conveyed by equity issues but not immediately incorporated into the market price.

[16] We explore other measures for the extent of informational asymmetry including the dispersion of one year ahead International Brokers Estimate System (IBES) analyst earnings forecasts. There is no empirical relation between this variable and the maturity of debt issues in our sample.

**Table I**

## Summary of Empirical Predictions and Proxy Variables Used

This table shows the empirical predictions of the major theories tested in the paper and proxy variables used to test the predictions. Asset maturity is measured as (Gross Property, Plant, and Equipment (PPE)/Depreciation). The market-to-book ratio is the ratio of the book value of assets minus the book value of equity plus the market value of equity divided by total assets. The stock return in the year before issue is measured from one year before until the end of the firm's last pre-issue year. The stock return in the year after issue is measured from the end of the issue year over the next 12 months. Business risk is industry earnings variability, which is measured as the standard deviation of growth in earnings before income taxes, and depreciation/assets by 3-digit Standard Industrial Classification (SIC) industry. The term premium is the difference between the yield on T-bonds with a yield of 10 years or more minus the yield on 30-day T-bills. Interest rate volatility is the standard deviation of monthly 20-year Treasury bond returns over a 3-month pre-issue period.

| Variable | Liquidity Risk | Underinvestment | Screening/ Asset Substitution | Taxes | Signaling |
|---|---|---|---|---|---|
| Asset Maturity | Positive | Positive | | | |
| Bond Rating | Negative | | Positive | | |
| Business Risk | Positive | | | | |
| Firm Size | Negative | Positive | Positive | | |
| Market-to-book | Positive | Negative | | Positive | |
| R&D/Sales | Positive | Negative | | | |
| Utility Industry Dummy | Negative | Positive | Positive | | |
| Return Before Issue | | | | | Positive |
| Return After Issue | | | | | Negative |
| Net Operating Loss Carryforwards/Sales | | | | Negative | |
| Taxes Paid/Assets | | | | Positive | |
| Term Premium | | | Negative | | |
| Taxes/Assets × Term Premium | | | | Positive | |
| Interest Rate Volatility | Positive | | | Positive | |
| Taxes/Assets × Rate Volatility | | | | Positive | |

eral, call and sinking fund features. Our empirical approach can be extended to incorporate a variety of these choices using either a structural model or a modified duration measure. In a later section, we investigate whether our main results change if we adjust for the presence of call provisions and sinking funds (similar to Mitchell (1991)).

Our results are also potentially sensitive to selection biases created by the sampling procedure. Specifically, the sample contains neither private debt issues, which are typically of short maturity nor equity issues, which theoretically have an infinite maturity. Thus, we also use a Heckman (1979) selection model to investigate whether our results are biased by omission of these issue types.

*B. The Data*

We use a database of 10,287 corporate debt issues compiled by the Capital Markets Division of the Board of Governors of the Federal Reserve Board.[17] Issues in this database were excluded if they were made by financial firms, were made by financial subsidiaries of nonfinancial firms (e.g., GMAC) or could not be matched with COMPUSTAT data. These restrictions result in a total of 7,369 issues to be used in our empirical analyses.[18] Issues in the database took place between late 1982 and early 1993 and were identified by Federal Reserve staffers who monitored *Bloomberg Business News,* the *Wall Street Journal, Moody's Bond Survey, S&P Credit Week, Investment Dealers Digest,* and the *International Financing Review.* Data items include the maturity date of new issues when available, issue date, type of issue, issue features, and issue amount. The database includes many nonregistered issues made in the Euro-Markets and has excellent coverage of the medium-term note (MTN) market. Firms do not normally report the maturity of medium-term notes, but given that these issues are an increasingly large part of the corporate debt market we imputed an average maturity of four years based on conversations with several participants in this market. Maturities on MTNs are normally clustered in the two- to seven-year range.

Our dataset does not cover some important parts of the credit market such as domestic and Euro-commercial paper, asset-backed receivables financing, private placements, and bank debt. This may bias our conclusions because many of these issues have short term to maturity. In a later section, we investigate whether omission of these issues is likely to have significantly biased our conclusions. In addition, we do not know if issues were swapped out in a way which significantly changed the maturity structure of a firm's liabilities.[19]

We measure firm characteristics using the COMPUSTAT II Industrial Primary, Secondary, and Tertiary (PST), Full Coverage and Research tapes. Debt issues were matched with COMPUSTAT data by fiscal year so that *ex-ante* characteristics are used to predict maturity of future debt issues.

Table II shows the number of debt issues and maturity information by year. The heaviest issue volume in our sample took place between 1990 and 1992, when interest rates were relatively low. An important fact about the sample appears in the last column of Table II. The mean term to maturity of debt issues was highest in the early 1980s, when the medium-term note market was still emerging. Even after excluding medium-term notes and Euro-notes, how-

[17] This dataset is in the public domain and may be obtained on the World Wide Web at http://www.cob.ohio-state.edu/dept/fin/osudata.htm.

[18] The number of observations shown in the regressions is smaller because of missing values for some of the independent variables on COMPUSTAT.

[19] Conversations with several market participants indicate that swaps which alter the maturity of promised interest payments are relatively rare and were only seen in any quantity toward the end of our sample period. Because our main results are robust across time subperiods in our sample, we doubt that failure to account for swaps has affected our results.

**Table II**

**Time Distribution of Debt Issues**

The sample contains 7,369 debt issues by U.S.-based corporations taking place between 1982 and 1993. The mean term to maturity without Medium-term notes (MTNs) Euronotes excludes all Euro-issues and Medium-term notes.

| Year | Number of Issues | Mean Term to Maturity (All Issues) | Mean Term to Maturity (Without MTNs/Euronotes) |
|---|---|---|---|
| 1982 | 158 | 17 | 20 |
| 1983 | 320 | 15 | 18 |
| 1984 | 485 | 15 | 17 |
| 1985 | 835 | 16 | 18 |
| 1986 | 724 | 14 | 17 |
| 1987 | 580 | 12 | 15 |
| 1988 | 564 | 11 | 16 |
| 1989 | 688 | 10 | 16 |
| 1990 | 889 | 10 | 16 |
| 1991 | 1,136 | 10 | 14 |
| 1992 | 868 | 12 | 15 |
| 1993 | 122 | 10 | 13 |
| 1982–93 | 7,369 | 12 | 16 |

ever, we find that average maturities were longer in the early 1980s. This may partly reflect aggregate substitution away from bank borrowing toward the public bond market.

Table III describes key features of the sample issues and firms. The mean term is 12.2 years to maturity. The mean Macaulay duration (unadjusted for calls and sinking funds) is 7 years. The mean asset maturity estimated using the method described above is 8.2 years. The average issuer in the sample is relatively large, with sales revenue of $9.6 billion (median of $3.7 billion). The mean market-to-book ratio of assets is 1.4, which is close to the average for all firms in COMPUSTAT.

## III. Results

We present the results of our empirical tests in three steps. First, we establish several stylized facts about maturity and issuer type by describing the sample. Second, we estimate Ordinary Least Squares (OLS) models and multinomial logit models of debt maturity choice to test existing theories of debt maturity.[20] Third, we analyze the sensitivity of the results by estimating a structural model of debt maturity choice which adjusts for selection bias due to omission of private debt issues and equity issues. We also estimate a model of effective debt duration which allows us to test whether the main results

[20] As in MacKie-Mason (1990a), these models can be justified using the weak revealed preference restriction that, conditional on borrowing from the public, firms will select the package of debt attributes that contributes most to their value.

**Table III**

**Description of Debt Issuers**

The sample contains 7,369 debt issues by U.S.-based corporations taking place between 1982 and 1993. Asset maturity is measured as (Gross Property, Plant, and Equipment (PPE)/Depreciation). Duration is the Macaulay duration (not adjusted for embedded options and sinking funds). The market-to-book ratio is the ratio of the book value of assets minus the book value of equity plus the market value of equity divided by total assets. The stock return in the year prior to issue is measured from one year before until the end of the firm's last pre-issue year. Industry earnings variability is measured as the standard deviation of growth in earnings before income, taxes and depreciation/assets by 3-digit Standard Industrial Classification (SIC) industry. Interest rate volatility is the standard deviation of monthly 20-year Treasury bond returns over a 3-month pre-issue period.

| Variable | Mean | First Quartile | Median | Third Quartile |
|---|---|---|---|---|
| Term to maturity (years) | 12.2 | 4 | 10 | 16 |
| Duration | 7 | 5 | 7 | 9 |
| Sales revenue ($ billions) | 8.95 | 0.83 | 3.11 | 9.26 |
| Asset maturity (years) | 8.2 | 2.3 | 5.4 | 11.7 |
| Income taxes/assets (%) | 2.7 | 1.1 | 2.3 | 3.9 |
| R&D/sales (%) | 1.3 | 0 | 0 | 0.82 |
| Net operating losses/sales (%) | 2.13 | 0 | 0 | 0 |
| Market-to-Book ratio | 1.40 | 1.07 | 1.21 | 1.49 |
| Stock return in year prior to issue | 9.8% | −14.3% | 8.2% | 26.9% |
| Stock return in 2 years after issue | 18.5% | −31.6% | −0.7% | 28.0% |
| Industry earnings variability | 0.178 | 0.031 | 0.066 | 0.165 |
| Interest rate volatility | 0.087 | 0.026 | 0.052 | 0.118 |
| Term premium (% points) | 2.38 | 1.55 | 2.53 | 3.21 |

would change after accounting for the presence of sinking fund provisions and call provisions.

### *A. Key Stylized Facts*

Panel A of Table IV shows a cross-tabulation of debt maturity by issue rating from Standard and Poors.[21] Firms with speculative grade ratings (below BBB) very rarely issue short-term notes to the public (maturity less than 5 years). The preponderance of speculative grade issues have a term to maturity of 5 to 29 years. Very short-term issues (which include medium-term notes and Euronotes) are issued disproportionately by firms with investment grade ratings. For example, one-sixth of the issues in the sample are made by firms with single-A ratings and a maturity of less than 5 years. A and AA rated issuers also participate heavily at the long end of the maturity spectrum (term to maturity of 30 years or more) but issue very little in between (15 to 29 year debt). This stylized fact is consistent with the view that lower quality issuers

[21] In some cases, Standard & Poor did not rate an issue, while Moody's did. We then substituted the equivalent Moody's rating for the purpose of producing this table. This process is imperfect because Moody's ratings are usually stricter than those of Standard & Poor.

**Table IV**

## Distribution of Debt Issues by Maturity and Issue Type Across Bond Ratings

This table shows the distribution of debt issues in a sample of 7,369 debt issues by Standard and Poor's bond rating and term and by issue type and rating. Medium-term notes are assumed to have a term of four years.

Panel A: Term to Maturity in Years by Bond Rating

| Term to Maturity | Unrated | CCC | B | BB | BBB | A | AA | AAA | Total |
|---|---|---|---|---|---|---|---|---|---|
| 0–4 years | 32 | 0 | 7 | 25 | 507 | 1124 | 427 | 105 | 2227 |
| 5–9 years | 23 | 5 | 129 | 71 | 194 | 376 | 236 | 80 | 1114 |
| 10–14 years | 64 | 28 | 385 | 129 | 299 | 478 | 220 | 47 | 1650 |
| 15–19 years | 51 | 6 | 122 | 39 | 57 | 124 | 48 | 3 | 450 |
| 20–24 years | 45 | 8 | 95 | 35 | 67 | 88 | 31 | 4 | 373 |
| 25–29 years | 42 | 6 | 111 | 73 | 72 | 65 | 8 | 1 | 378 |
| 30–100 years | 0 | 0 | 1 | 4 | 208 | 395 | 249 | 25 | 882 |
| Mean Term to Maturity | 14 | 15 | 14 | 13 | 13 | 12 | 13 | 10 | |

Panel B: Issue Type by Bond Rating

| Issue Type | Unrated | CCC | B | BB | BBB | A | AA | AAA | Mean Term to Maturity |
|---|---|---|---|---|---|---|---|---|---|
| Foreign notes/bonds | 1 | 0 | 0 | 0 | 0 | 6 | 11 | 4 | 3 |
| Euronotes/bonds | 8 | 0 | 2 | 7 | 21 | 151 | 191 | 79 | 8 |
| Medium-term notes | 26 | 0 | 1 | 23 | 477 | 964 | 313 | 40 | 4 |
| Straight debt | 49 | 18 | 362 | 153 | 531 | 890 | 386 | 98 | 15 |
| Warrant bonds | 9 | 2 | 23 | 4 | 2 | 4 | 8 | 3 | 11 |
| Equipment bonds | 4 | 0 | 10 | 3 | 33 | 162 | 104 | 38 | 11 |
| Mortgage bonds | 3 | 0 | 7 | 11 | 187 | 284 | 180 | 1 | 21 |
| LYONS | 0 | 0 | 9 | 9 | 13 | 8 | 2 | 0 | 18 |
| Convertibles | 127 | 21 | 266 | 127 | 76 | 56 | 7 | 3 | 18 |

avoid the short end of the maturity spectrum in order to avoid liquidity risk, but cannot issue long-term because the market screens them out. It is also likely that lower quality borrowers obtain shorter-term financing, mainly from banks and other private sources (Diamond (1991b)). Alternatively, buyers may require too high a premium on short-term speculative grade bonds because they have little time over which to amortize the substantial fixed costs of researching the issuer's credit quality.

Some of the variability in the term to maturity of issues across the quality spectrum may be attributable to the types of issues made by different firms and the ability of firms of different quality to access certain parts of the market. Panel B of Table IV shows the breakdown of issue type by bond rating. Most issues in the sample are plain vanilla notes, or bonds that do not have attached options (other than calls) and are not collateralized by specific assets. Warrant bonds are issued fairly rarely and mainly by firms with single-B ratings. Equipment bonds and mortgage bonds were issued most frequently by

investment grade firms and are a significant part of the market. Liquid Yield Option Notes (LYONS) were issued infrequently and most often by BB firms. Speculative grade firms very often elected to issue convertible bonds. Our sample contains approximately 650 convertible issues. Few highly rated issues were convertibles. Because speculative grade firms that issue convertibles usually select a longer term to maturity than when issuing straight debt, we segment our tests by debt type to see if the results are sensitive to excluding convertibles, LYONS, and warrant bonds. Eurobonds and Euronotes are also well represented in the sample and are mainly issued by firms with strong ratings (single-A or better). The Euromarkets are clearly open to larger firms with good ratings that are likely to be well-recognized by foreign investors. Finally, medium-term notes are a large part of the sample and are issued primarily by firms with BBB, A, and AA ratings. AAA rated firms in our sample usually resort to the Euronote market rather than the domestic medium-term note market. There have been periods in the past when high quality firms have been able to get cheaper financing in the Euromarkets because of clientele effects (Kim and Stulz (1988)). This appears to have been true for the very highest quality firms in our sample.

Thus far, several key stylized facts emerge from the data: 1) investment grade firms tend to issue very long-term debt and very short-term debt; 2) speculative grade firms are more likely to issue intermediate-term debt; 3) convertibles are an important form of financing for speculative grade firms; and 4) investment grade firms access short-term debt through the Euromarkets and the Medium-term Note market.

### *B. Univariate Analysis of Determinants of Maturity of New Issues*

Several of the stylized facts documented in Table IV are confirmed in Table V, which shows how issuer characteristics vary over the maturity spectrum (for all issue types and for straight debt only). Large firms primarily dominate issuance at the long end of the spectrum (term of more than 29 years) and at the short end of the maturity spectrum (0–9 years). Firms at the long end of the spectrum are also much more likely to have investment grade ratings. Fully 99 percent of debt issues with a term to maturity of 30 years or more are made by investment grade firms. Investment grade firms also issue most of the short-term debt in our sample. A Kruskal-Wallis test of the hypothesis that the investment grade dummy is distributed uniformly over the four maturity groups shown in the table is rejected at the one percent confidence level. This indicates that the observed difference in the fraction of investment grade firms across maturity bands is highly unlikely to be due to chance.

Firm size is a measure of liquidity risk and the potential for informational asymmetry. We find that the log of issuer sales displays a U-shaped pattern, very much like that observed with the investment grade dummy. Smaller firms issue in the middle of the maturity spectrum, while larger firms issue at both extremes of the spectrum.

**Table V**

## Characteristics of Issuers Stratified by Debt Maturity

Sample means of issuer characteristic measures stratified by debt maturity. Straight debt issues include straight bonds and notes, equipment bonds, and mortgage bonds. The Kruskal-Wallis *p*-value gives the significance of a test of whether a measure is not distributed identically across maturity bands.

| Variable | Term to Maturity in Years | | | | Kruskal-Wallis *p*-Value |
|---|---|---|---|---|---|
| | 1–9 | 10–19 | 20–29 | 30+ | |
| Asset maturity (years) | | | | | |
| Straight debt only | 8.8 | 8.5 | 8.5 | 13.0 | 0.0001 |
| All debt issues | 7.7 | 7.6 | 6.0 | 12.9 | 0.0001 |
| Investment grade dummy | | | | | |
| Straight debt only | 81.6% | 65.6% | 78.6% | 99.4% | 0.0001 |
| All debt issues | 86.5% | 57.9% | 44.4% | 99.3% | 0.0001 |
| Market-to-book ratio | | | | | |
| Straight debt only | 1.41 | 1.32 | 1.28 | 1.26 | 0.0001 |
| All debt issues | 1.41 | 1.41 | 1.50 | 1.26 | 0.0001 |
| Log of sales revenue in millions | | | | | |
| Straight debt only | 8.0 | 7.4 | 7.8 | 8.0 | 0.0001 |
| All debt issues | 8.2 | 7.2 | 6.6 | 8.0 | 0.0001 |
| R&D/Sales (%) | | | | | |
| Straight debt only | 0.97% | 0.72% | 0.61% | 0.77% | 0.0004 |
| All debt issues | 1.29% | 1.26% | 2.1% | 0.77% | 0.0001 |
| Standard deviation of ROA growth | | | | | |
| Straight debt only | 0.152 | 0.162 | 0.141 | 0.088 | 0.0001 |
| All debt issues | 0.177 | 0.194 | 0.241 | 0.091 | 0.0001 |
| Utility industry dummy | | | | | |
| Straight debt only | 17.5% | 17.9% | 21.7% | 42.7% | 0.0001 |
| All debt issues | 16.7% | 14.5% | 10.7% | 42.2% | 0.0001 |
| Net operating loss CF/Sales | | | | | |
| Straight debt only | 1.72% | 1.94% | 1.21% | 0.17% | 0.0035 |
| All debt issues | 1.17% | 3.48% | 4.98% | 1.71% | 0.0001 |
| Taxes paid/Assets | | | | | |
| Straight debt only | 2.53% | 2.15% | 2.22% | 2.94% | 0.0001 |
| All debt issues | 2.75% | 2.33% | 2.73% | 2.95% | 0.0001 |
| Stock return in two years following debt issue | | | | | |
| Straight debt only | 4.5% | 3.3% | −1.6% | 2.4% | 0.029 |
| All debt issues | 3.6% | 3.2% | −2.7% | 2.2% | 0.0001 |
| Stock return before issue year | | | | | |
| Straight debt only | 3.4% | 5.7% | 4.4% | 3.3% | 0.050 |
| All debt issues | 1.9% | 11.0% | 8.1% | 3.2% | 0.0001 |
| Term premium (% points) | | | | | |
| Straight debt only | 2.57% | 2.53% | 2.51% | 2.43% | 0.056 |
| All debt issues | 2.29% | 2.51% | 2.37% | 2.43% | 0.0001 |
| Sample size for straight debt | 1,126 | 1,629 | 304 | 871 | 3,930 |
| Sample size for all debt issues | 3,525 | 2,205 | 756 | 883 | 7,369 |

Interestingly, the mean of our estimate of asset maturity does not appear to vary much between firms that issue short term (term of 1 to 9 years) and firms that issue up to 29 years. However, firms that issue for more than 30 years

have assets with appreciably longer lives. Theories that predict that firms will match the maturity of assets and liabilities appear to be only partly correct.

The standard deviation of industry operating income/asset growth varies considerably across the maturity spectrum. Long-term issuers (30 years or more) are in industries that are considerably less risky than firms in the 20–29 year bracket. Among our sample of all debt issues, industry risk increases with maturity up to the 30 year point. This is consistent with firms lengthening maturity to avoid rollover risk. It is also likely that this reflects the higher business risk faced by firms issuing nonstraight debt. In our sample, firms issuing convertibles and LYONs were in industries with a standard deviation of growth of operating income/assets that was double that of industries of straight debt issuers.

The hypothesis that firms with high expected tax bills will issue long-term is partly supported by the data (at least for straight debt issuers). Firms that issue long-term are less likely to have net operating loss carryforwards on the books. Issuers of debt with a maturity of 30 years or more also tend to pay more taxes than other issuers, on average. It is difficult to tell whether these results support tax stories of debt maturity issue choice because firms with net operating loss carryforwards (NOLs) and low taxes have lower cash flows by definition, and may be screened out of the long bond market for reasons discussed earlier.

There does not appear to be substantial variation by maturity in pre-issue and post-issue stock returns. Compared to results found for equity issuers in Loughran and Ritter (1995), it appears difficult to argue that the debt maturity choice is primarily driven by exploitation of information asymmetry or by signalling.

### *C. Multivariate Regression Results*

In an effort to simultaneously control for the multiple effects that we hypothesize determine debt maturity choice, we present multivariate regressions predicting the log term to maturity in Table VI. The first two regressions in the table are for straight debt issues only (plain vanilla debentures, senior notes, mortgage bonds, and equipment bonds). The second two regressions include all issue types. We expect that the independent variables will have more power to explain maturity choice in the regression including all debt issues because maturity is likely to covary with factors that determine whether a firm is likely to issue a convertible, Eurobond, warrant bond, etc. The sample of straight debt issues is considerably smaller but offers a pure test of the determinants of maturity choice. The second and fourth regressions in Table VI include stock return data that are unavailable for some issues in the sample. These regressions all include year dummies in order to remove secular effects among the independent variables (e.g., the common component of stock returns). Coefficients on the year dummies are not reported.

Several important regularities emerge from the regression estimates in Table VI. First, asset maturity is positively related to the maturity of new debt

**Table VI**

## Regression Models Predicting Term to Maturity of Debt Issues

Ordinary Least Squares (OLS) regressions predicting the logarithm of the term to maturity of 6,348 corporate debt issues taking place between 1983 and 1993. Regressions for straight debt only exclude convertibles, Liquid Yield Option Notes (LYONS), medium-term notes, equipment bonds, mortgage bonds, and warrant bonds. Coefficients on year dummies are not shown. *t*-statistics are in parentheses.

| Variable | Straight Debt Only | | All Debt Issues | |
|---|---|---|---|---|
| Constant | 2.90 | 3.11 | 2.84 | 2.88 |
| | (17.5) | (12.0) | (22.9) | (14.6) |
| Asset maturity | 0.050 | 0.0036 | 0.0062 | 0.0055 |
| | (2.63) | (1.74) | (3.86) | (3.17) |
| Investment grade dummy | 0.133 | 0.125 | −0.226 | −0.240 |
| | (3.49) | (2.78) | (−8.65) | (−8.23) |
| Market-to-book | −0.054 | −0.068 | −0.023 | −0.025 |
| | (−2.64) | (−2.73) | (−1.68) | (−1.59) |
| Log of sales revenue | −0.016 | −0.017 | −0.036 | −0.033 |
| | (−1.64) | (−1.55) | (−5.74) | (−4.72) |
| R&D/Sales | 0.449 | 0.569 | 0.448 | 0.412 |
| | (0.94) | (1.09) | (1.91) | (1.51) |
| Industry standard deviation of ROA growth | −0.056 | −0.093 | −0.070 | −0.098 |
| | (−1.39) | (−1.80) | (−2.85) | (−3.44) |
| Utility industry dummy | 0.179 | 0.203 | 0.166 | 0.194 |
| | (4.34) | (4.50) | (4.90) | (5.32) |
| Stock return 1-year before issue | | 0.049 | | 0.086 |
| | | (1.02) | | (2.88) |
| Stock return 2-years after issue | | −0.052 | | −0.018 |
| | | (−1.43) | | (−0.67) |
| Net operating loss carryforwards/Sales | −0.095 | −0.082 | −0.078 | −0.062 |
| | (−1.26) | (−0.84) | (−1.51) | (−0.99) |
| Income taxes paid/Assets | 0.668 | 0.921 | −0.334 | −0.117 |
| | (0.94) | (1.19) | (−0.63) | (−0.20) |
| Term premium | −0.117 | −0.132 | −0.083 | −0.071 |
| | (−3.71) | (−3.58) | (−3.48) | (−2.61) |
| Taxes/Assets when term premium >2.5% | −0.954 | −0.699 | −0.759 | −0.646 |
| | (−1.15) | (−0.76) | (−1.25) | (−0.97) |
| Interest rate volatility | 0.057 | 0.229 | 0.196 | 0.369 |
| | (0.36) | (1.14) | (1.63) | (2.47) |
| Taxes/Assets when rate volatility >0.08 | −0.034 | −0.308 | 0.733 | 0.455 |
| | (−0.04) | (−0.35) | (1.28) | (0.72) |
| Number of observations | 3,239 | 2,780 | 6,348 | 5,571 |
| Adjusted $R^2$ | 0.068 | 0.062 | 0.150 | 0.147 |

issues. As noted before, credit quality is a key determinant of the maturity of new debt issues. In the regression predicting straight debt issues, we find that investment grade firms are more likely to issue long-term. The opposite is true, on average, in the regression including all issue types. The rationale for this is apparent in Table V, which shows the greatest preponderance of speculative grade issues in the 20–29 year range (these are usually convertibles with a much shorter effective duration).

Firms with stronger growth opportunities, as measured by the market-to-book ratio, tend to issue debt of shorter maturity. This effect is statistically and economically significant and is consistent with Myers' (1977) argument that growing firms can solve the underinvestment problem by issuing debt that expires before growth options are to be exercised. This is also consistent with Barclay and Smith (1995) who find that firms which have more short-term debt also have higher market-to-book ratios. On the other hand, we do not find that firms with higher R&D/sales ratios issue shorter-term debt. This result may reflect collinearity among the R&D/sales variable and other variables (particularly log of sales and the market-to-book ratio). Alternatively, it may be that R&D-intensive firms have a stronger incentive to issue long-term to avoid a costly refunding crisis because they face higher expected costs of financial distress.[22]

We also find that utilities, on average, issue relatively long-term debt. Because, on average, utilities have lower growth opportunities, this result is consistent with the Myers' (1977) view that firms with the potential for underinvestment problems should issue shorter-term debt. In our sample, utilities are heavy issuers of mortgage bonds.

The liquidity risk story suggests that firms with a higher probability of default will issue longer term debt. Our results show that larger firms tend to issue debt of shorter term-to-maturity on average. This effect is consistent with the liquidity risk explanation of debt maturity because larger firms are less likely to default. This result also differs from the findings of Morris (1991) and Barclay and Smith (1995) that the liabilities of larger firms have longer average term to maturity. The tendency of speculative grade firms to avoid issuing short-term is also consistent with the view that firms with higher default risk go long to avert the potential deadweight costs associated with a refunding crisis. On the other hand, we find that firms in industries with more volatile earnings tend to issue less long-term debt. This is inconsistent with the liquidity risk explanation of debt maturity choice, but may reflect collinearity among our measure of earnings volatility and other variables. For example, the Pearson correlation between earnings volatility and market-to-book is 0.17, and the correlation between earnings volatility and asset maturity is −0.18.

[22] Titman (1984) suggests that firms with more unique products are likely to be more subject to experience deadweight losses because of inefficient liquidation. Opler and Titman (1994) present results which suggest that this problem is most severe among firms with significant expenditures on research and development.

Asymmetric information models argue that firms use the maturity of new debt issues to signal their value and to exploit market mispricing. For example, overvalued firms would be most likely to issue longer term debt that is more price-sensitive to a misestimate of future cash flows. Another test of this idea uses past stock returns as predictors of debt maturity. One would usually expect a stock price runup prior to the issue of informationally disadvantaged securities (Lucas and McDonald (1990)). Our results, however, show no statistically significant association between the past stock price runup and the maturity of new debt issues. In addition, the stock return after debt issues does not depend on debt maturity. Signalling models imply that undervalued firms that signal their undervaluation by issuing short-term will experience positive abnormal stock return at the time of issue.

The tax hypothesis that long-term debt is more likely to be issued by firms with a higher expected marginal tax rate is not supported by the data. Firms with higher income tax bills relative to assets, if anything, issue more short-term debt. Moreover, the coefficient on net operating loss carryforwards/sales (influential in MacKie-Mason (1990a) relating nondebt tax shields to the debt-equity choice) is insignificant. Interactions of a tax variable with the term premium and interest rate volatility are statistically insignificant.[23]

An unexpected result is the negative and statistically significant association between the term premium and maturity. There are at least four possible explanations for this result: 1) firms have difficulty borrowing long-term in high interest rate environments because the required rate of return creates an incentive to shift to risky projects; 2) (irrational managers, rational market) managers think they can "ride the yield curve" by avoiding the long end of the maturity spectrum when the term premium is high; 3) (rational managers, irrational market) managers issue short-term debt when the term premium is high because the expectations hypothesis does not hold (see Campbell and Shiller (1991)); or 4) (rational managers, rational market) in a general equilibrium the firms in our sample may be inframarginal borrowers and gravitate toward the short end of the yield curve when it steepens. We do not have strong evidence in favor of any of these explanations.

### *D. Multinomial Logits*

One important problem with the linear regressions presented in Table VI is that the relation between debt maturity and some independent variables appears to be nonmonotonic. The univariate results in Table V suggest important monotonic effects in credit ratings and firm size.

We address this problem in Table VII, which presents multinomial logit regressions predicting whether an issue is in a maturity class of 1–9 years, 10–19 years, 20–29 years, or 30 years or more. These regressions (for straight issues and all issues) allow us to detect any important nonlinear effects while

[23] While not shown, a variable which predicts future expected taxes by forecasting the likelihood of solvency (Altman's Z-score) is interacted with the term premium and interest rate volatility. The coefficients on these interactions are statistically and economically small.

**Table VII**

## Multinomial Logit Regressions Predicting Maturity of Corporate Debt

Multinomial logit regressions predicting the logarithm of the term to maturity of 6,348 corporate debt issues taking place between 1982 and 1993. Regressions for straight debt only exclude convertibles, Liquid Yield Option Notes (LYONS) medium-term notes, equipment bonds, mortgage bonds and warrant bonds. Coefficients on year dummies are not shown. The coefficient baseline is for issues which have a maturity of 1–9 years. Coefficients on year dummies and the constants are not shown. Z-statistics are in parentheses.

| | Straight Debt Issues Only | | | All Debt Issues | | |
|---|---|---|---|---|---|---|
| Variable | 10–19 years | 20–29 years | 30+ years | 10–19 years | 20–29 years | 30+ years |
| Asset maturity | 0.0019 | −0.022 | 0.024 | 0.0089 | −0.018 | 0.039 |
| | (0.231) | (−1.69) | (2.76) | (1.48) | (−2.00) | (5.62) |
| Investment grade dummy | −0.330 | 0.053 | 3.22 | −1.06 | −1.32 | 2.66 |
| | (−2.40) | (0.24) | (6.83) | (−12.1) | (−10.9) | (6.33) |
| Market-to-book | −0.043 | −0.089 | −0.374 | −0.0098 | −0.050 | −0.167 |
| | (−0.50) | (−0.48) | (−2.68) | (−0.18) | (−0.74) | (−1.44) |
| Log of sales revenue | −0.203 | −0.124 | −0.045 | −0.169 | −0.316 | 0.036 |
| | (−5.55) | (−2.14) | (−0.99) | (−7.39) | (−10.1) | (0.96) |
| R&D/Sales | −0.657 | −11.4 | 0.941 | −0.246 | 1.41 | 1.69 |
| | (−0.36) | (−2.42) | (0.46) | (−0.27) | (1.31) | (0.93) |
| Industry standard deviation of ROA growth | −0.047 | −0.149 | −0.361 | −0.110 | −0.175 | −0.503 |
| | (−0.33) | (−0.63) | (−1.43) | (−1.29) | (−1.50) | (−2.33) |
| Utility industry dummy | −0.164 | 0.138 | 0.54 | 0.136 | 0.0022 | 0.731 |
| | (−1.01) | (0.55) | (3.05) | (−1.11) | (0.01) | (4.92) |
| Net operating loss carryforwards/Sales | −0.512 | −0.903 | −1.67 | −0.197 | −0.592 | −1.03 |
| | (−2.13) | (−1.07) | (−0.63) | (−1.06) | (−2.46) | (−0.44) |
| Income taxes paid/Assets | −4.53 | −8.37 | 6.54 | −5.02 | −2.94 | 3.84 |
| | (−1.58) | (−1.80) | (1.98) | (−2.45) | (−1.04) | (1.32) |
| Term premium | −0.169 | −0.364 | −0.344 | −0.141 | −0.434 | −0.305 |
| | (−1.68) | (−2.58) | (−3.10) | (−2.01) | (−4.75) | (−3.47) |
| Taxes/Assets when term premium >2.5% | −1.79 | −3.07 | −2.81 | −2.06 | −3.67 | −2.77 |
| | (−0.57) | (−0.61) | (−0.76) | (−0.94) | (−1.23) | (−0.90) |
| Interest rate volatility | 0.321 | −1.10 | 0.167 | 0.762 | −0.930 | 0.378 |
| | (0.52) | (−1.06) | (0.25) | (1.86) | (1.84) | (0.72) |
| Taxes/Assets when rate volatility >0.08 | 1.12 | 3.98 | 0.421 | 2.16 | 4.64 | 1.86 |
| | (0.37) | (0.83) | (0.12) | (1.01) | (1.63) | (0.65) |
| Observations/Log-likelihood | | 3,239/−3758 | | | 6,348/−6625 | |
| Pseudo $R^2$/Chi-square *p*-value | | 0.085/0.0001 | | | 0.14/0.0001 | |

simultaneously controlling for a variety of factors that are hypothesized to affect debt maturity. All coefficients reported in Table VII show differences relative to a baseline group of issues with a maturity of 1–9 years.

The results show that asset maturity is related to debt maturity in a nonlinear way. Firms issuing for 20–29 years have *lower* asset maturity (statistically significant at the 5 percent level) than those that issue for 1–9 years. On the other hand, firms which issue for 30 years or more have a considerably higher asset maturity than other firms; many utilities with long-lived plant and equipment are in this group. There is also an important nonlinear effect in credit quality. As noted earlier, firms that issue in the 10–29 year bracket have lower credit ratings than those that issue very short and very long. The size effect is also nonlinear. Firms issuing debt in the 10–29 year maturity bracket tend to be considerably smaller than other firms. There also appears to be a nonlinear effect in taxes/assets with high tax firms issuing short and very long (more than 30 years). Given the other nonlinear effects observed here, it appears likely that there is no tax effect *per se* in the data, but that more established, credit-worthy firms (which also happen to pay more taxes) tend to congregate at the short and long ends of the maturity spectrum.

### *E. Sensitivity Analysis*

One shortcoming of our analysis is that we exclude equity and private debt issues from our sample. To determine whether our main results are sensitive to omitting private debt issues and equity issues we estimate a Heckman (1979) selection model that includes adjustment terms for censoring. Specifically, we estimate probits predicting the debt/equity choice and the public/private debt choice using variables found to be statistically significant predictors of the public/private issue choice in MacKie-Mason (1990b).[24] These probits include a variety of variables that are significant predictors of these other capital structure choices, but are not in our debt maturity model for lack of theoretical justification.[25] The Inverse Mills Ratio from each of these probits is included in a second stage equation predicting the log term to maturity of issues in our sample. These additional terms control for selection bias.

The first column of Table VIII shows that the selection terms are statistically significant predictors of debt maturity choice. This indicates that the debt maturity choice is not independent of the debt/equity choice and the public/private debt choice. Nonetheless, most of our main results do not change after controlling for

[24] We identify private debt issues in a manner similar to that of MacKie-Mason (1990b). Specifically, we measure total debt issue from the statement of changes in cash flows. We then subtract the total amount of public debt issued using our dataset. The residual is considered private debt issued.

[25] These variables are a dummy for positive dividends, a measure of cash deficit, the market-to-book ratio, an industry risk measure, lagged one year stock return, NOL carryforwards/sales, R&D/sales, advertising/sales, percent of tangible assets, log of assets, and debt/assets at book. We include every variable that is statistically significant in MacKie-Mason (1990b). The market-to-book ratio is also added, given its importance in Smith and Watts (1992).

**Table VIII**

## Regression Models Adjusted for Omitted Debt Issues and Call and Sinking Fund Provisions

Ordinary Least Squares (OLS) regressions predicting the logarithm of the term to maturity of 5,334 corporate debt issues taking place between 1983 and 1993. Regressions adjusting for omission of bank loans and equity are based on a Heckman (1979) selection model that takes the form:

$$\text{Log of maturity} = \beta X + \Omega_1 M_d + \Omega_2 M_p + \epsilon$$

where $M_d$ is the Inverse Mills ratio estimated from a probit predicting the debt/equity choice for all firms on COMPUSTAT between 1983 and 1993; $M_p$ is the Inverse Mills ratio estimated from a probit predicting the public/private debt choice for all firms on COMPUSTAT between 1983 and 1993, and $\epsilon$ is a spherical error. Issues of debt and equity are identified when a firm issues securities for cash that exceed five percent of assets in a given year. Duration is measured as the Macaulay duration. Duration is adjusted for sinking funds by computing the midpoint of the maturity date and the beginning of sinking fund payments. Duration is adjusted for call provisions by computing the midpoint of the term to maturity and the term to call. Coefficients on year dummies are not shown. *t*-statistics are in parentheses.

| | Adjustment for Omission of Bank Loans and Equity | Adjustment for the Presence of Calls and Sinking Funds | |
|---|---|---|---|
| Variable | (Heckman Model) | Duration | Adjusted |
| Constant | 2.29 | 11.5 | 9.91 |
| | (6.44) | (18.9) | (18.2) |
| Asset maturity | 0.0042 | −0.0085 | −0.0072 |
| | (2.34) | (−1.11) | (−1.06) |
| Investment grade dummy | −0.209 | 0.213 | 0.428 |
| | (−6.74) | (1.75) | (3.94) |
| Market-to-book | −0.096 | −0.0074 | 0.030 |
| | (−4.53) | (−0.109) | (0.49) |
| Log of sales revenue | 0.039 | −0.313 | −0.215 |
| | (3.06) | (−10.2) | (−7.80) |
| R&D/Sales | 0.987 | 1.21 | 1.85 |
| | (3.48) | (1.16) | (1.98) |
| Utility industry dummy | 0.261 | 0.490 | 0.339 |
| | (6.81) | (2.96) | (2.29) |
| Net operating loss carryforwards/Sales | −0.161 | −0.623 | −0.579 |
| | (−2.51) | (−2.77) | (−2.89) |
| Industry standard deviation of ROA growth | −0.097 | −0.090 | −0.011 |
| | (−3.23) | (−0.74) | (−0.11) |
| Term premium | −0.051 | −0.610 | −0.446 |
| | (−1.82) | (−5.31) | (−4.35) |
| Taxes/Assets when term premium >2.5% | −0.842 | −5.41 | 5.65 |
| | (−1.22) | (−1.90) | (−2.22) |
| Interest rate volatility | 0.455 | 0.809 | 1.55 |
| | (2.84) | (1.12) | (3.21) |
| Taxes/Assets when rate volatility >0.08 | 0.242 | 1.97 | 1.77 |
| | (0.37) | (0.74) | (0.74) |

**Table VIII**—*continued*

| Variable | Adjustment for Omission of Bank Loans and Equity (Heckman Model) | Adjustment for the Presence of Calls and Sinking Funds | |
|---|---|---|---|
| | | Duration | Adjusted |
| Inverse Mills ratio for debt-equity choice | 1.97<br>(5.85) | | |
| Inverse Mills ratio for public-private debt choice | −0.924<br>(−6.38) | | |
| Observations | 5,088 | 4,721 | 4,721 |
| Adjusted-$R^2$ | 0.171 | 0.056 | 0.048 |

censoring of equity and private debt.[26] If anything, the asset maturity, credit quality, and market-to-book effects identified above are stronger.

The second two columns of Table VIII show OLS regressions that predict the Macaulay duration of promised debt payments rather than the term to maturity of new debt. This measure captures the timing and size of debt payments and is amenable to adjustment for other features of the debt contract, which may affect effective duration such as call and sinking fund provisions. The model in Column two predicts duration, but with no adjustment for call and sinking fund provisions. The model in Column three of Table VIII adjusts for call provisions, refunding restrictions, and sinking fund provisions.[27] Coefficient estimates differ little between the adjusted and unadjusted duration models. While most of our main results hold in the duration model, the coefficient estimates in the duration models sometimes differ substantially from those reported earlier in Table VI. The duration model, however, excludes observations for which we were unable to compute duration because coupon rates were unknown (e.g., medium-term notes).

## IV. Concluding Discussion

This study tests several leading models of corporate debt maturity choice by examining the determinants of the maturity of new debt issues made between

[26] In an unreported model, we also estimated a selection model for firms with commercial paper ratings. Including a term adjusting for exclusion of commercial paper did not change our main results.

[27] Adjustment for sinking funds is straightforward. Sinking funds almost universally call for a straight line reduction in principal starting a fixed number of years before maturity. Duration is computed from the issue date until the midpoint between maturity and the beginning of payments into the sinking fund. Adjustment for call provisions is more complex and cannot be carried out fully with the data in our sample because the impact of a call depends on how far out of the money a call option is. Instead, as a crude approximation we use the midpoint between the duration to call and the duration of a bond as our estimate of the effective duration. This accords with estimates of the impact of calls on durations of nonfinancial corporate bonds given by Dunetz and Mahoney (1988).

1982 and 1993. We find that size and bond ratings are important determinants of a firm's propensity to borrow long-term. This strongly supports the premise of Diamond's (1991a) model of debt maturity choice, where firms can be screened out of the long-term end of the maturity spectrum because of moral hazard problems. In our sample, smaller and riskier firms rarely issue short-term debt and never issue debt with a term-to-maturity of more than 29 years. This is consistent with the idea that firms with high liquidity risk issue long-term debt to avoid the risk of inefficient liquidation.

The strength of the incremental approach taken in this study is that it provides relatively strong tests of signalling and tax-based theories of debt maturity choice that depend on transient economic variables such as informational asymmetry about a firm's quality, the term structure of interest rates, interest rate volatility, and a firm's tax position. To our surprise, we find little support for signalling and tax-based theories of debt maturity choice. In our sample, debt maturity choice is not related to future stock market performance as implied by signalling models and does not depend on a firm's tax position in any way as predicted by tax-based theories of debt maturity choice.

The weakness of the incremental approach is that it provides noisy tests of agency theories of maturity choice that depend largely on slowly changing characteristics such as asset lives and the investment opportunity set. Nonetheless, our results are consistent with the view that firms attempt to control the agency costs of debt by altering the maturity of their borrowings. Firms with greater growth options tend to issue debt that is shorter in maturity than other firms. This appears to be a rational adaptation to contracting difficulties that arise in the presence of growth options in corporate borrowing. Our results concerning the agency explanation of corporate debt maturity are very similar to those obtained in Barclay and Smith (1995) and Stohs and Mauer (1994) using balance sheet measures of debt maturity.

Finally, we find the term premium to be inversely related to the maturity of new corporate debt issues. If the expectations hypothesis of the term structure holds, it is unlikely that managers would gain by issuing short term in an environment with a steep yield curve and vice-versa. Our result on the term structure may either indicate that market participants naively attempt to "ride the yield curve" or that they are rationally responding to a market that sometimes systematically misprices bonds in part of the yield curve.

While informative, our results leave important questions unanswered. First, we cannot clearly determine whether demand or supply factors drive the size and bond ratings effects. This is an important topic for future research that might be addressed by examining the demand schedules that firms offer to the market when searching for buyers in the market for medium-term notes. Second, we do not account for how far firms are away from an optimal maturity structure at the time of issue. Our models would probably have considerably more explanatory power if we accounted for the deviation between optimal maturity and the maturity of liabilities at the time of issue. This could be examined in a hybrid model like that used by Opler and Titman (1995) to study the debt/equity choice. Third, our analysis neglects important parts of the

credit market—commercial paper, trade credit, private placements, and bank debt. Fourth, while structurally rich, our model does not incorporate information about the propensity to use the credit markets altogether and has only crudely adjusted for other features of debt issues such as convertibility provisions, collateral, seniority structure, and presence of debt guarantees. Fifth and finally, we have neglected potentially important information in the *pricing* of new debt issues. In principle, the impact of debt maturity for different types of firms can be observed in pricing differentials across debt issues. We encourage other researchers to examine these issues in future work.

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