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The Debt Maturity Choice: A Multinominal Logit Analysis

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THE DEBT MATURITY CHOICE: A MULTINOMIAL LOGIT ANALYSIS

Abstract

This paper presents an empirical investigation of the determinants of firms' debt maturity choices. Testable hypotheses about the determinants are identified and discussed. A multinomial logit model to test the hypotheses is developed and estimated on a sample of bonds offered by industrial corportations from 1982 to 1986.

THE DEBT MATURITY CHOICE: A MULTINOMIAL LOGIT ANALYSIS

The debt maturity choice is one of the most common choices facing corporations, yet relatively little is known about how this choice is made. The few theoretical studies in this area have focused on the relevance of the maturity decision to firm value. Empirical studies have been hindered by a lack of adequately detailed data. Consequently, our knowledge of the determinants of debt maturity remains aptly described by the 1979 edition of a popular finance textbook: "[T]he issue of debt maturity has not been well developed; little more can be provided as a guide to policy." 1/

This paper seeks to improve our knowledge of debt maturity determinants by positing testable hypotheses about the determinants and testing them with respect to the observed maturities of new, publicly issued bonds. A multinomial logit model is developed and estimated on a sample of industrial bonds issued between 1982 and 1986.

The paper is organized as follows: Section I reviews the literature on the debt maturity decision; Section II presents the hypotheses to be tested; Section III describes briefly the multinomial logit methodology; Section IV describes the data; Section V discusses the explanatory variables used to test the hypotheses; Section VI presents and discusses the results; and Section VII draws the conclusions.

I. Literature Review

Both theoretical and empirical studies have investigated corporations' debt maturity choices. Theoretical studies start with the presumption that corporate managements make financial decisions to maximize the value of shareholders' wealth and proceed to investigate how these decisions affect firm value. Theoretical studies have focused on three connections between firm value and debt maturity: the corporate-tax-shield/bankruptcy-cost tradeoff, the resolution of agency problems, and the effect of interest rate changes.

I.A. Tax-Shield/Bankruptcy Cost Tradeoff

Brick, Mellon, Surkus, and Mohl (BMSM) [11] and Kane, Marcus, and McDonald (KMM) [23] both consider the tax-shield/bankruptcy-cost tradeoff but reach different conclusions. BMSM develop a discrete-time, multiperiod programming model that solves for the capital and debt maturity structures maximizing the present value of operating cash flows, where present value is determined by the Capital Asset Pricing Model (CAPM). Debt consists of coupon-bearing bonds with 2, 5, 10, 20 or 25 years to maturity; financial decisions are constrained to prevent the probability of bankruptcy from rising above a predetermined level. Model simulations show a positive relationship between cash flow variance and term to maturity. In particular, decreases (increases) in the variance of cash flow decrease (increase) the average maturity of bonds issued, although BMSM are reluctant to state this result as a general rule. They explain the variance-maturity relationship in terms of a risk/return tradeoff: given the leverage ratio, the less variable the cash flow stream, the lower the probability of bankruptcy and the more willing a firm becomes to use cheaper but riskier short-term debt (riskier because interest expenses are more changeable).

KMM reach the opposite conclusion using a continuous-time option valuation model. Capital and maturity structure decisions are made to maximize the present value of a firm whose underlying asset earns a cash flow generated by a diffusion process. Debt consists of discount bonds, the yields on which are modeled explicitly.2/ Model simulations show a negative relationship between cash flow variance and term to maturity, contrary to BMSM's simulations. KMM interpret their results as meaning that with stabler cash flows "the firm rebalances its capital structure less frequently" (p. 494), implying that the greater flexibility afforded by shorter term debt is unnecessary.

I.B. Agency Problems

Myers [32], Barnea, Haugen and Senbet (BHS) [5,6], and Flannery [15], explore the use of maturity decisions to resolve agency problems and thereby raise firm value. Myers and BHS both discuss the "incentive problem" that arises when firms finance short-lived "growth opportunities" with long-term credit. Creditors value bonds financing growth opportunities at less than their fair value because creditors bear the risk that the firm will forgo the opportunity if new information shows that the opportunity would benefit creditors alone. Myers and BHS solve the incentive problem by shortening the term of debt so that debt matures before the growth opportunity expires. This causes creditors to raise their bond valuations because they can always use funds from the maturing bonds to exploit the growth opportunity themselves if new information shows the opportunity would benefit creditors alone.

BHS also propose shortening debt maturity as a solution to the "asset substitution problem." In lending to finance a project, creditors also essentially buy the project and write a call option on the project that is held by the borrowing firm. Since the option's value increases with the variance of the project's income, the borrowing firm has an incentive to substitute a riskier project for the one it claims to be financing. Creditors anticipate this possibility at the outset, however, and reduce their bond valuations to compensate for greater default risk. BHS observe that shortening debt maturity increases creditors' bond valuations because shorter term bonds are less subject to price variation in the event that asset substitution does occurs.

Debt maturity choices can also solve agency problems arising from information asymmetries. BHS contend that poorly informed creditors value bonds at less than their fair value because they mistake "good" projects for "bad" ones.

To minimize the impact of low bond values on firm value, BHS suggest setting maturity dates to coincide with the arrival of new information confirming that the mistaken projects are, in fact, good ones; that way, firms can at least immediately refinance projects on terms more favorable than before.

Flannery [15] takes BHS's argument regarding information asymmetries to its logical conclusion. He demonstrates that firms with good projects might successfully signal project quality and obtain fair market (symmetric information) value for bonds by selling bonds with short terms to maturity. Successful signalling requires that flotation costs be high relative to the interest cost saving from having a good project correctly identified. This is because high flotation costs make it too costly for firms with "bad" projects to imitate firms with "good" projects (i.e., a separating equilibrium obtains). Low flotation costs lead to a pooling equilibrium in which firms with good projects cannot signal project quality and firms with good and bad projects make similar debt maturity choices.

I.C. Interest Rate Changes

The theory of portfolio management under stochastic interest rates comprises a voluminous literature beginning with Grove [20]. Applications of the theories are practiced most widely by financial intermediaries in the form of "bond portfolio immunization" and "gap management." Applications found in corporate finance textbooks rarely go further than the exhortation to match asset and liability maturities. Recent empirical research on nonfinancial firms shows that the explanatory power of the single-factor market model of stock returns can sometimes be increased by adding an interest rate variable (Fama and Schwert [13], Folger et al. [17], and Sweeny and Warga [38]), suggesting a "mismatch" in asset and liability durations that affects firm value. Tests of the "mismatch" hypothesis have heretofore been impeded by a lack of data. For a sample of commercial banks and savings and loan associations, however, Flannery and James

[16] demonstrate empirically that the interest rate sensitivity of stock returns is related to the mismatch of asset and liability maturities.

Morris [31] develops a variant of the firm-value/debt-maturity connection to reach a different rule than the simple maturity-matching dictum. Morris shows that when net operating income is highly positively correlated with short-term interest rates, rolling over a series of short-term loans reduces the volatility of net income. Moreover, because interest rates and the return on the market are positively correlated, a short-term borrowing strategy reduces systematic risk and raises firm value.

I.D. Empirical Studies

Most empirical studies of the debt maturity choice employ aggregate data. Silvers [37] tests for determinants of debt duration using the FTC Quarterly Financial Reports for Manufacturing. He constructs a debt duration proxy by attributing payoff characteristics to different classes of balance sheet liabilities. Silvers' results support the notions that asset durations, interest rate expectations, internal funds, and availability of external funds affect debt duration. Bosworth [8], Taggart [39], and White [44] use Federal Reserve flow of funds data for nonfinancial corporations to estimate financial decision models which include the decision to borrow short term (debt due in one year or less) and long term (debt due in more than one year). Their results suggest that interest rates, revenue growth, and levels and level changes of balance-sheet accounts affect the size of short- and long-term borrowings, although no consensus emerges on the underlying corporate decision model or the determinants of maturity choices.

Studies employing aggregate data share several deficiencies. Available aggregate data lack the detail needed to construct proxies of such potentially important maturity determinants as default probabiity and agency problems. Lack of detail also limits the inquiry to an investigation of different types of debt whose maturity characteristics are unobserved. Finally, use of aggregate data results in estimated relationships between debt maturity measures and maturity determinants that lack precision.

A recent study by Titman and Wessels (TW) [42] uses data from the Annual Compustat Industrial Files to investigate the determinants of short-term and long-term debt for a sample of 469 firms.3/ TW find that smaller firms make greater use of short-term financing, a finding they attribute to the high transactions costs small firms face when issuing long-term securities. Variables proxying growth, nontax debt shields, asset structure, size, profitability, earnings volatility, industry, and firm uniqueness were found to have little influence on the relative use of short-term versus long-term debt.

II. Testable Implications

Existing theoretical and empirical studies of the debt maturity choice suggest several determinants of this choice; the task now becomes one of formulating testable hypotheses and developing a research method. Several methods are available. Following TW and Silvers, one could test for debt maturity determinants by studying the maturity composition of outstanding debt. Alternatively, one could follow Bosworth, Taggart, and White (BTW) and test for maturity determinants by studying the maturity composition of borrowings (changes in outstanding debt). A third method, one in the spirit of BTW, is to test for maturity determinants by studying the original terms to maturity of a single class of borrowings, say, bonds. This is the approach used here.

Studying maturity characteristics of a single class of borrowings offers several advantages. Since the unit of observation is an individual bond, its maturity characteristics can be observed precisely. Individual bonds can also be matched with data on individual firms, permitting construction of potentially better proxies of maturity determinants than is possible from working at the aggregate level. In addition, estimated relationships between bond maturities and maturity determinants are potentially more precise. The main limitation of this approach is that it fails to control for possible interactions between bond maturity choices and maturity choices for other types of debt.

The following hypotheses are tested in Section VI:

a. The Default Probability (DP) Hypothesis

The KMM version - the lower (higher) the probability of default by the borrowing firm, the longer (shorter) the term of the bond offered.

The BMSM version - the lower (higher) the probability of default by the borrowing firm, the shorter (longer) the term of the bond offered.

b. The Agency Problem (AP) Hypothesis

The Myers, Barnea, Haugen and Senbet (MBHS) version - the larger (smaller) the agency problems facing the borrowing firm, the shorter (longer) the term of the bond offered.

The Flannery version - the better (worse) the project being financed, the shorter (longer) the term of the bond offered.

c. The Hedging (HG) Hypothesis

The Traditional version - the more the duration of a firm's assets (liabilities) exceeds the duration of its liabilities (assets), the longer (shorter) the term of the bond offered.

The Morris version - the more positive (negative) the correlation between net operating income and short-term interest rates, the shorter (longer) the term of the bond offered.

d. The Liquidity Premium (LP) Hypothesis - the larger (smaller) the liquidity premium for increasing bond term, the shorter (longer) the term of the bond offered.

The KMM and BMSM versions of the DP Hypothesis are competing hypotheses about the influence of default probabilities on maturity choice. The BMSM version will tend to be supported if most firms give a high priority to maximizing cash flow at each point in time, leading them to respond to lower default probabilities by shortening bond terms so as to benefit from generally lower short-term interest rates. This response is more likely if flotation costs are relatively small and interest rates contain liquidity premiums that increase with loan term (see below). The KMM version will tend to be supported if most firms give a high priority to maximizing the value of outstanding debt and equity at each point in time. Such firms will respond to lower default probabilities by increasing bond term so as to reduce flotation costs. This response is more likely the higher are flotation costs.

The MBHS and Flannery versions of the AP Hypothesis compete to an extent. The MBHS version will tend to be supported if firms are unable to resolve agency problems by other means, including writing restrictive bond covenants and signalling. High costs of writing and monitoring bond covenants are the conditions most conducive to the MBHS version. The Flannery version will tend to be supported if information asymmetries are the most prevalent type of agency problem, if information asymmetries cannot be resolved through other means, and if high flotation costs and low premiums for credit risk exist, making it possible for firms with superior projects to signal project quality successfully by issuing short-term debt.

The traditional and Morris versions of the HG Hypothesis are also competing hypotheses. Support for the traditional version will tend to be found if firms assign a high priority to minimizing the effect of interest rate changes on share value for a given debt-equity ratio, whereas support for the Morris version will tend to be found if firms assign a high priority to stabilizing net income. Share price and net income stabilization are more likely to be motivating factors when interest rates are highly volatile, as has been true since the late 1970s.

The LP Hypothesis is offered to help reconcile the paradox of statistically significant relationships between interest rates and the maturity distribution of bond offerings (Bosworth, Taggart, White, and Silvers) despite evidence of a high degree of efficiency in bond markets (i.e., zero profits from "yield curve speculation").4/ Considerable support exists for the pure expectations theory of the term structure augmented by a liquidity premium that increases with loan term, although the evidence is mixed on whether this premium remains constant or varies directly or inversely with the level of rates.5/ Disregarding flotation costs, value maximizing firms should choose short-term bonds, ceteris paribus, because short-term interest rates embody the smallest liquidity premium. Risk-averse firms should make the debt maturity choice based on their willingness to pay for certainty in nominal borrowing costs, ceteris paribus.6/ This willingness, in turn, should change with the level of interest rates. A risk-averse firm should be less willing (more willing) to pay for certainty in borrowing costs when interest rates are at historical highs (lows), since most rate changes would be expected to bring rates lower (higher). Under the circumstances, a risk-averse firm would sell short-term rather than long-term bonds (long-term bonds rather than short-term bonds). Thus, the existence of liquidity premiums gives risk-averse firms an economic incentive to vary their maturity choices with interest rate levels; this incentive is greater (smaller) if premiums vary directly (inversely) with the level of interest rates. Failure to find a significant statistical relationship between maturity choice and interest rates would suggest that most firms are value maximizers -- and, thus, prefer short maturities, ceteris paribus -- or that most firms are risk averse with price-inelastic demands for interest rate insurance -- and, thus, prefer long maturities, ceteris paribus -- or that liquidity premiums are generally too small to influence the maturity choice.

Empirical tests of the hypotheses are presented in Section VI. In interpreting the test results, it is important to bear in mind that the tests are actually joint tests of the proposed hypotheses and of the variables used to proxy the determinants of maturity choice (default risk, agency problems, etc.). Thus, a given hypothesis may fail to find support either because the hypothesis is not, in fact, true or because the determinant proxy fails to reveal that the hypothesis is, in fact, true.

III. Method

To test hypotheses of the debt maturity choice, a statistical procedure is needed that relates proxies for the determinants of the choice to the observed term of the bond. An obvious candidate is a linear model of the form:

$$y_i = \beta' x_i \qquad i = 1,\dots,S$$

where

y_i = observed term to maturity of bond i,

x_i = an N x 1 vector of observations on the determinant proxies for bond i,

β = an N x 1 vector of parameters.

There are two a priori reasons for expecting the linear bond term model to perform poorly. First, it seems probable that firms regard bonds with "close" terms to maturity -- say, ten and eleven-year bonds -- as essentially perfect substitutes while regarding bonds with "distant" terms to maturity -- say, ten- and thirty-year bonds -- as imperfect substitutes.7/ If so, then bond term and the determinants of bond term are not linearly related. Specifically, any-size change in a determinant will cause no change in a firm's preference for eleven-year bonds over ten-year bonds even though a comparable change in the determinant will affect the firm's preference for thirty-year bonds over ten-year bonds. Because the linear model presumes a fixed response in the dependent variable to changes in an explanatory variable, estimates of the model will tend to reject even true hypotheses about how changes in determinants affect the choice of bond term. Second, the linear model presumes that the same variables that "explain" low values of the dependent variable -- in the sense of having a measurable effect on them -- also explain high values of the dependent variable. Previous empirical work on debt maturity decisions (e.g., Bosworth, Taggart) suggests that such is unlikely to be true: the independent variables with explanatory power in the equations for short-term debt are rarely the same ones with explanatory power in the equations for long-term debt.

Both limitations of the linear model can be overcome by replacing the continuous dependent variable, years to maturity, with a categorical or qualitative variable and using a model of category choice. Of the available qualitative response models, the multinomial logit (MNL) model developed by Theil [41] is best suited for the problem at hand. Under the MNL model, the log-odds that bond i falls into maturity category j instead of maturity category 1 is posited to be a linear function of the determinant proxies. Specifically,

$$Ln(P_{ij}/P_{i1}) = \beta_j' x_i \qquad j = 2,\dots M \quad i = 1,\dots S \qquad (1)$$

where

- Ln = natural logarithm,
- P_{ij}/P_{i1} = the odds that bond i falls into maturity category j instead of maturity category 1,
- M = number of maturity categories,
- S = number of bonds in the sample,
- x_i = an N x 1 vector of observations on the determinant proxies for bond i,
- β_j = an N x 1 vector of parameters for the log-odds that a bond falls into maturity category j instead of maturity category 1.

(It should be noted that with M maturity categories, M-1 log-odds ratios can be defined using the probability of falling into category 1 in the denominator.) Although the MNL model posits a linear relationship between the independent and dependent variables, it implies a nonlinear relationship between the independent variables and the probabilities of bonds falling into various maturity categories. This can be seen by rewriting Equation (1) as:

$$(P_{ij}/P_{i1}) = \exp(\beta_j' x_i) \qquad j = 2,\dots M \quad i = 1,\dots S \qquad (1)'$$

and noting that since bond i falls into one of the M categories with probability 1 (i.e., $P_{i1} + \sum_{j=2}^{M} P_{ij} = 1$), summing Equation (1)' over j yields

$$\sum_{j=2}^{M} (P_{ij}/P_{i1}) = (1 - P_{i1}) / P_{i1} = \sum_{j=2}^{M} \exp(\beta_j' x_i) \qquad i = 1,\dots S \qquad (2)$$

and, hence

$$P_{i1} = [1 + \sum_{j=2}^{M} \exp(\beta_j' x_i)]^{-1}$$

$$P_{ij} = \exp(\beta_j' x_i) / [1 + \sum_{j=2}^{M} \exp(\beta_j' x_1)]^{-1} \qquad (3)$$

$j = 2,\ldots M; \quad i = 1,\ldots S$

The β_j's, which contain the evidence on the hypotheses about debt maturity choice, could be estimated by applying the technique of ordinary least squares to the model in Equation (1) if the log-odds, the $Ln(P_{ij}/P_{i1})$'s, were observable. They are not, however. One procedure for dealing with the unobserved probabilities -- the one used here -- is to use maximum likelihood estimation on the probability expressions defined by Equation (3). Specifically, the sample bond data are used to define MxS binary variables as follows:

$$y_{ij} \begin{cases} = 1, \text{ if the ith bond falls into category j} \\ = 0 \text{ otherwise} \end{cases}$$

$j = 1,\ldots M; \quad i = 1,\ldots S$

The likelihood function for observing a given sample of S bonds classified into M maturity categories can be written as:

$$\ell = \prod_{i=1}^{S} P_{i1}^{y_{i1}} P_{i2}^{y_{i2}} \cdots P_{iM}^{y_{iM}}$$

with the unobserved probabilities, the P_{ij}'s, defined by Equation (3). Maximization of the likelihood function yields estimates of the β_j's as well as asymptotic variances of the estimates needed for hypothesis testing.

A final observation should be made regarding normalization in the MNL model. Given M bond maturity categories, the log-odds that bond i falls into maturity category j instead of maturity category 1 is described by a set of M-1 equations (j = 2,...M). The log-odds that bond i falls into maturity category j instead of maturity category k is easily calculated from equations among the original set of M-1 equations, since

$$Ln(P_{ij}/P_{ik}) = Ln(P_{ij}/P_{i1}) - Ln(P_{ik}/P_{i1})$$

and, thus by Equation (1),

$$\mathrm{Ln}(P_{ij}/P_{ik}) = (\beta'_j - \beta'_k)\, x_i \,.$$

IV. Data

The data for this study came from three sources: Moody's Bond Survey, the Annual Compustat Industrial Files, and the Citibank data base. Data on bond terms came from Moody's Bond Survey, a weekly publication reporting recent public bond offerings as well as detailed descriptions of the bond offered. From the Bond Survey, a sample of 295 bonds was chosen comprising all of the fixed rate, non-convertible bonds issued between July 1982 and December 1986 by industrial corporations (excluding utilities) included in the Compustat files.8/ Table I compares the sample with the universe of publicly offered industrial bonds of all types (including convertibles, flexible-rate bonds, etc.). The sample represents 17.7% of the industrial bonds issued between 1982 and 1986, and 25.3% of the value of such bonds.

Financial statement data for each of the firms with bonds in the sample were obtained from the Compustat files. Except where noted, the explanatory variables described in the next section were created from financial statement data for the fiscal year ending just prior to a bond's issue date. In principle, therefore, almost a full year could elapse between the close of a fiscal year and the time a bond was offered. Given the relative stability of the financial conditions facing these firms, however, this time lag was not considered a major problem.

Finally, data on market interest rates in the month before each bond's issue date were taken from the Citibank data base and matched with the appropriate bond.

The sample of 295 bonds was subsequently narrowed to 148 bonds. One hundred and forty-seven bonds were eliminated because they were part of a bond series issued over a brief span of time, usually two to three months. Borrowing firms that float small amounts of bonds frequently -- a byproduct of shelf registration -- would have posed no problem if they had tended to choose the same bond maturity each time. This was rarely the case, however. Serial offerings made the task of constructing independent variables that fully reflected the effects of previous offerings extremely difficult. Hence, it was decided to restrict the sample to the bonds of firms that offered bonds no more frequently than once a year. The sample of 148 bonds comprises the offerings of 122 firms; the 16 firms that issued bonds more than once usually issued bonds in 1982 and again in 1986. An obvious avenue for future research is whether the determinants of maturity choice for "serial issuers" are the same as those for "infrequent issuers."

The definition of discrete maturity categories was guided by the distribution of terms to maturity in the original 295-bond sample. Figure 1 presents a histogram of the terms to maturity of the sampled bonds. Interestingly, 63% of the sample bonds have one of three original terms to maturity: 10 years (32.1%), 30 years (22.0%), or 20 years (8.8%). In addition, the histogram shows a small clustering of bonds with terms to maturity of between one and nine years. After some experimentation, a three-maturity category classification (i.e., M=3) was developed with the categories defined as follows: Short (terms to maturity less than 10 years); Medium (terms to maturity 10 to 19 years); and Long (terms to maturity of 20 or more years). To test the hypotheses about the determinants of the debt maturity choice, models of the following form were estimated:

$$Z_{iMS} \equiv Ln(P_{iM}/P_{iS}) = \beta_{11} + \beta_{12}DPH_i + \beta_{13}APH(MBHS)_i + \beta_{14}APH(F)_i + \beta_{15}H(T)_i + \beta_{16}H(M)_i + \beta_{17}LP_i \quad (4a)$$

$$Z_{iLS} \equiv Ln(P_{iL}/P_{iS}) = \beta_{21} + \beta_{22}DPH_i + \beta_{23}APH(MBHS)_i + \beta_{24}APH(F)_i + \beta_{25}H(T)_i + \beta_{26}H(M)_i + \beta_{27}LP_i \quad (4b)$$

where

P_{iI}/ P_{iS} = the odds that bond i falls into maturity category I instead of the short maturity category; I = M (Medium) or L (Long),

DPH_i = observed value of the proxy testing the DP Hypothesis for bond i, 9/

$APH(MBHS)_i$ = observed value of the proxy testing the MBHS version of the AP Hypothesis for bond i,

$APH(F)_i$ = observed value of the proxy testing the Flannery version of the AP Hypothesis for bond i,

$H(T)_i$ = observed value of the proxy testing the traditional version of the HG Hypothesis for bond i,

$H(M)_i$ = observed value of the proxy testing the Morris version of the HG Hypothesis for bond i,

LP_i = observed value of the proxy testing the LP Hypothesis for bond i.

V. Explanatory Variables

Four variables were used to proxy the probability of default in tests of the DP Hypothesis: DA, NWTD, ARETA, and GRADE. DA, the book value debt-to-asset ratio, is perhaps the most widely used indicator of default probability. DA is defined here as the sum of current liabilities and long-term debt divided by total assets. NWTD is the ratio of net worth at market value to total debt at book value. Feidler's [14] survey of studies on financial ratios as predictors of credit risk noted a widespread tendency for low net worth-to-debt ratios prior to default.10/ Market value net worth is defined here as the product of share price and number of common shares outstanding at the close of the fiscal year preceding the bond issue; total debt is defined as the sum of current and long-term liabilities and preferred stock. ARETA, balance sheet retained earnings divided by balance sheet assets, was found by Altman [2] to be the most useful financial ratio for predicting corporate failures. GRADE is the Moody's rating assigned to a bond at the time of issue (Aaa=6, Aa=5, A=4, Baa=3, Ba=2, B=1). Bond ratings have been found to be highly correlated with bond quality (Pogue and Soldofsky [35], Pinches and Mingo [34], and Kaplan and Urwitz [24]) but possibly delayed indicators of quality (Ederington et al. [12]). High default probabilities should result in high values of DA and low values of NWTD, ARETA, and GRADE. High (low) default probabilities should lead firms to choose short (long) bond terms according to the KMM version of the DP Hypothesis and long (short) bond terms according to the BMSM version.

Four variables were chosen to proxy proneness to agency problems in tests of the MBHS version of the AP Hypothesis: REFIN, EXPAND, GA, and LOGA. REFIN and EXPAND were based on information about the purpose to which the proceeds of a bond issue would be put. A description of purpose, which firms issuing bonds publicly must file with the SEC, appears in Moody's Bond Survey. Purposes fell into three categories:

Category 1	Refinancing: reducing or repaying debt; repurchasing outstanding shares.
Category 2	Ongoing Operations: general corporate purposes; working capital requirements.
Category 3	Expansion: capital expenditures for existing operations or new operations; acquisition of another company.

The purpose of an issue should provide information about possible agency problems facing bond-issuing firms. Myers [32] argues that firms financing assets in place (e.g., firms giving refinancing as a purpose) should use higher debt ratios because assets in place are not a growth opportunity and, therefore, not subject to the incentive problem that leads debt to be unfairly valued. Extending Myers' logic, firms refinancing assets in place should choose longer term debt because the absence of incentive problems implies that debt will be fairly valued. Moreover, since information about existing assets is probably easier to disseminate than information on new projects, firms refinancing assets in place should also choose longer term debt because the absence of information asymmetries implies that debt will be fairly valued. This reasoning led to the creation of two binary variables, REFIN and EXPAN, defined as follows:

EXPAND	=1	if the purpose of an issue is a category 3 purpose only.
	=0	if the purpose is a category 1 or 2 purpose or a category 3 purpose combined with a category 1 or 2 purpose.
REFIN	=0	if the purpose of an issue is a category 1 purpose only.
	=1	if the purpose is a category 2 or 3 purpose or a category 1 purpose combined with a category 2 or 3 purpose.

If EXPAND=0 or REFIN=0, the firm is financing assets in place rather than growth opportunities and is, therefore, not subject to the incentive and information asymmetry problems leading firms to favor shorter term debt. REFIN was used in addition to the more obvious EXPAND variable because it was not known, a priori, whether creditors regard a category 2 purpose -- ongoing operations -- as expanding the scale of current operations and, thus, a growth opportunity.

A potential weakness of EXPAND and REFIN is that they depend upon the accuracy of the statements of purpose made to the SEC. If firms typically use funds for purposes other than those announced and if potential creditors know this, then EXPAND and REFIN will fail to provide evidence on the BMSM version of the AP Hypothesis.

GA, a growth rate proxy, was chosen to overcome the problems inherent in EXPAND and REFIN. GA is the growth rate of gross plant and equipment measured from the close of the fiscal year before a bond was issued to the close of the fiscal year in which the bond was issued. Firms experiencing high rates of growth in fixed assets were presumed more likely to have financed growth opportunities and, therefore, more likely to have faced the incentive and information asymmetry problems leading firms to favor shorter term debt. Thatcher [40] used a similar variable to proxy the presence of agency problems leading to the use of the call feature.11/ A potential weakness of GA is that funds raised to finance a growth opportunity may not be spent for fixed assets until a later accounting period. Although measuring fixed asset growth over a longer horizon would alleviate this weakness (while possibly introducing others), the timeliness of the sample period (1982-86) prevented it.

LOGA, the natural logarithim of book value balance sheet assets at the close of the fiscal year prior to the bond issue, was chosen to proxy proneness to information asymmetries. A priori reasoning suggested that smaller firms should have more trouble conveying information to potential creditors because of limited resources, lack of sophistication or creditor disinterest owing to the smaller size and lesser liquidity of the issue. Information asymmetries, in turn, increase the likelihood that bonds will be valued at less than their fair value and increase firms' incentives to issue shorter term bonds. Malitz [27] used the same variable to proxy proneness to information asymmetries leading firms to offer bonds with different combinations of covenants.

Two variables were used to proxy project quality in tests of the Flannery version of the AP Hypothesis: DOM and ERROR. DOM is the difference between annual operating margin for the fiscal year in which the bond was offered and annual operating margin for the preceding fiscal year. The larger (smaller) DOM, the more likely a firm is to have financed a "good" ("bad") project and, thus, to have chosen a short (long) bond term.12/ ERROR is a measure of abnormal stock return in the year following the bond issue. Specifically, ERROR is the difference between the realized annualized stock return in the year following the bond offering and the annualized return predicted by a single-factor model; that is:

$$ERROR_i = R_{i,t+1} - \hat{\alpha}_i - \hat{\beta}_i R_{m,t+1}$$

where

$R_{i,t+1}$ = realized return on stock i in year t+1.

$R_{m,t+1}$ = realized return on the market portfolio in year t+1.

$\hat{\alpha}_i$, $\hat{\beta}_i$ = parameter estimates of the single-factor model for stock i.

Parameter estimates of the single-factor model were obtained by regressing annualized monthly stock returns for the sixty months prior to the bond issue on annualized monthly stock returns for the S&P500. The more positive (negative) ERROR, the more likely that new information revealed after the offering showed that the project financed was "good" ("bad") and, thus, the more likely was the firm to have chosen a short (long) bond term. Both DOM and ERROR possess the same potential weakness as GA, namely that they may fail to distinquish between "good" and "bad" projects if project quality takes more than one year to be reflected in the proxies.

Three variables were used to proxy firms' hedge positions in tests of the traditional version of the HG Hypothesis: GAMMA, MATCH, and DMAT. GAMMA identifies potentially unhedged firms by gauging the susceptibility of firm value to interest rate changes. Following Sweeney and Warga [38], GAMMA is the estimate of the coefficient on the interest rate change variable in the following two-factor model:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \gamma_i \Delta I_t + \epsilon_{it}$$

where

R_{it} = the annualized monthly return on stock i,

R_{mt} = the annualized monthly return on the S&P 500,

ΔI_t = the change in the Dow-Jones Bond Yield from the the previous month.13/

The model was estimated for the 60 months prior to the bond issue. If γ_i is positive (negative) and statistically significant, then the duration of the firm's liabilities is presumed greater than (less than) the duration of its assets and the hedging firm should choose shorter (longer) bond maturities to reduce the sensitivity of stock return to interest rate changes. GAMMA equals the value of $\hat{\gamma}_i$ if $\hat{\gamma}_i$ is statistically significant; otherwise GAMMA equals zero. For GAMMA to represent a firm's incentive to use maturity decisions to hedge, the composition of the balance sheet must have remained stable in the 60 months prior to the bond issue; otherwise, GAMMA will fail to identify hedging behavior.14/

MATCH indicates the bond term a firm should pick to fulfill the textbook exhortation to finance long-term assets with long-term funds.15/ MATCH is defined as long-term liabilities plus shareholders' equity less long-term assets, all scaled by total assets. The direction of the relationship between MATCH and bond term cannot be established a priori because without observing the maturity composition of balance sheet accounts, extreme values of MATCH cannot be interpreted unambiguously. If long-term liabilities and net worth have "terms to maturity" roughly equal to those of long-term assets, then non-zero values of MATCH represent unhedged positions. Under these circumstances, the traditional version predicts that the larger (smaller) MATCH, the more (less) long-term funds have been used to finance short-term assets and the greater the hedging firm's incentive to choose shorter (longer) bond terms. If instead the observed values of MATCH represent hedged positions, the traditional version predicts that the larger (smaller) MATCH, the greater the incentive to pick a long (short) bond term to maintain the hedge position.

DMAT indicates the bond term a firm should pick to match the duration of assets and liabilities. DMAT is the fraction of long-term debt maturing within five years. Like MATCH, the direction of the relationship between DMAT and bond term cannot be established a priori because without observing the durations of balance sheet accounts, extreme values of DMAT are difficult to interpret. If asset durations are roughly similar across the sampled firms, then extreme values of DMAT represent deviations from hedged positions. Under these circumstances, the traditional version predicts that the larger (smaller) the fraction of maturing debt, the more likely is a hedging firm to choose long (short) bond terms. If instead observed values of DMAT represent hedged positions (i.e., DMAT proxies for the duration of both assets and liabilities), the traditional version predicts that the larger (smaller) DMAT, the more likely is the hedging firm to choose short (long) bond terms to maintain the hedge. DMAT will capture hedging incentives more accurately the more significant are bonds as a source of funds.

The variable CORR was used to proxy the income/interest rate relationship in a test of the Morris version of the HG Hypothesis. CORR is the sample correlation coefficient between net operating income and the 4-6 month commercial paper rate. The coefficient was computed from 20 quarterly observations ending in December of the year before a bond offering. Sample correlation coefficients not significantly different than zero at a 5% significance level were coded as zeros. According to the Morris version of the HG Hypothesis, larger positive (negative) values of CORR should lead firms to stabilize net income by choosing short-term (long-term) debt.

Two variables, RRATE and SPREAD, were used to proxy the level of real interest rates in tests of the LP Hypothesis. RRATE is the average level of the Moody's triple-A corporate bond rate in the month preceding an offering less the annualized percentage change in the consumer price index in the three months preceding the offering. RRATE proxies the level of real interest rates more accurately the more nearly recent inflation experience resembles long-run inflation expectations. Because recent changes in the CPI may lag behind changes in inflation expectations, a second variable, SPREAD, was also created. SPREAD is the average difference between the Moody's triple-A corporate bond rate and the rate on four- to six-month commercial paper in the month preceding the issue. Compared with changes in the CPI, the commercial paper rate potentially embodies better inflation forecasts but is subject to short-term financial market conditions.16/ The LP Hypothesis predicts that the higher (lower) RRATE or SPREAD, the shorter (longer) the term of the bond chosen.

VI. Results

VI.A. One-Way Analysis of Variance

One-way analysis of variance tests were used to reduce the number of MNL models estimated. A priori reasoning suggested that variables showing no statistically significant variation across maturity categories are unlikely to have influenced firms' bond maturity choices and can be excluded from the MNL analysis. Variables showing statistically significant variation may prove to have had no influence on maturity decisions once the effects of other variables are controlled for. Table II presents mean values of the explanatory variables by maturity category along with F-ratios from one-way analyses of variance among the group means.

All of the variables chosen to proxy default probabilities show significant differences in group means across maturity categories, although differences for NWTD are significant only at the 14% level. Two of the four proxies selected to test the MBHS version of the AP Hypothesis -- REFIN and LOGA -- show significant differences in group means across maturity categories. Neither of the two variables chosen for tests of the Flannery version of the AP Hypothesis shows significant variation at standard significance levels, but ERROR shows significant variation at the 26% significance level as well as showing the hypothesized pattern.17/ Two of the three proxies chosen for tests of the traditional version of the HG Hypothesis -- MATCH and DMAT -- show significant differences in group means across maturity categories. CORR, the proxy chosen to test the Morris version of the HG Hypothesis, failed to show significant variation. Of the two interest rate proxies chosen to test the LP Hypothesis, only RRATE showed significant differences in group means across maturity categories.

The results of the ANOVA tests were used to reduce the set of variables on which to perform MNL analysis to those showing differences in group means significant at the 15% level or better. Table III, which presents the correlation matrix for the explanatory variables, shows low sample correlations among most of the variables, even many selected to test the same hypothesis (viz REFIN and LOGA, MATCH and DMAT). The MNL analysis was performed on a subsample of 122 bonds for which complete observations on all variables were available; 26 bonds were reserved as a holdout sample.

VI.B. Multinomial Logit Models

Representative results from the MNL analysis are presented in Table IV. Panel A reports coefficient estimates of three models; t-ratios appear in parentheses beneath the estimates. Panel B presents goodness-of-fit statistics for the model estimates and additional tests of significance for the coefficient estimates. The likelihood ratio statistic strongly rejects the hypothesis that the coefficient estimates in each model are jointly zero, and McFadden's pseudo-R^2 statistic, ranging from .16 to .20, indicates that the three model estimates fit the data quite well.18/ Moreover, fitted values of the models result in correct classifications of the sample bonds in about 63% of the cases.

Model I includes the nine variables having means that differ significantly across maturity categories (Table IV, Panel A). Coefficient estimates of three variables -- ARETA, GRADE, and MATCH -- fail to achieve significance at the 15% significance level in any of the three equations. The other six variables have statistically significant coefficient estimates in at least one of the three Model I equations, and likelihood ratio tests reject at the 15% significance level the hypothesis of jointly zero coefficient estimates in each of the six cases (Table IV, Panel B).

Model II includes the six variables with statistically significant coefficients in Model I. The likelihood ratio tests reject at the 10% level the hypothesis of jointly zero coefficient estimates for NWTD, REFIN, LOGA, and RRATE, but this hypothesis cannot be rejected for DMAT and DA (Table IV, Panel B). The latter two variables are excluded from Model III.

Table V provides the main evidence on the DP, AP, HG, and LP Hypotheses. Table V reports the results of likelihood ratio tests of the hypotheses corresponding to Models I, II, and III. In these tests, the unrestricted log-likelihood is the maximized value of the log-likelihood function for Model I, II, or III. The restricted log-likelihood is the maximized value of the log-likelihood function for Model I, II, or III but excluding the variable proxies pertaining to a particular hypothesis.

The likelihood ratio tests strongly support the significance of the default proxies as determinants of bond maturity. The support is strongest from Models II and III, which reject at the 1% level the hypothesis of jointly zero coefficient estimates for the DP proxies. 19/ In addition, the coefficient estimates of all three models support the KMM version over the BMSM version of the DP Hypothesis (Table IV, Panel A). The KMM version holds that the lower the probability of borrower default (the higher NWTD, the lower DA), the longer the term of the bond offered. The coefficient estimates of NWTD suggest that decreasing the default probability significantly increases the odds of a long-term bond over a short- or medium-term bond (the NWTD coefficient estimates are positive and significant in the Z_{LS} and Z_{LM} equations), and the coefficient estimates of DA imply that decreasing the default probability increases the odds of a medium-term bond over a short-term bond (the DA coefficient estimates are negative and significant in the Z_{MS} equations). By supporting the KMM version of the DP Hypothesis, the coefficient estimates fail to support the BMSM version, which holds that the lower the default probability, the shorter the term of the bond offered to enable the borrower to profit from lower short-term rates.

The likelihood ratio tests also support strongly the significance of the AP proxies REFIN and LOGA as determinants of bond maturity. Specifically, the data reject at the 5% significance level the hypothesis of jointly zero coefficient estimates for the AP proxies in all three models (Table V). The data also generally reject the hypothesis of jointly zero coefficient estimates for REFIN and LOGA separately (Table IV, Panel B).

The coefficient estimates of LOGA strongly support the MBHS version of the AP Hypothesis (Table IV, Panel A). The MBHS version holds that increasing information asymmetries about projects' expected cash flows (decreasing LOGA) leads creditors to reduce their bond valuations and borrowers to shorten bond terms to coincide with the date that information becomes symmetric. The coefficient estimates of LOGA in all three models imply that increasing information asymmetries decreases the odds of a long-term bond over a medium-term one (the LOGA coefficient estimates are positive and significant in the Z_{LM} equations). The coefficient estimates also imply that increasing information asymmetries increases the odds of a medium-term bond over a short-term one (the LOGA coefficient estimates are negative and generally significant in the Z_{MS} equations), an apparent contradiction to the MBHS version. But the MBHS version does not posit a monotonic relationship between information asymmetries and bond term; indeed, the seemingly contradictory estimates can be interpreted as supporting the MBHS version. Specifically, firms that pick a maturity date before the date information becomes symmetric also decrease the proportion of repayment coming from the project financed and increase the proportion of repayment coming from a refinancing. Since firms facing information asymmetries have comparatively poor access to financial markets, creditors should tend to reduce their bond valuations as term to maturity decreases due to uncertainty about the probable success of the borrower's refinancing. A firm could ameliorate the depressing effect of information asymmetries on bond value by picking a maturity date closer to the date that information becomes symmetric. Such behavior would tend to produce coefficient estimates implying that increasing information asymmetries increases the odds of a medium-term bond over a short-term one. This hypothesized behavior is consistent with the negative LOGA coefficient estimates in the Z_{MS} equations.

The coefficient estimates of REFIN provide equivocal evidence on the MBHS version of the AP Hypothesis. The MBHS version hypothesizes that firms financing growth opportunities (REFIN=1) pick bond terms to coincide with the opportunity's expiration date to ameliorate the depressing effect on bond price of the incentive problem (and possibly other agency problems). But the coefficient estimates of REFIN in all three models (Table IV, Panel A) imply that a firm financing a growth opportunity is more likely to pick long-term bonds than if it were refinancing assets in place (the REFIN coefficient estimates are positive and significant in the Z_{LS} and Z_{MS} equations).

One interpretation of REFIN's coefficient estimates consistent with the MBHS version is that firms resolve the incentive problem mainly through credit markets other than the public bond market while resolving at least some agency problems through the public bond market. Other credit markets offer potentially superior avenues for resolving the incentive problem because they afford greater flexibility in the choice of contract terms -- including loan term -- as well as comparative ease in renegotiating payments should a growth opportunity's expiration date be uncertain. Resolution of the incentive problem mainly through other credit markets would leave the term to maturity of publicly traded bonds free to reflect efforts to resolve such other agency problems as the information asymmetry and asset substitution problems. The coefficient estimates of REFIN support the MBHS version if firms borrowing to finance ongoing operations and expansion (REFIN=1) tend to be more successful at articulating to creditors an intended use of funds and a sense of commitment to that use than firms borrowing to refinance assets in place (REFIN=0). Under the MBHS version, firms free of the information asymmetry and asset substitution problems choose longer term bonds, whereas firms confronted with the depressing effect on bond price of the information asymmetry and asset substitution problems pick shorter term bonds. Such behavior is consistent with the estimated coefficients of REFIN (the REFIN coefficient estimates are positive and significant in the Z_{LS} and Z_{LM} equations).

The likelihood ratio tests offer some support for the traditional version of the HG Hypothesis and for the significance of MATCH and DMAT as determinants of bond maturity (Table V). With Model I, the data reject the hypothesis of jointly zero coefficient estimates for MATCH and DMAT. The hypothesis is rejected only at significance levels of 11% or more, however, and the coefficient estimates of MATCH are never significant, either individually as judged by their t-ratios (Table IV, Panel A) or jointly as judged by the likelihood ratio test statistic (Table IV, Panel B). With Model II, which excludes MATCH, the data reject the hypothesis of jointly zero coefficient estimates of DMAT, but again, only at significance levels of 11% or higher. With both Models I and II, the coefficient estimates of DMAT are consistent with the traditional version of the HG Hypothesis under one of the possible interpretations of the coefficients. The traditional version holds that the more the duration of a firm's assets exceeds that of its liabilities, the longer the term of the bond offered. A priori reasoning suggested that when DMAT proxies for the duration of both assets and liabilities, the traditional version would be supported by the finding that smaller values of DMAT cause firms to pick longer bond terms. Confirming a priori reasoning, the coefficient estimates show that decreasing the fraction of maturing debt increases the odds of a medium- or long-term bond over a short-term bond (the DMAT coefficient estimates are negative and significant in the Z_{MS} and Z_{LS} equations).

The likelihood ratio tests also give strong support for the significance of RRATE as a determinant of bond maturity but equivocal support for the LP Hypothesis. The data reject the hypothesis of jointly zero coefficient estimates for RRATE at the 5% significance level or better in all three models (Table V). The coefficient estimates are highly significant in the Z_{LS} and Z_{LM} equations for all three models (Table IV, Panel A) but have algebraic signs exactly opposite of those that a priori reasoning suggested would support the LP Hypothesis. The LP Hypothesis holds that the larger the liquidity premium, the shorter the term of the bond offered. A priori reasoning suggested that higher real interest rates (higher RRATE) decrease firms' willingness to pay liquidity premiums to lock in long-term rates because of the greater chance of lower rates in the future, thereby decreasing the odds of longer term bonds over shorter term ones. The coefficient estimates imply instead, however, that higher real rates increase the odds of a long-term bond over a medium- or short-term bond (the RRATE coefficient estimates are positive and significant in the Z_{LS} and Z_{MS} equations).

The results for RRATE would support the LP Hypothesis if recently realized inflation rates are lagged indicators of expected inflation rates. Specifically, if the rate of CPI inflation rises more gradually than expected inflation rates, RRATE overstates the true real rate. Under the LP Hypothesis, this overstatement would cause RRATE and the odds of a longer term bond to be positively related (positive RRATE coefficient estimates in the Z_{LS} and Z_{MS} equations) because low true rates encourage risk averse firms to incur the liquidity premium and lock in a rate by picking long-term bonds. Conversely, if the rate of CPI inflation falls more gradually than expected inflation rates, RRATE understates the true real rate. Under the LP Hypothesis, this understatement would cause RRATE and the odds of a long-term bond again to be positively related because high true real rates discourage risk averse firms from incurring the liquidity premium and locking in a rate. Additional testing is clearly necessary before the LP Hypothesis can be said to be unequivocally supported. 20/

VI.C. Additional Results

The coefficient estimates of the MNL models provide considerable insight into the significance and direction of relationships between the independent and dependent variables. The estimates are otherwise difficult to interpret, however. In particular, the effect of a unit change in an independent variable on the dependent variables is not apparent owing to the non-linear relationship between the independent and dependent variables (Equation (3)). Hence, exercises in comparative statics were performed on the model estimates. For each model, the estimated probabilities that a bond is short term, medium term or long term were calculated by setting the continuous explanatory variables (DA, NWTD, ARETA, GRADE, LOGA, MATCH, DMAT and RRATE) equal to their sample means and setting the binary variable (REFIN) equal to zero. The probabilities were then reestimated after allowing for a one-standard deviation increase in one of the continuous explanatory variables or a one-unit increase in the binary variable, an increase substantially larger than one standard deviation. Table VI reports the results of this exercise for Model II. Not surprisingly, the largest changes in estimated probabilities resulted from changing the purpose of a bond from refinancing to financing ongoing or new projects. Such a change increases the estimated probability of a bond being long term by 34 percentage points while reducing the estimated probability of being medium term or short term by 27 and 7 percentage points, respectively. A one-standard-deviation increase in LOGA has roughly half the effect of a unit change in REFIN, changing estimated probabilities by as much as 17 percentage points. One-standard-deviation changes in DA, NWTD and DMAT have about half the effect of a comparable change in LOGA. A one-standard-deviation change in RRATE has one-third the effect of a comparable change in LOGA.

Finally, the predictive ability of the models was tested by using them to classify a holdout sample of 26 bonds. Table VII reports out-of-sample classifications for Model III; within-sample classifications are reported for comparison. Model III correctly classifies a slightly higher proportion of the holdout sample than the estimation sample: 65% versus 63%. Short-term bonds are most frequently misclassified in both samples, suggesting that one or more determinants of the bond maturity choice may have been omitted.21/

VII. Conclusion

This study sought to expand our knowledge of the determinants of corporations' debt maturity decisions. Testable hypotheses based on past theoretical and empirical work were posited and tested on a sample of newly issued bonds. Using terms of new bonds to study maturity determinants is a departure from past empirical work. The main strengths of this approach are more precise measures of the dependent and independent variables and more precise measures of the relationships estimated. The main limitation of this approach is its failure to control for potential interactions between maturity choices for bonds and other types of debt. A limitation shared with past empirical work is that the tests presented here are really joint tests of the debt maturity determinants and the variables used to proxy these determinants.

The study's major results are as follows:

1) Default probabilities play a leading role in firms' debt maturity choices. This role is consistent with the KMM version rather than with the BMSM version of the Default Probability Hypothesis. Specifically, lower default probabilities lead firms to increase the terms of bonds offered. Support for the KMM version implies that firms place a greater emphasis on maximizing firm value than cash flow. In addition, it suggests bond flotation costs are high relative to the interest cost savings from borrowing at lower short-term interest rates.

2) Agency problems also play a major role in debt maturity choices. This role is generally consistent with the MBHS version of the AP Hypothesis. In particular, larger agency problems lead firms to reduce the terms of bonds offered. Support for the MBHS version implies relatively high costs of writing and monitoring bond covenants, with the result that debt maturity choices are used to resolve agency problems. Of these problems, the information asymmetry and asset substitution problems appear to be resolved through public bond markets, whereas the incentive problem appears to be resolved through other credit markets.

3) Hedging behavior plays a smaller role in firms' debt maturity decisions,

with hedging behavior taking the form envisioned by the traditional version of the HG Hypothesis. Specifically, greater asset durations lead firms to offer longer term bonds. Support for the traditional version implies that firms give at least some weight to the goal of minimizing the effect of interest rate changes on share price.

4) Real interest rates have a significant effect on debt maturity choice. In addition, model estimates support the Liquidity Premium Hypothesis when the estimates are reinterepreted to take into account potential weaknesses in the real interest rate proxy. According to the LP Hypothesis, larger liquidity premiums lead firms to offer shorter term bonds. Support for the LP Hypothesis implies that liquidity premiums reach significant magnitudes and that firms are risk averse but have price-elastic demands for interest rate insurance.

This study suggests several possible avenues for future research. The MNL models were least successful in classifying and predicting bonds with short terms, suggesting the omission of one or more determinants of the maturity decision. The experiments performed here should be carried out on other, larger bond samples to verify the robustness of the reported results. As noted earlier, the firms in this study issued bonds relatively infrequently (less often than once a year), but many firms issued bonds every few months, probably as a result of SEC Rule 415. An unexplored question is whether "serial issuers" ran finer-tuned maturity policies than "infrequent issuers," or whether the maturity choices of the two issuers were largely similar. A particularly intriguing question is whether greater financial market volatility since the late 1970s has led to a shortening of firms' planning horizons and an accompanying shift in firms' maturity choices. Model estimation on samples drawn from earlier time periods could be used to investigate this question.

TABLE I
BONDS ISSUED BY SAMPLE FIRMS AND BY ALL
INDUSTRIAL CORPORATIONS

	NUMBER OF ISSUES		PRINCIPAL AMOUNT (BILLIONS OF DOLLARS)	
YEAR	SAMPLE	UNIVERSE	SAMPLE	UNIVERSE
1982	43*	280	4.7*	14.1
1983	28	210	2.9	14.3
1984	38	200	3.4	20.5
1985	107	396	15.4	37.4
1986	80	585	13.1	69.8
1982-86	296	1671	39.5	156.1

*July - December

FIGURE 1
DISTRIBUTION OF BONDS BY
ORIGINAL TERMS TO MATURITY

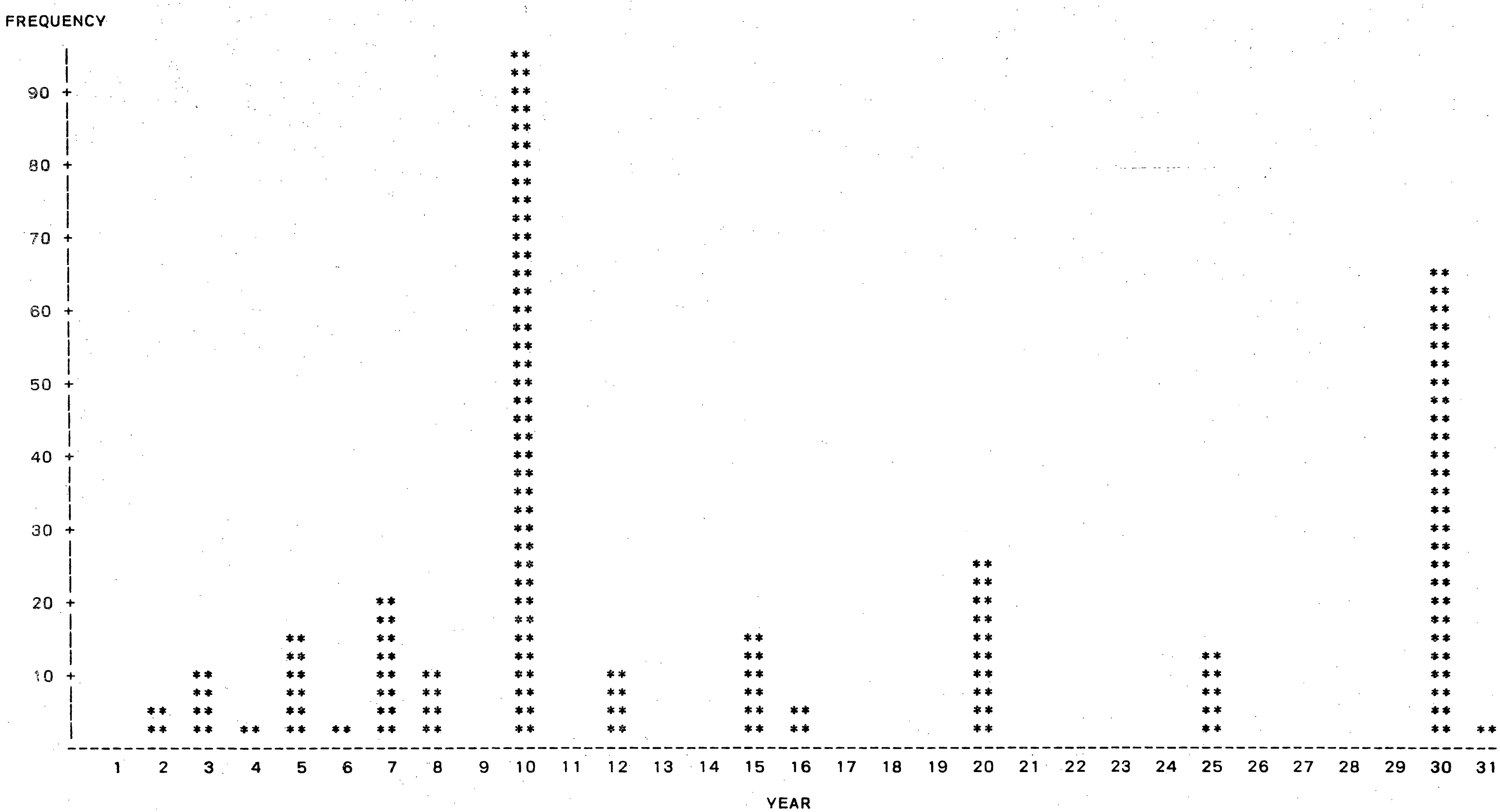

TABLE II
TESTS OF SIGNIFICANCE OF THE EXPLANATORY VARIABLES

Explanatory Variables	Short-term Bonds	Medium-term Bonds	Long-term Bonds	F Ratio	Signif-icance Level
Default Probability Hypo.					
DA	0.51	0.50	0.43	5.60	0.00
NWTD	1.37	2.14	2.78	2.00	0.14
ARETA	0.27	0.26	0.36	4.42	0.01
GRADE	3.33	2.85	3.78	7.49	0.00
Agency Problem Hypo., MBHS Version					
REFIN	0.62	0.70	0.91	6.19	0.00
EXPAND	0.14	0.17	0.19	0.12	0.89
GA @	0.10	0.12	0.10	0.29	0.75
LOGA	7.62	6.79	7.60	6.31	0.00
Agency Problem Hypo., Flannery Version					
DOM #	0.00	-0.01	0.00	0.27	0.77
ERROR !	2.02	-2.98	-3.27	1.35	0.26
Hedging Hypo., Traditional Version					
GAMMA +	0.35	0.40	-0.34	1.17	0.31
MATCH $	0.14	0.19	0.21	2.63	0.08
DMAT	0.49	0.43	0.34	4.35	0.01
Hedging Hypo., Morris Version					
CORR %	0.04	0.11	0.09	0.17	0.85
Liquidity Premium Hypo.					
RRATE	7.79	8.09	9.05	5.23	0.01
SPREAD	2.59	2.88	2.75	1.65	0.20

@ based on 144 observations
# based on 145 observations
! based on 127 observations
+ based on 128 observations
$ based on 147 observations
% based on 85 observations

TABLE III
CORRELATION MATRIX FOR THE EXPLANATORY VARIABLES

	DP Hypo.				AP Hypo., MBHS Ver.		HG Hypo., Traditional Ver.		LP Hypo.
	DA	NWTD	ARETA	GRADE	REFIN	LOGA	MATCH	DMAT	RATE
DA	1.00								
NWTD	-.40	1.00							
ARETA	-.72	.44	1.00						
GRADE	-.56	.14	.59	1.00					
REFIN	-.14	.13	.09	.08	1.00				
LOGA	-.23	-.15	.22	.73	-.10	1.00			
MATCH	-.06	.09	.09	-.16	.11	-.35	1.00		
DMAT	.06	-.12	-.13	-.18	-.20	-.22	.03	1.00	
RRATE	-.10	.05	.08	.14	.07	.11	.06	-.06	1.00

TABLE IV
MULTINOMIAL LOGIT ANALYSIS

Panel A: Model Estimates[a]

	MODEL I			MODEL II			MODEL III		
	Z_{MS}	Z_{LS}	Z_{LM}	Z_{MS}	Z_{LS}	Z_{LM}	Z_{MS}	Z_{LS}	Z_{LM}
CONST	9.65***	0.05	-9.60***	7.51***	-0.02	-7.52***	1.93	-6.11***	-8.05***
	(2.27)	(0.01)	(-2.81)	(2.17)	(-0.00)	(-2.61)	(0.93)	(-2.48)	(-4.20)
DA	-7.94**	-6.36	1.59	-4.37*	-4.18	0.19			
	(-1.90)	(-1.41)	(0.54)	(-1.53)	(-1.34)	(0.08)			
NWTD	0.16	0.44**	0.28***	0.10	0.38*	0.28***	0.24	0.52***	0.27***
	(0.65)	(1.71)	(1.96)	(0.42)	(1.60)	(1.96)	(0.98)	(2.07)	(2.30)
ARETA	-2.30	-1.73	0.57						
	(-0.98)	(-0.60)	(0.27)						
GRADE	-0.21	-0.20	0.01						
	(-0.49)	(-0.44)	(0.02)						
REFIN	0.04	1.79***	1.75***	0.07	1.90***	1.83***	0.39	2.39***	2.00***
	(0.06)	(2.01)	(2.28)	(0.11)	(2.20)	(2.45)	(0.66)	(2.90)	(2.74)
LOGA	-0.42	0.15	0.57***	-0.57***	-0.10	0.47***	-0.31*	0.18	0.49***
	(-1.21)	(0.38)	(1.96)	(-2.33)	(-0.37)	(2.28)	(-1.53)	(0.79)	(2.79)
MATCH	0.80	3.60	2.80						
	(0.29)	(1.16)	(1.32)						
DMAT	-3.00***	-3.66***	-0.66	-2.44**	-3.16***	-0.72			
	(-1.99)	(-2.19)	(-0.57)	(-1.72)	(-1.99)	(-0.63)			
RRATE	0.08	0.32**	0.24***	0.10	0.33***	0.24***	0.09	0.33***	0.24***
	(0.53)	(1.91)	(2.08)	(0.60)	(2.01)	(2.10)	(0.60)	(2.07)	(2.11)

a Asymptotic t-ratios in parentheses
*** Significantly different than zero at the 5% level
** Significantly different than zero at the 10% level
* Significantly different than zero at the 15% level

TABLE IV continued

Panel B: Goodness-of-Fit Measures and Likelihood Ratio Tests

	Model I	Model II	Model III
Likelihood Ratio Statistic[a]	49.03	45.21	39.02
McFadden's R^2 [b]	0.20	0.18	0.16
Akaike Information Criterion[c]	119.52	115.44	114.53
% of observations correctly classed	63.12	63.93	63.12
Likelihood Ratio Statistics, Explanatory Variables[d, e]			
DA	3.91 (.14)	2.48 (.29)	
NWTD	5.97 (.05)	5.82 (.05)	11.30 (.00)
ARETA	1.03 (.60)		
GRADE	0.26 (.88)		
REFIN	7.01 (.03)	8.40 (.01)	12.56 (.00)
LOGA	4.49 (.11)	9.14 (.01)	9.22 (.01)
MATCH	2.15 (.34)		
DMAT	5.47 (.06)	4.36 (.11)	
RRATE	5.93 (.05)	6.30 (.04)	6.40 (.04)

[a] $2 \ln [\ell(\hat{\beta}) / \ell(0)]$; tests the hypothesis that the coefficient estimates are jointly zero.

[b] $1 - [\ln \ell(\hat{\beta}) / \ln \ell(0)]$

[c] $- \ln \ell(\hat{\beta})$ + number of estimated coefficients

[d] $-2 \ln [\ell(\hat{\hat{b}}) / \ell(\hat{\beta})]$; tests the hypothesis that the coefficient estimates of the named variable are jointly zero.

[e] Significance levels in parentheses.

TABLE V
LIKELIHOOD RATIO TESTS OF
THE DP, AP, HG, AND LP HYPOTHESES

	DP coefficients jointly zero	AP coefficients jointly zero	HG coefficients jointly zero	LP coefficients jointly zero
Model I				
Log-likelihood restricted	-106.19	-104.91	-103.31	-102.49
unrestricted	-99.53	-99.53	-99.53	-99.53
DOF	8	4	4	2
Chi-square value	13.33	10.77	7.57	5.93
Significance level	.10	.03	.11	.05
Model II				
Log-likelihood restricted	-107.73	-109.76	-103.62	-104.59
unrestricted	-101.44	-101.44	-101.44	-101.44
DOF	4	4	2	2
Chi-square value	12.58	16.64	4.36	6.30
Significance level	.01	.00	.11	.04
Model III				
Log-likelihood restricted	-110.18	-114.78	N/A	-107.73
unrestricted	-104.53	-104.53	N/A	-104.53
DOF	2	4	N/A	2
Chi-square value	11.30	20.50	N/A	6.40
Significance level	.00	.00	N/A	.04

TABLE VI
COMPARATIVE STATIC EXERCISES USING MODEL II[a]

One-Unit Change in:	Change in the Estimated Probability of Being: Short-Term	Medium-Term	Long-Term
DA	9	- 8	- 1
NWTD	- 5	- 5	10
REFIN	- 7	-27	34
LOGA	12	-17	5
DMAT	10	- 7	- 3
RRATE	- 3	- 3	6

[a]Amounts are changes in percentage points

TABLE VII
PREDICTIVE ABILITY OF MODEL III

Panel A. Within-Sample Prediction

Actual	Predicted: Short	Medium	Long	Total
Short	2	13	4	19
Medium	2	38	14	54
Long	0	12	37	49
Total	4	63	55	122

Percent correctly classified: 63.1%

Panel B. Out-of-Sample Prediction

Actual	Predicted: Short	Medium	Long	Total
Short	0	1	1	2
Medium	0	11	4	15
Long	1	2	6	9
Total	1	14	11	26

Percent correctly classified: 65.4%

FOOTNOTES

1/ Charles W. Haley and Lawrence D. Schall, The Theory of Financial Decisions (second edition), New York: McGraw-Hill, 1979, p. 381.

2/ Like BMSM, KMM assume that bankruptcy is costly, but unlike BMSM, KMM let the probability of bankruptcy in each period be determined endogenously.

3/ TW do not define their short-term and long-term debt variables. However, given the data available from the Compustat files, short-term and long-term debt are most likely defined as liabilities due within one year and in one year or more, respectively.

4/ Boyce and Kalotay [9] and Brick and Ravid [11] present theoretical demonstrations of why divergences between corporate and personal income tax rates should lead value-maximizing firms to borrow long term with an upward-sloping yield curve and short term with a downward-sloping yield curve. Tests of the LP Hypothesis provide indirect evidence for this "Tax Wedge Hypothesis."

5/ Liquidity premiums represent added return that the marginal investor requires to compensate for unanticipated changes in the general level of interest rates and that the marginal risk-averse firm pays in exchange for locking in a certain rate. Kessel [25], Van Horne [43], Malkiel [28], Nelson [33], McCulloch [1975], and Friedman [19] find evidence suggesting that liquidity premiums increase with loan term. However, McCulloch finds that liquidity premiums are constant, whereas Kessel and Friedman find premiums vary directly with the level of rates and Van Horne, Malkiel, and Nelson find premiums vary inversely with the level of rates.

6/ Jensen and Meckling [22] identify reasons why the interests of managers and shareholders may diverge and, therefore, why firms may exhibit risk-averse behavior.

7/ Evidence for this a priori belief comes from the bond sample summarized by Figure 1 presented below, in which bonds with 14, 17, 18, 19, 21, 22, 23, 24, 26, 27, 28, and 29 years to maturity are absent. If a term to maturity of 27 years were not a near-perfect substitute for a term to maturity of 30 years, bonds with 27-year terms would be observed. Of course, the failure to observe bonds with certain maturities could be due to sampling error. But in view of the large size of the sample relative to the population (see Table I), sampling error seems unlikely.

8/ Firms that simultaneously issued "straight debt" and some other security were excluded from the sample. The sample period was chosen to start after the introduction of SEC Rule 415 (Shelf Regristration).

9/ A single proxy suffices to test both versions of the DP Hypothesis because the versions are competing hypotheses about the sign of the proxy's coefficient. In contrast, versions of other hypotheses are competing hypotheses about the determinants.

10/ Altman [2] found that defining net worth in market value rather than book value terms added to the predictive powers of the worth-debt ratio.

11/ Thatcher used the "unexpected growth rate," defined as the difference between the growth rate of gross plant and equipment in the five years following the bond issue and the growth rate during the five years preceding the issue.

12/ Operating margin is net operating income divided by sales. Operating margin was chosen in preference to profit margin (net income divided by sales) on grounds that the latter can be influenced by financial policy decisions.

13/ ΔI_t is calculated using averages of the Dow-Jones Bond Yield for the last week of the month rather than the Dow-Jones Bond Yield quoted for the last day of the month.

14/ GAMMA was estimated to be significantly different than zero at the 5% level for 16 of the 148 firms in the sample. For these firms, estimates of the two-factor model were used to generate year-ahead predictions of annual return for the ERROR variable.

15/ It should be noted that financing long-term assets with long-term funds would rarely hedge the net worth of an industrial firm against interest rate changes. Given the prevalence of the maturity-matching dictum, however, the MATCH proxy seems a logical determinant to test.

16/ Moody's triple-A corporate bond rate was used to gauge the level of long-term rates in preference to a U.S. government security rate on grounds that the latter is less representative of the opportunties facing corporations.

17/ According to the Flannery version, firms with "good" projects but facing information asymmetries choose short-term debt to signal project quality. The group means for ERROR show that firms choosing the short-term category had realized stock returns exceeding predicted returns in the year following the bond offering (high values of ERROR), suggesting that these firms had financed exceptionally good projects. In contrast, firms choosing the medium- and long-term categories had realized returns less than predicted returns (low values of ERROR), suggesting that they had financed "bad" projects.

18/ Hensher and Johnson [21] observe that values of McFadden's pseudo-R^2 of between 0.2 and 0.4 indicate extremely good fits (p. 51).

19/ The weaker support from Model I is a reasonable result if the DP Hypothesis is correct and if ARETA and GRADE are poorer proxies of default probability than DA and NWTD, in which case excluding ARETA and GRADE would cause little reduction in model fit.

20/ The coefficient estimates of RRATE are inconsistent with the Tax Wedge Hypothesis advanced by Boyce and Kalotay [9] and Brick and Ravid [11] (see Footnote 4). The Tax Wedge Hypothesis predicts that value-maximizing firms borrow long-term (short-term) when the yield curve is upward-sloping (downward-sloping). Despite the yield curve's being upward-sloping throughout the 1982-86 period, many firms nevertheless offered short-term bonds. Moreover, it is doubtful that RRATE would have had a measurable effect on the choice of bond terms if the Tax Wedge Hypothesis were correct that the yield curve's slope alone mattered.

21/ An alternative explanation for the frequent misclassification of short-term bonds is related to the "independence of irrelevant alternatives" problem. Specifically, firms may regard the short-term/medium-term bond distinction as trivial for the same reason that a traveler may regard a red bus/blue bus distinction as trivial when all he really desires is transportation (see Maddala [26]). That firms would view issuing, say, three-year bonds as equivalent to issuing thirteen-year bonds is difficult to accept on a priori grounds, however. Estimates of Models I, II, and III on a subsample of short- and medium-term bonds suggest that the misclassifications are more likely due to omitted determinants than to an irrelevant distinction: likelihood ratio tests reject the hypothesis of jointly zero coefficient estimates at reasonable significance levels.

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