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I am submitting herewith a dissertation written by Alan James Kirkpatrick entitled "Firm-Specific Influences on Liability Maturity Structure." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Business Administration.

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FIRM-SPECIFIC INFLUENCES ON LIABILITY MATURITY STRUCTURE

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ABSTRACT

The repayment schedule is a fundamental characteristic of a debt security which, along with such items as amount and rate, must be specified in order to completely define the security. The levered firm's overall liability maturity structure represents these repayment plans collectively. This research addressed the influence of firm-level factors on observed liability maturity structures.

The literature in finance suggests maturity structure roles for certain attributes of the income stream of the firm, as well as the assets generating the income. However, there are few empirical tests of the liability maturity structure matter in general, only one of which is cross-sectional in focus. Therefore, the research involved measurement and tests of the theoretically derived influences bearing on the maturity decision, including asset growth, expected lives of assets, variability of income, covariability of income with interest rates, and the proportion of assets financed with debt. The liability maturity structures of the sampled firms were directly obtained with the duration measure.

The regression results indicate statistical significance of asset lives, asset growth, and the extent of debt capital financing, thereby supporting maturity structure relevance of the habitat theory, principal-agent relationships, and the interplay of amount with maturity of debt. The risk reduction role of income-interest rate patterns is unclear and dependent upon variable measurement alternatives. The variability of firm income, viewed as a risk measure, was not statistically significant. The research demonstrates that

liability maturity structures are established in recognition of identifiable characteristics of firms.

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LIST OF ABBREVIATIONS OF REGRESSION VARIABLES

ld	=	liability duration
ad	=	asset duration
corr	=	correlation between net operating income and interest rates
g	=	growth rate of fixed assets
cv	=	coefficient of variation of net operating income
dr	=	debt ratio
ld_{t-1}	=	lagged liability duration
ld/ad	=	ratio of asset to liability duration
interact	=	$corr_*dr$ (interaction term)

CHAPTER I

INTRODUCTION

The concept of corporate liability maturity structure refers to the composition of debt obligations of firms with respect to time to maturity. The maturity schedule is a characteristic which must be established for each debt obligation and it therefore constitutes a required decision faced by every firm employing debt. In spite of the fundamental nature of this issue, the finance literature does not offer a dominant theoretical background, and the available empirical tests do not unambiguously resolve the factors which statistically influence liability maturity structures of firms. This research will assess the relationship between firm-level factors and liability maturity structure. In particular, the research focuses on the association between certain characteristics of the income stream of the firm, the assets which generate this income, and the maturity structure decision.

Firms select from a spectrum of maturities ranging from a few days to several decades. The decision-making environment includes lenders whose interaction is reflected in their willingness to hold the dated claims offered by the firm. The scheduled maturity of a particular debt obligation should be a feature of the loan contract which is established in recognition of some identifiable factors. In turn, these individual maturity choices collectively form a liability portfolio for which there exists a measurable time dimension based on the repayment dates of the individual debt obligations.

The maturity choice has important consequences for investors. The most obvious concern involves the possibility of default on an obligation because of insufficient cash flow generation by the firm. Unless renewal or extension occurs, the original maturity choice could cause the firm to be in default on a debt obligation which calls for repayment when the firm is generating relatively low cash flows. Further, since the interest rates on short term debt will be revised more frequently to prevailing market rates than will rates on relatively longer term debt, the maturity choice affects the variability of the interest expense of the firm. This in turn affects the variability of the tax shield provided by interest expense, and therefore, the stability of net income (as well as measures such as earnings per share). Therefore, it only seems reasonable that repayment schedules are carefully considered and not arbitrarily chosen. Further, the nature and circumstances of the firm must dominate those of the lender in the establishment of maturity; a lender whose own circumstances call for a maturity other than the one appropriate for a particular firm will be attracted to the debt obligations of another firm with different underlying characteristics. Identification of characteristics bearing on the maturity decision is the focus of this study.

Even with these indications of the significant role of the maturity structure of debt capital, the time dimension of corporate liabilities is usually obscured. The liquidity and leverage ratios used in financial condition analysis do not accurately reflect repayment plans. In the case of the current ratio, we observe a crude partitioning of debt into only two maturity categories (short or long term), following the traditional one-year cutoff point. The total debt ratio, which is the basic measure of financial leverage of a firm, makes no distinction whatsoever between debt of various maturities. The various coverage ratios are somewhat more attuned to the time dimension of debt, but only the current period cash inflows and repayments are considered. Curiously, overall liability maturity structure measures are not found in financial statements or other financial data sources, even though liability maturity structure lends itself to direct measurement.

This research investigates whether firm-level characteristics exist which might systematically determine the location of firms along the liability maturity continuum. The concentration is on cross-sectional statistical tests of several factors thought to influence maturity decisions. The duration concept is employed as a direct measure of liability maturity structure for a sample of manufacturing firms. The results indicate that maturity decisions can be traced to underlying characteristics of firms, such as asset lives, the extent of debt financing, and the growth rate of assets. Thus, in addition to verifying the practice of matching liability maturities to asset lives, the research explains why firms might choose not to match maturities.

CHAPTER II

LITERATURE REVIEW AND HYPOTHESES

The purpose of this chapter is to provide a survey of the literature related to corporate liability maturity structure and to state hypotheses corresponding to unanswered questions on the subject. Section A addresses the reasoning behind the habitat theory under which firms choose liability maturities in light of asset lives. This concept represents the earliest related literature activity and continues to provide fundamental insight. Section B contains an evaluation of alternative specifications of the risk associated with the maturity structure issue. The next part of this chapter, Section C, analyzes the role of income patterns in maturity structure decisions. Section D considers the similarities between the maturity decision and the fixed versus variable rate debt instrument decision. The relationship between agency problems and maturity structure will be developed in Section E. Section F contains a discussion of floatation costs and call premiums. Section G summarizes the theoretical influences on liability maturity structure. Section H includes the methodology and results of the few existing empirical studies on this subject, and the final subdivision of Chapter II, Section I, summarizes the unresolved issues leading to the hypotheses of this research.

A. THE HABITAT THEORY

The habitat theory indicates that firms can protect net worth from variability in an environment of fluctuating market interest rates if the maturities of debt obligations are chosen to correspond to the expected lives of the assets held by the firm. Redington [17] developed this maturity strategy on the corporate level in 1952, while in 1966 Modigliani and Sutch [13] provided the "preferred habitat" label in the context of maturity decisions. The theme of the habitat theory revolves around the lives of assets of the firm in the sense that asset maturities establish and reflect the preferred maturity habitat. The synchronized liability maturity strategy which results is variously referred to as "immunizing," "matching," or "hedging," and is included in corporate finance texts as a viable maturity strategy.[1]

The simplest form of the habitat theory involves an asset expected to generate cash flow at some future date associated with a liability maturing at the same point in time. In the likely case of periodic cash flows, the liability repayment plan is established to be correspondingly gradual. The approach can be expanded to deal with a collection of assets grouped into current and fixed asset categories. Maturities are considered approximately matched by financing the permanent portion of current assets and the fixed assets of the firm with long term debt (and/or equity); then, the inevitable fluctuations in current assets during the operating cycle

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[1]For example, see Van Horne [23].

are financed with relatively short term borrowings. Precise implementation of the habitat theory becomes elusive as one considers complex balance sheet structures of large firms. However, perception and estimation of the (asset) habitat can realistically serve as a guide to the selection of liability maturities.

The most apparent rationale for following the matching strategy involves an orderly retirement of debt obligations. Scheduling debt repayments to correspond with expected asset cash returns reduces the possibility of default, as well as providing logical and efficient use of funds. Mismatching a short term liability with a relatively long-lived asset creates the problem that repayment will occur before full receipt of the cash flows from the asset. Although lenders often accommodate renewal of short term debt instruments, there exists the potential problem that weak firm performance could make renewal troublesome, costly (in the form of a higher borrowing rate), or perhaps impossible. At the least, successful renewal of short term debt creates some transactions costs and inconvenience. The other departure from the matched position occurs if the liability maturity chosen occurs after the asset ceases to generate cash inflows. In this case, the problems include inconvenience and transactions costs of investment in some temporary asset (or the return lost on idle funds), or a prepayment penalty on early retirement of the debt.

The second justification for matching asset and liability maturities focuses on the effect on net worth in an environment of fluctuating market interest rates. Changes in these rates influence discount rates, and lead to alteration of the present value of the cash flows associated with the assets and liabilities. If the maturities are matched, these present value changes are offsetting and net worth in market value terms will be unchanged, regardless of the direction of change in interest rates. If the asset and liability maturities are not matched, net worth will increase or decrease, depending on the actual direction of change in rates and on relative asset and liability maturities. Given an asset financed with comparatively short term debt and an increase in rates, the decrease in the present value of the asset will exceed the decrease in the present value of the liability, causing net worth to decline. The use of a relatively longer maturity liability results in an increase in net worth if interest rates increase.[2] Only if maturities are matched will net worth maintain its initial level.

Samuelson [19] used these principles to show how financial institutions can benefit from a seemingly unfavorable increase in interest rates if the maturity of liabilities exceeds that of assets. However, an element of risk is present since interest rates might instead decline. Grove [7] assessed this uncertainty for investors whose utility functions include expected net worth and variance of net worth. Not surprisingly, the maturity strategy chosen depends on risk tolerance; investors may accept some net worth variability for the possibility of enhancing their net worth by choice of differing asset and liability maturities. The matching strategy is selected by extreme risk averse investors or by those who perceive equal prob-

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[2]The changes in net worth are in the opposite direction if interest rates decline.

abilities of an increase or decrease in future interest rates. However, it is apparent that maturity mismatching can provide an increase in net worth if interest rates are accurately forecasted. Grove developed a measure of the investor's willingness to gamble in this manner and labeled it an "index of the wealth-holder's audacity," implying the difficulty of consistently accurate interest rate forecasts.[3]

Protection of net worth can be achieved without matching the maturities of assets and liabilities through participation in the financial futures markets. If asset maturities are shorter than liability maturities, the decline in net worth associated with a decrease in market rates can be offset by the purchase of a futures contract (on a bond). On the other hand, if asset maturities are longer than liability maturities, the decline in net worth associated with an increase in market rates can be offset by selling a futures contract. Thus, the immunization objective can be consistent with mismatched maturities, at least to the extent that futures markets are used for immunizing (based on current reporting standards, futures market activity cannot be gleaned from financial statements). Notably, the use of futures contracts in this manner ignores potential debt service problems of a firm choosing relatively short term liabilities.

The literature concerning the habitat theory describes the time dimension of assets and liabilities with the duration measure,

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[3]Grove [7], page 48.

originally developed by Macaulay [11]. The duration of a stream of cash flows can be written:

$$D = \sum_{t=1}^{T} (t)(C_t)/(1 + r)^t \Big/ \sum_{t=1}^{T} (C_t)/(1 + r)^t \qquad (1)$$

where,

t = year of the cash flow (in coded units)

C_t = cash flow, year t

T = final year of cash flow

r = discount rate

This measure of average maturity can be calculated at the level of the individual investor or, with more effort, at the level of the firm.

The habitat concept suggests that corporate liability maturity structure decisions are made with reference to the expected lives of assets. The justifications involve concern about orderly retirement of debt obligations in accordance with the pace at which assets generate cash inflows, transactions costs, and net worth variability.

B. MATURITY STRUCTURE DECISIONS AND SYSTEMATIC VERSUS TOTAL RISK

The extensive use of the capital asset pricing model (CAPM) in the finance literature encourages consideration of it as a potential analytical framework for the maturity structure issue. The CAPM specifies systematic risk as the relevant risk of a security for diversified investors under perfect market conditions; according to the model, firm-specific (unsystematic) risk is unimportant because it can be eliminated by extensive diversification. Insofar as corporate maturity structure research is concerned, the appropriateness of the CAPM can be judged by reference to the general compatibility of the model with the issues to be resolved, as well as whether any firm-specific maturity structure influences derive from its application.

Morris [15] assessed the relationship between debt maturity and equilibrium expected returns within the traditional CAPM framework. Appendix A contains Morris' derivation which indicates that systematic risk is affected by maturity choice and the covariance between interest costs and the return on the market, $cov(I,R_m)$.[4] If the firm borrows short term and $cov(I,R_m)>0$, systematic risk declines relative to its level under a longer term strategy. More specifically, if interest costs are positively related to the return on the market, net income will be negatively associated with the return on the market because higher (lower) interest costs reduce (increase) net income. The resulting negative relationship between return on the market and net income implies lower systematic risk if $cov(I,R_m)>0$. If $cov(I,R_m)<0$, systematic risk will be lower with long term debt.

The multi-period nature of the maturity structure issue is not entirely compatible with the traditional, single period CAPM. Morris

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[4]Holding debt level constant, the covariance measure is $cov(r,R_m)$, where r is the firm's borrowing rate.

noted this and used the multi-period Bogue and Roll [3] model in a second attempt to link expected returns with debt maturities. In this case, asset prices are based upon the expected association (during each of several future periods) between interest costs and the value of the market portfolio.[5] However, this is not a reliable multi-period analysis of maturity choice since the Bogue and Roll model relies heavily on the traditional CAPM framework, yet it allows uncertainty in the risk-free rate, which is not consistent with the CAPM.[6]

The extended CAPM developed by Long [10] was used to more properly address the asset pricing role played by debt maturity decisions.[7] This model is a multi-period, discrete time conceptualization of expected equity returns, in which both consumption good prices and interest rates are uncertain. The analysis in Appendix B indicates that maturity structure can affect expected return based on the signs of the following covariances:

1. The covariance between interest costs (or rates) and the return on the market, $cov(I,R_m)$.
2. The covariance between interest costs (or rates) and the inflation rate, $cov(I,I^*)$.

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[5]The derivation was done in terms of dollar value instead of percentage returns.

[6]Fama [5] refers to the interest rate variability in this model as "inadmissable uncertainty."

[7]Specific results were not obtained using the multi-period model developed by Merton [12].

3. The covariances between interest costs (or rates) and the return on bonds of various maturities, $cov(I,R_{bm})$, where the subscript "m" indicates bond maturity dates.

The first covariance term, $cov(I,R_m)$, was apparent earlier in the traditional CAPM framework (as well as in Morris' multi-period analysis), although only here does it play a legitimate role, since Long's model specifically allows for stochastic interest rates. The additional covariances arise out of investor concern about the wealth impact of future prices of goods and the future level of interest rates; that is, investors are concerned with factors beyond the mean and variance of their future wealth.

Application of asset pricing models to the liability maturity issue seems to indicate that firms can alter their systematic risk level by arrangement of liability maturity dates. If one assumes that capital markets operate in this manner, a question arises regarding the benefits accruing to the firm. A maturity strategy which reduces systematic risk results in a commensurate reduction in expected return, but there is not an optimal security market line position. Further, portfolio theory indicates that investors hold the market portfolio of all risky securities in some combination with the risk-free asset; a change in the beta level of one or more securities leaves the beta of the market portfolio unchanged.

If market imperfections not addressed by the CAPM are introduced, investors will be concerned with the total variability of returns and alternative maturity arrangements will be important. Perhaps the most important market imperfection for the subject at hand is the possibility of costly bankruptcy. In perfect markets there are no value losses associated with bankruptcy, since the assets of the firm are assumed to draw their full economic value and no direct expenses are incurred in dissolution. In reality, bankrupt firms can incur "dead-weight" losses[8] associated with liquidation under distressed circumstances, legal and accounting activities, and operational disruptions. The potential for bankruptcy and any related costs are not captured in the CAPM; that is, bankruptcy drains are not reflected in the covariance between the firm's returns and that of the market (systematic risk). Bankruptcy is instead related to the unsystematic risk of the firm and bankruptcy concerns are inextricably linked to maturities of debt instruments. This suggests that maturity structure is logically assessed within the total risk framework, within which both systematic and unsystematic risk are relevant. In general, this framework becomes appropriate the greater the departure from the perfect markets assumptions of the CAPM (for example, the existence of transactions costs limit the ability of investors to hold the well-diversified portfolios necessary to eliminate unsystematic risk).

Another market imperfection involves lack of availability of complete information about the asset and liability maturity structures of the firm. One can argue (within the perfect markets

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[8]These costs are not necessarily incurred if the capital structure of the firm is reorganized as suggested by Haugen and Senbet [8]; in this case, the (smaller) costs of reorganization involve the transactions costs associated with issuing new stock and retiring the debt of the firm.

assumption of the CAPM) that investors can create their own preferred maturity structure making firm level concern unimportant. This presumes that investors have full information regarding the asset and liability maturities of the firm. Realistically, publicly available maturity information is somewhat less than complete (notably on the asset side); thus, although investors may not have sufficiently detailed information about maturities (so that, for example, they can immunize their net worth), the management of the firm does have access to the pertinent information.[9] The conclusion must be that the firm cannot ignore the importance of its maturity structure on the grounds that investors will create their own "homemade" maturity structure, because investors have incomplete information.

In addition to the foregoing discussion of the conceptual incompatibility of the CAPM with the maturity structure decision, the model does not provide any insight into firm-specific influences. The level of the covariance between interest costs (or rates) and the market return is a market level factor confronted by all firms identically; this is also the case for the covariance terms in Long's extended CAPM.

In a recent paper, Reuben [18] demonstrated algebraically that returns generated by the firm are unaffected by liability maturity structure. Although alteration of maturity structure in the model can reallocate risk and expected return among the various security

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[9]For example, a firm might mismatch asset and liability maturities, yet effectively immunize via financial futures. Investors, though, cannot know of these futures contracts because the holdings are not disclosed in financial statements.

holders, the total value of the firm remains unchanged. These results are partially due to exclusion of bankruptcy costs and the fact that the model treated short and long term debt equivalently as far as interest deductibility is concerned.[10] Reuben's empirical test demonstrates that operating returns are unaffected by the ratio of short to long term debt during periods of stable interest rates, yet returns were (negatively) related to the short term debt ratio during periods of high and unstable rates. These empirical results indicate that maturity decisions play an important role in financial management.

C. INCOME VARIABILITY AND CORPORATE DEBT MATURITY

Within the total risk framework, investors will be concerned about the variability of the net income of the firm and the potential transmission of this risk to stockholder returns. Morris 15 considered the effect of alternative maturity strategies on net income variability. Consider first a matching approach where an asset is supported by a liability of equivalent maturity; interest cost in this case is constant and the expected value of net income is:

$$E(NI) = (\widetilde{NOI} - I)(1 - T) \qquad (2)$$

where,

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[10]The next section of this chapter indicates that the variability of net income is affected differently by the interest expense on short versus long term debt.

$\widetilde{NOI}$ = net operating income, a random variable as denoted by the tilde

I = interest charges

T = tax rate

With the matched asset and liability maturities, the variance of the probability distribution of net income is $(1 - T)^2 \sigma^2_{NOI}$. This result serves as a benchmark for evaluating the effect on the dispersion of the net income distribution if a relatively short term debt strategy is used.

Now consider an alternative maturity decision involving a series of short term obligations (for example, one year maturities) as the source of funds for the same, longer lived asset. If the borrowing rate is a normally distributed random variable, interest expense will be similarly distributed, and expected net income can be written:

$$\begin{aligned} E(NI) &= E[(\widetilde{NOI} - \tilde{I})(1 - T)] \\ &= E[\widetilde{NOI}(1 - T)] - E[\tilde{I}(1 - T)] \end{aligned} \tag{3}$$

The variance of net income under short term financing is:

$$\begin{aligned} \sigma^2_{NI} &= E\{[\widetilde{NOI}(1 - T) - \tilde{I}(1 - T)] \\ &\quad - E[\widetilde{NOI}(1 - T) - \tilde{I}(1 - T)]\}^2 \\ &= E(1 - T)^2 \{\widetilde{NOI} - E(\widetilde{NOI})\}^2 \\ &\quad + (1 - T)^2 \{\tilde{I} - E(I)\}^2 \\ &\quad - 2(1 - T)^2 \{\widetilde{NOI} - E(\widetilde{NOI})\} \{\tilde{I} - E(\tilde{I})\} \\ &= (1 - T)^2\sigma^2_{NOI} + (1 - T)^2\sigma^2_I - 2(1 - T)^2 \operatorname{cov}(\widetilde{NOI},I) \end{aligned} \tag{4}$$

The variance of net income with a short maturity strategy will be greater than under the matching strategy if cov(NOI,I) $\leq$ 0, since the sum of the second and third terms in equation (4) will be positive (σ^2_{NI} with matched maturities is equivalent to only the first term in (4)). However, if cov(NOI,I) $>$ 0, and if the third term in (4) exceeds the second, the variance of net income can be reduced with a series of short term obligations. In other words, with short term borrowing and positive association between net operating income and interest rates, fluctuations in net operating income which would otherwise be transmitted to net income are smoothed by similar fluctuations in interest costs. High operating income levels will be associated with high interest costs, and the tax shield provided by interest will be large when the firm has more taxable income to shield. Similarly, if net operating income falls together with interest costs, the tax shield falls when it is least needed (and the risk of default due to nonpayment of interest declines). The fluctuating interest and the associated tax shield work to the advantage of both equity and debt investors by reducing the dispersion of net income.

This analysis points to the covariance between net operating income and interest rates as a firm-specific influence on corporate liability maturity structure.[11] There may be limitations to the application of the proposition, such as concern about non-renewal. On balance, however, it is plausible that firms consider maturity decisions in light of their operating income-interest rate patterns.

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[11]The empirical test by Morris is discussed in Section H of this chapter.

D. THE ASSOCIATON BETWEEN MATURITY STRUCTURE AND VARIABLE RATE DEBT INSTRUMENTS

A firm can achieve the potential reduction in net income variability offered by short term debt without actually borrowing short term by obtaining longer term debt with a variable rate provision. A liability with, for example, annual interest rate adjustments based on prevailing market conditions, is effectively a one-year liability as far as interest expense variability is concerned. Additionally, the variable rate debt may lessen concern over possible non-renewal of short term debt, and it serves to reduce inconvenience and transactions costs associated with renewals.

Agmon, Ofer, and Tamir [1] developed an approach to the decision between fixed and variable rate debt instruments. Their analysis involved maximization of a stockholder return objective function which incorporated the effect of alternative debt repayment schedules generated by various combinations of fixed and variable rate liabilities. The particular proportions of fixed and variable rate debt depend on market and firm-specific variables. The market factors include:

1. the relative required returns on fixed and variable rate debt, since a sufficiently low required return for one type or the other would encourage its use, and
2. the magnitude of the variance of the variable debt repayment, σ^2_{VDR}, implying concern over highly unstable debt service.

As with the case for maturity choice, the firm-specific influences on the rate provision decision revolve around the nature of the operating income stream of the firm. These are: (1) the variance of the firm's operating income, σ^2_{NOI}, and (2) the covariance between net operating income and the variable debt repayment, cov(NOI,VDR). The role of σ^2_{NOI} was not specifically discussed by Agmon, Ofer, and Tamir, although it appears that large values of σ^2_{NOI} would discourage use of variable rate debt. The authors do show that if cov(NOI,VDR) > 0, the use of variable rate debt is favored. If cov(NOI,VDR) ≤ 0, the decision goes exclusively to fixed rate debt.

The preceding discussion regarding the choice between fixed and variable rate debt quite closely parallels the choice between short and long term debt. It was shown in the preceding section that relatively short debt maturities can reduce the dispersion of the distribution of net income if the firm-level covariance between net operating income and interest charges, cov(NOI,I), is positive. The work by Agmon, Ofer, and Tamir indicates preference for variable rate debt instruments if cov(NOI,VDR) is positive. These covariances are nearly equivalent, with the difference being that cov(NOI,I) does not address principal repayment, while VDR in cov(NOI,VDR) does. This is predictable since cov(NOI,I) resulted from assessment of the effects on net income variance, and principal repayment does not appear in the calculation of net income. More importantly, however, cov(NOI,VDR) is non-zero only due to fluctuations in the interest portion of the variable debt repayment. Thus, variable rate debt theory bypasses any alternatives regarding maturity by assuming repayment at the end of the time horizon; similarly, maturity theory does not directly consider possible renewal difficulties. In any event, positive values of cov(NOI,I) and/or cov(NOI,VDR) offer potentially favorable interest expense variability for firms choosing short term and/or variable rate debt, respectively. Agmon, Ofer, and Tamir state that "firms should search for and issue variable rate debt instruments with a payment schedule that has a positive covariance with the firm's operating income."[12] The words "short term" can be substituted for "variable rate" in this quotation, demonstrating consistency between the maturity and rate provision issues. As additional support for the similarity, the variable rate theory indicates that a firm will tend to choose variable rate debt the larger the expected ratio of cov(NOI,VDR) to σ^2_{VDR}. This corresponds to the importance of the relative magnitudes of the terms in equation (4) in the context of maturity choice.

The extension of fixed or variable rate loans by financial institutions was recently addressed by Santomero [20]. As before, the preferred funding strategy is influenced by the covariance between the return on the loan and the institution's funding costs; anticipation of positive (negative) covariance induces choice of variable (fixed) rate liabilities. Further, the variance of return at the institution level is affected by the covariance of the borrower's project with interest rates (or inflation). Projects with returns negatively associated with interest rates increase the risk of default on a variable rate loan. The nature of the rate provision

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[12] Agmon, Ofer, and Tamir [1], page 125.

matter is again shown to be consistent with the maturity decision, even to the extent of recognizing the importance of characteristics of the institution's borrower as financial intermediation takes place.

It has been shown that the association between asset returns and interest rates can be used to reduce the total risk of a firm given an appropriate rate provision or maturity decision. Yet, the rate provision matter has not been demonstrated with data from firms and the corresponding maturity choice has not been tested with an actual measure of liability maturity structure. This research will provide statistical insight into these and other influences on corporate liability maturity structures.

E. AGENCY THEORY AND THE MATURITY STRUCTURE DECISION

The financial theory of the agency relationship, developed by Jensen and Meckling [9], is generally concerned with the lack of perfect alignment of the objectives of the principal and agent. The divergence of objectives calls for the principal (for this application, the lender) to offer appropriate incentives to discourage the agent (the owner/manager) from taking actions detrimental to the welfare of the principal. The principal will also conduct costly monitoring activities to help assure that the agent acts in the best interest of the principal. The agency problems which are pertinent in this research involve informational asymmetry, owner risk incentives, and suboptimal future investment decisions.

Barnea, Haugen, and Senbet [2] discuss the circumstances under which debt maturity affects agency costs associated with potential differences between agent and principal regarding perception of the investment opportunities of the firm. The owner may not precisely communicate to the lenders the true nature and value of the firm (including future investment opportunities), and this may in turn cause lenders to undervalue the firm's debt at purchase. With long term financing, the cost of the misperception is permanent; however, if the debt matures soon after the true nature of the firm is revealed, the excessive return required by lenders has a minimally unfavorable present value effect on the debt. At this point, the firm is revealed and the yield required by lenders will be properly established based on a correct assessment of the firm.

The second agency problem is concerned with the relationship between debt maturity and the owner's incentive to switch (after debt funds are raised) to riskier projects than originally envisioned by lenders. The basis for this incentive is that owners can be viewed as holding an option to buy back the firm at an exercise price equal to the face value of the debt, and the value of this option is an increasing function of the variability of returns on the assets of the firm. Thus, owners have an incentive to acquire risky assets to enhance their wealth at the expense of debtholders.[13] Lenders will anticipate this risk incentive problem and offer a lower price (equivalently, a higher required return) for the debt, and the owners

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[13]Galai and Masulis [6], page 64.

should take steps to avoid this incentive and the associated agency cost. Barnea, Haugen, and Senbet [2] indicate that lenders' concern over asset switching can be attenuated by the use of relatively short term debt. The short maturity choice is effective because the value of a short term option is less sensitive than a longer term option to a change in the variance of the returns of the underlying asset.

The third agency problem related to debt maturity concerns the discretionary nature of future investment opportunities. If debt matures before an investment option expires, the owners will make the investment if its net present value (NPV) exceeds the required repayment to the lenders; if the NPV is less than the required repayment, the (single opportunity) firm will be taken over by the creditors who will themselves make the investment if the NPV is positive. If the debt matures after the investment option expires, the potential exists for the NPV to be less than the required repayment (but positive nonetheless), yet the lenders cannot exercise the expired option. Thus, long maturity debt can create suboptimal investment decisions and reduced firm value. Although this concept was originally developed by Myers [16], a related problem has been identified by Bodie and Taggart [4], wherein owners of firms with long term debt cannot reap all of the benefits of future investments because some of the benefit goes to lenders via a reduction in the probability of default (although they continue to receive the same coupon).

Barnea, Haugen, and Senbet [2] also show how callable debt serves a purpose similar to short term debt in reducing the effects of agency problems. However, because of commonly imposed call deferment periods[14], maturity appears to be the better way to control agency problems in practice.

In each of the three cases, agency problems and costs are related to investment opportunities. Further, the problems are consistently reduced with relatively short term debt. Thus, this research will pursue the statistical association between cross-sectional growth rate differentials and liability maturity structure.

F. FLOATATION COSTS AND CALL PREMIUMS

Maturity decisions could be influenced by the nature of floatation costs on bonds. Specifically, if floatation costs are equivalent across all maturities, firms would have the incentive to issue the longest possible maturity in order to reduce the frequency of incurring these costs. Morris [14] developed an iterative approach to find the least costly maturity choice, based on the present values of interest and floatation costs associated with different maturities. In the model, floatation costs consisted of a fixed element (independent of the maturity of the debt) and a variable element, which was positively related to maturity (i.e., longer term bonds involve greater floatation costs). The optimal maturity choice depends on the relative importance of the fixed and variable components of floatation costs. Other things equal, a large fixed component increases the preferred maturity, while a larger variable

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[14]Van Horne [23], page 617, indicates corporate bonds are frequently not callable for ten years from the date of issuance.

component reduces the preferred maturity; if the variable component is trivial (i.e., if floatation costs are the same for all maturities), the model confirms the notion of using the longest possible maturity to minimize the frequency of incurring floatation costs. Therefore, floatation pricing influences the maturity decision, although such pricing arrangements should be confronted similarly by all firms. Even if this were not the case and the fixed and variable portions of floatation costs varied across firms, no clues are available to describe the types (or characteristics) of firms exposed to greater or lesser variable floatation costs.

Call provisions allow the firm to retire a bond issue prior to its scheduled maturity. In order to call a bond, the firm must pay a call premium to the bondholders and the bond issue in question must be beyond the call deferrment period. The most apparent motivation for calling a bond is to reduce interest expense if rates decline after the bond is issued. In this case, bondholders will suffer a drop in yield as they reinvest the price received for their bonds. However, compensation and protection is available in the form of higher coupons on callable bonds, call premiums, and call deferrment periods. Since there is no reason to believe firms have better interest rate forecasting abilities than bondholders, the call premiums and coupons on callable bonds will be set to result in indifference as to whether an issue is callable or not.

There is, however, a potential problem when measuring the liability maturity profile of a firm with callable debt. If there is a possibility of an issue being called, the nominal maturity will be overstated. The likelihood of a bond being called depends on a number of factors including the coupon rate, the schedule of call premiums, the call deferrment period, and most importantly, the trend in future interest rates. In measuring liability maturity structures, there is no apparent method for adjusting the stated maturities of callable debt. Actually, there is a distinction between the case of early retirement due to a call versus the case of a correspondingly short term debt instrument; in the former case, the decision rests entirely with the firm while in the latter case, the firm must be in position to repay. Suppose a long term callable bond for a given firm has a potential maturity of three years based on the expectation of a call at that point in time, and another debt item has a specific and required maturity of three years; equivalent maturity treatment of these obligations in a calculation of liability maturity structure is obviously incorrect. The callable bond _may_ be retired early at the option of the firm, but the firm will not be _required_ to do so; a similar degree of discretion does not exist on the obligation with the definite maturity.

G. SUMMARY OF THE THEORETICAL INFLUENCES ON LIABILITY MATURITY STRUCTURE

The purpose of this section is to summarize the firm-specific factors bearing on the maturity decision. The overall purpose of this research is to verify such factors in a cross-sectional multiple regression.

The habitat theory suggests that liability maturity decisions are made with reference to the expected maturities of the assets of the firm; that is, firms with relatively short (long) asset lives will tend to employ relatively short (long) maturity debt. Adherence to the matching strategy implied by this theory offers synchronization of cash inflows and outflows, and immunization of the market value of net worth.

The second firm-specific influence identified in the literature is the association between net operation income and short term interest rates. If the covariance between these variables is positive, the use of short term (or variable rate) debt can reduce the total risk of the firm.

Another influence on the maturity decision involves the theory of the principal-agent relationship. The literature indicates short term debt may be useful in reducing certain agency problems and costs of debt, including foregone investment opportunities, informational asymmetry, and owner risk incentives. Since these problems are encountered as investment opportunities arise, high growth firms could be expected to favor relatively short term debt.

Finally, there is reason to believe firms might use the maturity decision to control the risks associated with the level of indebtedness and/or the variability of operating income. A high debt ratio can be offset by stretching out repayments in order to defer or reduce the "crisis at maturity" problem. Similarly, since default occurs as the result of insufficient income (or net cash flow) relative to maturing debt, firms with highly uncertain net operating income might favor relatively long debt maturities.

H. EMPIRICAL TESTS OF CORPORATE DEBT MATURITY STRUCTURE INFLUENCES

Anticipation of liability maturity structure differences among firms is reasonable in light of the relationships established in the literature review thus far. There are testable hypotheses about maturity structure which can be developed regarding preferred habitats, income patterns, variable rate debt, overall use of financial leverage, and agency problems.[15] However, there are few studies to date about influences on corporate maturity structure, and only one of these studies approaches the matter at the level of individual firm; maturity structure has ordinarily been assessed with aggregate data for broad balance sheet categories. Although analysis at this level of abstraction does not resolve the role of any firm-specific characteristics in maturity decisions, the time series studies provide explanations for historical trends in short and long term debt usage.

Taggart [22] grouped Federal Reserve flow of funds data (1957-1972) into broad categories (liquid assets, inventory, fixed assets, short term debt, long term debt, and equity) and constructed several equations representing sources and uses of funds relationships. The results supported the concept of asset and liability maturity matching in that increases in long term debt were associated with expansion of fixed assets (and the permanent portion of current

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[15]These hypotheses will be formally stated in Section I of this chapter.

assets) and short term debt was statistically related to variation in short term assets.

Silvers' [21] time series study used Federal Trade Commission aggregate manufacturing industry data over the 1961 to 1975 time period. The study by Silvers is in some respects more closely related to the current research than is Taggart's, because his regression design involved determinants of aggregate liability maturity structure in a single equation; the previously cited study by Taggart involved separate equations for individual sources of funds. Silvers developed four hypotheses to explain variation in aggregate liability maturity structure through time:

1. Firms match asset and liability durations in order to achieve the immunization objective.
2. Firms attempt to forecast interest rates (based on yield differentials on bonds of various maturities) and shorten (lengthen) liability maturities if interest rates are expected to fall (rise). If the expectations are realized, interest costs through time will be minimized.
3. The financial markets offer more (fewer) long term funds when aggregate debt ratios are low (high).
4. High (low) levels of aggregate profitability result in relatively long (short) liability maturity structures, because firms will apply available profits first to repayment of the shorter term debt (in order to reduce the risk of default).

The proxy variables corresponding to each of the hypotheses were asset duration, the spread between long and short term rates, debt ratio, and return on equity, respectively. Silvers chose the duration measure to measure the liability maturity structure for the manufacturing sector. The results are presented below in Table 1.

Table 1

Silvers' Time Series
Regression Results

Variable	Coefficient	t-statistic
Asset Duration	.8496	3.541
Long-Short Interest Spread	.0609	3.185
Debt Ratio	-2.959	5.761
Return on Equity	.1280	2.326

The R^2 of the regression equation was .69, the hypothesized signs were obtained, and each coefficient was statistically significant at the .025 level. The validity of the second hypothesis can be challenged; Silvers relied on the expectations theory to justify the use of yield differentials to forecast rates, yet the theory indicates that any borrowing pattern across maturities would involve the same interest expense. Further, although the study offers some duration measurement techniques which will be used in the present research, firm-specific variables were not addressed. Silvers states that "in an aggregate sample such as the Federal Trade Commission data, such interesting variables cannot be tested, although they may be important."[16]

The sole published test using cross-sectional, firm-specific data was reported by Morris [15], although his article was predominantly a theoretical exposition of the role of operating income and interest rate patterns. His theory indicates that firms with a positive covariance between operating income and interest rates can reduce the variability of net income by employing relatively short term debt. The empirical test involved a simple regression of the ratio of short term debt to total assets, and the correlation between net operating income and commercial paper rates for 535 firms over the period 1952 through 1970. The results are contained in Table 2.

Table 2

Morris' Cross-Sectional Regression Results

Variable	Coefficient	t-statistic
Correlation Between Changes in Net Operating Income and Changes in Commercial Paper Rates	.02	2.42

The coefficient for the correlation variable was significant at the 1% level, although the R^2 of the regression equation was only .01.

[16]Silvers [21], page 61.

Morris also measured the correlation variable without changes in the raw data, but it was not statistically significant.

The results of the Morris study indicate that liability maturity structure is only negligibly explained by operating income-interest rate patterns. There are several factors which may have contributed to this result:

1. The correlation variable was measured over the period 1952-1970, and the short term debt ratio was calculated for each firm as of 1970. Market rates of interest were quite stable for this time period, and firms would have had a minimal incentive to follow the maturity strategy developed by Morris.[17]
2. The short term debt ratio inaccurately represents debt items which can affect net income variability. The ratio is importantly influenced by non-interest bearing liabilities (such as accounts payable and accruals), as well as items which are interest-bearing, but at a fixed rate (such as the current portion of long term debt).
3. The short term debt ratio does not allow for the interest variability equivalence of long term variable rate debt and short term debt, now established in the literature.
4. The short term debt ratio inadvertently reflects the overall debt-equity mix, since the ratio will vary across firms with equal proportions of short and long term debt, but unequal debt ratios.

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[17]For that matter, the strategy had not been developed by 1970.

The available empirical tests do not resolve the firm-specific influences on liability maturity structure. Time series studies have no potential for identification of such influences, since the observations are not made at the level of individual firms. The cross-sectional study by Morris is not conclusive due to weaknesses in variable selection, and there are no cross-sectional studies using a collection of explanatory variables.

I. THE UNRESOLVED ISSUES AND HYPOTHESES OF THIS RESEARCH

The literature review suggests various influences on liability maturity structure at the level of the firm. These include asset lives, operating income-interest rate relationships, variability of net operating income, and growth opportunities. However, the literature is nearly devoid of empirical studies concerned with these matters, and in fact, there are no studies attempting to comprehensively explain cross-sectional liability maturity structure variation. The purpose of this research, therefore, is to statistically test the identified firm-specific maturity structure influences. These can be stated in the form of hypotheses as follows:

First Hypothesis:

Corporate liability maturity structure is (positively) influenced by asset maturity structure.

Second Hypothesis:

Corporate liability maturity structure is (negatively) influenced by the level of association between operating income and interest rates.

Third Hypothesis:

Corporate liability maturity structure is (negatively) influenced by the volume of investment opportunities of the firm.

Fourth Hypothesis:

Corporate liability maturity structure is (positively) influenced by the variability of net operating income.

The final hypothesis addresses an interrelationship involving debt amount and debt maturity under which highly levered firms distribute debt repayment over a relatively long period (compared to less highly levered firms) in order to reduce the risk of default.

Fifth Hypothesis:

Corporate liability maturity structure is (positively) influenced by the relative importance of debt in the capital structure.

CHAPTER III

METHODS AND PROCEDURES

The purpose of this chapter is to describe the methodology employed to assess the hypotheses stated in Chapter II. The variables used will be defined in Section A. Sample selection criteria and the regression models are addressed in Sections B and C, respectively.

A. VARIABLES AND MEASUREMENTS

The dependent variable should capture the time profile of liabilities. This profile is directly available from equation (1), the duration measure described in the literature review. The requisite raw data were taken from the annual reports of each firm included in the sample. Exact maturities cannot be determined for a few short term liabilities and, following Silvers [21], constant maturity estimates were used for those items (one year for accruals and other liabilities, six months for short term debt, and one-and-one-half months for accounts payable). The footnotes to the financial statements provided the repayment schedules for the long term debt items. The complete repayment schedule (amounts and due dates) for each debt item was used in the duration of calculations, to the level of semiannual payments. Interest on the remaining balance of each loan was included in the durations and was calculated using the actual rates given in the financial statement footnotes. The duration measure requires the use of a discount rate, and the average corporate AAA bond rate during 1979 and 1980 (12%) was selected. Occasionally, annual reports do not provide a repayment schedule on relatively minor debt items and these items were excluded; also, lease payment schedules were sometimes incomplete.[18] Although financial analysts within firms would be able to obtain this information, the liability duration calculations used in this research are complete in terms of information available to investors. Further, Moody's Industrial Manuals and 10-K reports were cross-checked to assure that the most detailed data base was utilized for each firm. An example of the liability duration calculation is contained in Appendix C. This research marks the first time liability duration has been used as the measure of liability maturity structure of individual firms. The duration is unconditionally the definitive measure of liability maturity structure; in fact, the short term debt ratio used in earlier studies is merely an expedient proxy for overall liability duration.

The habitat theory indicates liability maturity structure decisions are made with reference to the maturity structure of assets. Therefore, the duration measure was applied to individual asset items of each firm in the sample. Constant maturity estimates were necessary for "other current assets" (one year) and land (one hundred years). The maturity used for cash and marketable securities was zero, and the calculated average collection and inventory turnover periods were used for accounts receivable and inventory,

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[18]The duration measure is scale independent and omitted liabilities are effectively included at the average of the specified items.

respectively. The life of the fixed assets of each firm was an annuity based upon the number of years of depreciation remaining in the net plant and equipment account. Out of consistency considerations, the discount rate used for the asset duration calculations was the same as that used for the liability durations. An example of the asset duration calculation is contained in Appendix C.

The second independent variable, the correlation between changes in net operating income and changes in commercial paper rates, was calculated for each firm over a ten-year period through the year of the study (1980). As an improvement over the measurement by Morris [15], annual average interest rates were used instead of single rates at the beginning of each year.

Following the agency theory-debt maturity relationship described in the literature review chapter, agency problems associated with foregone investment opportunities, informational asymmetry, and owner risk incentives can be controlled by the use of relatively short term debt. The extent of each of these problems is positively related to the volume of investment opportunites; therefore, the third independent variable was the growth rate of gross fixed assets for each firm, measured by the fitted log-linear trend over a ten-year period.

As pointed out in Chapter II, Section B, the total risk framework seems to capture the most apparent risk elements surrounding the liability maturity structure decision. Holding other factors constant, the possibility of a firm being unable to retire a debt obligation at the scheduled maturity is greater with a short maturity structure than a relatively longer one. Firms with highly variable cash flows can reduce the chance of default by using debt with relatively distant repayment, thereby lowering the debt service in each future period. Therefore, the coefficient of variation of net operating income (before depreciation) measured over a ten-year period was included as another explanatory variable.[19]

The matters of maturity choice and debt amount are interrelated and, in fact, a loan contract requires specification of both items. In general, maturity decisions are more crucial the greater the emphasis on debt in the capital structure. Other influences notwithstanding, it would seem reasonable for a heavily debt oriented firm to distribute repayment over a relatively long time horizon. The debt ratio for the firms sampled was included to account for this interrelationship between debt level and maturity.

Firms would be expected to make adjustments to their liability maturity structures through time. This phenomenon could be gradual owing to barriers to adjustment (in econometrics, the "partial adjustment" process); alternatively, adjustment might be incomplete if liability maturity structure is importantly influenced by the expectation of a variable which is not known at the time maturity structure is established (the "adapative expectations" process). Either view of the adjustment process suggests the use of a lagged dependent variable (1979 liability duration) in the regression equation.

[19]Alternatively, default risk might be evaluated by bond rating categories, but not all firms use rated liabilities. Further, an attempt to use dummy variables for rating categories was complicated by differences in the characteristics (e.g., secured status) of rated debt instruments across the sample (and within individual firms).

Finally, the literature indicates that variable rate debt instruments serve to reduce income variability in the same manner as short term debt, if operating income is positively correlated with interest rates. However, in a multiple regression designed to address several influences on maturity structure, the duration measure cannot reflect this equivalence.[20] Thus, an alternative dependent variable was developed to individually test the role of income-interest rate patterns in maturity structure decisions in a simple regression. This variable is the ratio of short term, interest-bearing debt plus long term variable rate debt to total debt (considered a variable rate debt ratio).

The duration calculation may be sensitive to measurement assumptions, notably the level of financial statement detail on particular assets and liability items. Asset duration calculations involve an estimate of the life of fixed assets, and the number of years of depreciation remaining in the book value account may underestimate the "true" revenue-producing life. The asset duration for Dupont (the firm used to illustrate the duration calculations in Appendix C) was 1.638 years, using the number of years remaining in the book value account for the fixed asset maturity. If this fixed asset maturity underestimates the true life by 50%, recalculation of the asset duration yields 2.29 years; an underestimation of 100% produces an asset duration of 2.78 years (a 200% error produces 3.376 years).

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[20]For example, the actual maturity of a variable rate debt instrument must be preserved in order to assess the habitat theory so the instrument cannot be simultaneously considered "short term" in the context of interest rate variability.

Although asset duration is somewhat sensitive to the lives of fixed assets, the reliability of the variable is largely preserved by following the same procedure for each firm. A similar sensitivity test was done for the land life assumption, and because of the relatively smaller land investment, the duration calculations were not significantly changed. The duration calculation is well known to be quite insensitive to the discount rate used; the asset duration increases to only 1.769 years with a 10% discount rate, decreasing to 1.520 years with a 14% discount rate. The liability duration calculation involved no arbitrary assumptions, but was tested for sensitivity to changes in the discount rate. Using a 12% discount rate, the liability duration for Dupont is 2.633 years; using a 10% rate generates 2.998 years, while a 14% rate reduces the duration to 2.342 years. Although the duration calculations are somewhat sensitive to measurement assumptions, the firms in the sample were treated consistently and accurately in light of all publicly disclosed information.

B. THE SAMPLE

The sample consisted of 96 firms drawn from the Standard and Poor's 400 Industrials Index after screening according to several criteria. In order to be able to properly use a common average annual interest rate for each year in the calculation of the correlation between net operating income and interest rates, each firm in the sample was required to operate on a calendar year basis. Next, firms with major mergers (one in which the sales of the acquired firm are greater than 25% of combined sales) in the year of the cross-sectional regressions were eliminated since the combination of liabilities could potentially cause a departure from the acquiring firm's target or pre-merger liability maturity structure. Also, firms with major capital expenditures (greater than 30% of net fixed assets) were eliminated because major expansion is often funded with short term debt awaiting project completion and long term debt placement. Finally, firms with a total debt ratio of less than 30% were excluded, in order to recognize maturity choice as a more important decision for firms using a significant amount of debt capital. The final sample included firms representing 21 of the 26 industry categories making up the Standard and Poor's Industrials Index. A complete list of the sample is contained in Appendix D. A complete list of the observations of the variables for each of the firms is also included in Appendix D. Table 3 provides the industry distribution of the sample.

C. THE CROSS-SECTIONAL REGRESSIONS

The primary test of the various firm-specific influences takes the form of a cross-sectional multiple regression of the following form (hypothesized signs are in parentheses above each independent variable):

$$ld_j = b_0 + b_1\overset{(+)}{[ad_j]} + b_2\overset{(-)}{[corr_j]} + b_3\overset{(-)}{[g_j]} + b_4\overset{(+)}{[cv_j]} + b_5\overset{(+)}{[dr_j]} + b_6\overset{(+)}{[ld_j]}_{t-1} \qquad j = 1, 2, \ldots 96 \text{ firms} \tag{5}$$

Table 3

Industry Distribution of the Sample
and the Standard and Poor's
Industrials Index

Industry	Sample Number	Sample Percent	Standard and Poor's Number	Standard and Poor's Percent
Mining	5	5.2	25	6.3
Construction	1	1.0	7	1.8
Manufacturing				
Food	5	5.2	38	9.5
Tobacco	1	1.0	3	.7
Textiles	2	2.1	7	1.7
Apparel	2	2.1	7	1.7
Lumber	1	1.0	8	2.0
Furniture	1	1.0	2	.5
Paper	10	10.4	14	3.5
Printing	3	3.1	11	2.7
Chemicals	22	22.9	42	10.6
Petroleum	0	--	15	3.8
Rubber	3	3.1	5	1.3
Leather	0	--	3	.7
Glass, Concrete	4	4.2	10	2.5
Metal	11	11.5	20	5.1
Machinery	10	10.4	72	18.1
Transportation Equip.	6	6.3	23	5.8
Instruments	3	3.1	13	3.3
Miscellaneous	2	2.1	4	1.0
Transportation	1	1.0	9	2.3
Wholesale Trade	1	1.0	5	1.3
Retail Trade	2	2.1	30	7.5
Financial	0	--	1	.3
Services	0	--	16	4.0
Conglomerates	0	--	8	2.0
Total	96	99.8	398	100.0

where,

ld = liability duration

ad = asset duration

corr = correlation between changes in net operating income and commercial paper rates

g = growth rate of fixed assets

cv = coefficient of variation of net operating income

dr = total debt ratio

ld_{t-1} = lagged liability duration

The equation was estimated using ordinary least squares to test the significance of the explanatory variable on liability duration. The equation was also estimated using the ratio of liability to asset duration as the dependent variable.[21]

In order to assess the variable rate and short term equivalence, this research included a simple regression of the variable rate debt ratio (vrdr) and the correlation between net operating income and interest rates. Using the correlation variable as previously defined, the equation to estimate is:

$$vrdr_j = b_0 + b_1\overset{(+)}{[corr_j]} \qquad j = 1, 2, \ldots 96 \text{ firms} \qquad (6)$$

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[21]Whether liability maturity structure is relatively short or long might only be meaningful when considered in conjunction with asset maturity structure.

CHAPTER IV

RESULTS

This chapter contains the statistical results of the research. First, general characteristics of the data are reported, with special emphasis on items which are measured for the first time in this research. The cross-sectional regression results are provided in the next section. The final section contains an evaluation of potential statistical problems. An expanded interpretation of these results is contained in Chapter V.

A. CHARACTERISTICS OF THE VARIABLES

This research involved the measurement of several variables as defined in the preceding chapter. Table 4 contains a matrix of the correlations between these variables, and Table 5 contains the univariate statistics. Liability duration and its lagged (by one year) value are highly related, exhibiting respective means of 2.46 and 2.48, and a correlation coefficient of .90. The close association between the liability durations is attributable to a substantial portion of liability maturity structure carrying over from one year to the next. This is particularly true for the sample used in this research, since firms were discarded if major capital expenditures or mergers occurred in the year of the study (activities which carry the potential for significant change in liability maturity structure). Confirmation of the slow pace of maturity struture adjustment is apparent from similar correlations between the two liability

TABLE 4

Correlation Matrix

	ld	ad	corr	g	cv	dr	ld_{t-1}	ld/ad	interact
ld	1.0	.61	.22	.07	-.03	.19	.90	.19	.27
ad	.61	1.00	.30	.37	.24	-.02	.70	-.56	.32
corr	.22	.30	1.0	.15	.26	-.12	.25	-.27	.98
g	.07	.37	.15	1.0	.56	-.11	.13	-.36	.13
cv	-.04	.24	.26	.56	1.0	-.05	.03	-.29	.24
dr	.19	-.02	-.12	-.11	-.05	1.0	.16	.26	-.01
ld_{t-1}	.90	.70	.25	.13	.03	.16	1.0	-.01	.30
ld/ad	.19	-.56	-.27	-.36	-.29	.26	-.01	1.0	-.25
interact	.27	.32	.98	.13	.24	-.01	.30	-.25	1.0

Table 5

Univariate Statistics

Variable	Mean	Standard Deviation	Minimum Value	Maximum Value
ld	2.464	.907	.501	5.234
ld_{t-1}	2.483	.906	.541	4.959
ad	1.638	.820	.406	4.634
ld/ad	1.740	.847	.395	4.966
corr	.253	.360	-.795	.807
g	.094	.050	.000	.316
cv	.370	.135	.143	.750
dr	.503	.095	.327	.725
interact	.126	.177	-.459	.421

durations and the independent variables (see Table 4). The adjustment process in liability duration from one year to the next was quite subtle in the sample.

The calculation of liability (and asset) duration at the level of the firm was done for the first time in this research. The measure reflected individual bonds and loans, often numbering 35 to 40 for individual firms. The liability duration variable ranged from .501 to 5.23 years across the sample, with a mean and standard deviation of 2.465 and .907, respectively.[22] The distribution of liability durations was nearly normal with a third moment skewness measure of .422. A histogram has been constructed for visual inspection and appears as Figure 1. The asset duration calculations ranged from .41 to 4.59 years with a mean of 1.638 and standard deviation of .82. This duration measure is somewhat skewed to the right, with a skewness measure of 1.196 (see Figure 2).

The correlation between net operating income and interest rates is of necessity measured through time. Since there cannot be a single ideal time period over which such a variable should be measured, the potential for error in measurement exists. Rank order correlations were calculated for the income-interest rate correlations over alternative time periods in order to assess the consistency of this variable. There are two issues involved: (1) whether the income-interest rate relationship is sufficiently stable so that firms can

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[22] A similar measure which uses nondiscounted cash flows, the weighted average maturity, was calculated and displayed a range of .57 to 11.73 years, a mean of 4.81 and a standard deviation of 2.1.

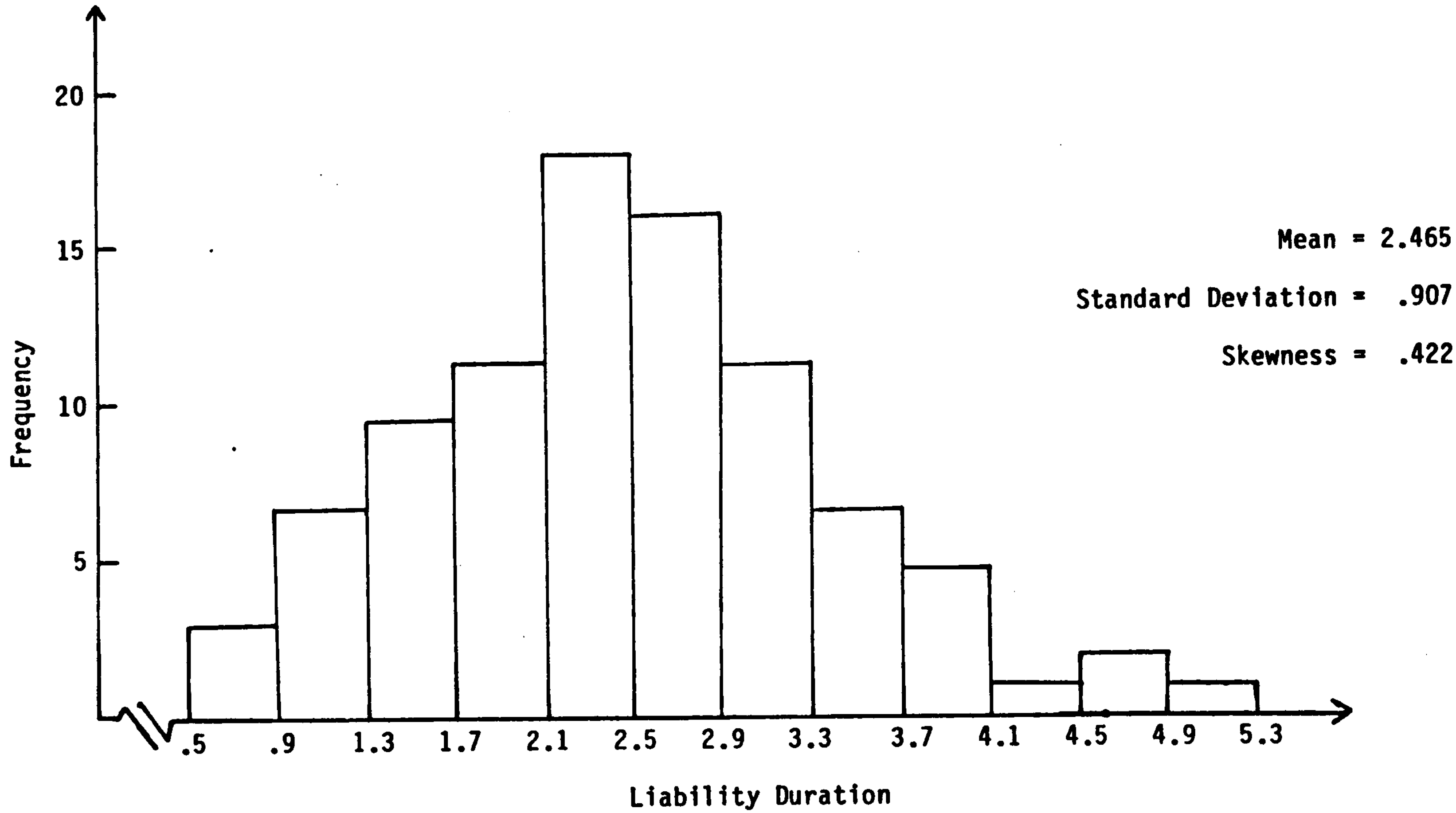

Figure 1

Liability Duration Frequency Distribution

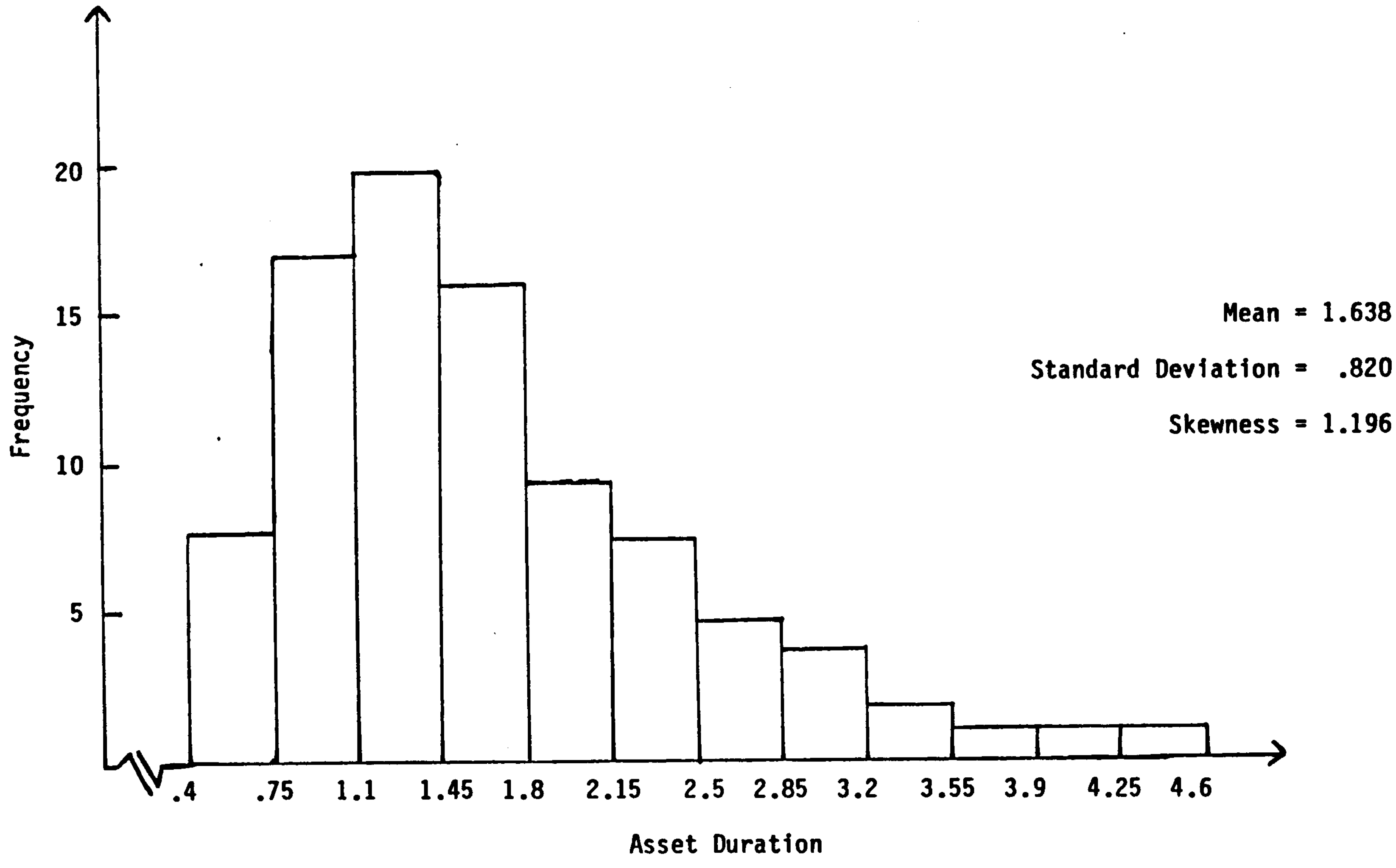

Figure 2

Asset Duration Frequency Distribution

reasonably and confidently make liability maturity structure decisions based upon them, and (2) whether the correlations are satisfactory regression variables. In order to shed light on the first question, the correlation between changes in net operating income and interest rates was calculated over two non-overlapping time periods, 1964 through 1972 and 1973 through 1980. The rank order correlation between these time periods was .23 which is statistically significant at the .05 level, indicating some degree of consistency which firms can expect. In terms of the proposition advanced by Morris [15] about income-interest rate patterns and risk reduction through maturity choice, the crucial factor to the firm is whether the sign of the correlation might change. The signs were fairly consistent across the non-overlapping time periods with 61% unchanged, 26% from negative to positive, and 13% from positive to negative. Although the positive to negative change (which is potentially more costly to a firm opting for short maturities) is the less common one, it does occur and could deter use of short term debt by some firms. The second issue is concerned with the time period to be used in measuring the correlation regression variable. A second rank order correlation was calculated for the correlation between net operating income and interest rates measured over the last ten years versus the last fifteen years, two reasonable time frame alternatives for the computation of this regression variable. In this case, the rank order correlation was .98, indicating the variable is virtually free of this sort of time period dependence.

Table 6 contains average asset and liability durations for firms within several industrial categories. The paper and mining groups exhibit the longest asset durations (2.715 and 2.882 years respectively); these two industries also have the longest liability durations (3.579 and 2.882 years, respectively). Similarly, the food and machinery industrial groupings exhibit the shortest asset and liability durations, informally supporting the habitat theory and the maturity matching concept. The largest ratio of liability to asset duration is found in the machinery group, and the smallest in the mining group.

B. REGRESSION RESULTS

The principal test of the stated hypotheses involved the multiple regression presented as equation (5) in Chapter III. The results obtained with this specification were dominated by the lagged dependent variable (liability duration), which produced the expected positive sign, an F ratio of 146.6, and virtually all of the R^2 (.8). The other independent variables were not significant at the .05 level (the significance level chosen for this research) when considered simultaneously with the lagged dependent variable. The lagged variable was included to reflect the adjustment of liability duration through time. As pointed out in the preceding section, sample selection criteria ensured reasonable stability of liability maturity structures, resulting in minimal observed adjustment. Also, a multicollinearity problem is suggested by a high (.70) correlation between lagged liability duration and the strongest independent

Table 6

Average Durations for Selected Industries[a]

Industry	ld	ad	ld/ad
Mining	3.260	2.882	1.137
Food	1.608	1.352	1.398
Paper	3.579	2.715	1.339
Chemical	2.387	1.423	1.815
Metal	2.483	1.675	1.485
Machinery	2.132	.989	2.354
Transportation Equip.	2.344	1.485	1.839

[a]Those industries with five or more firms in the sample.

variable of positive sign. The results after omitting the lagged variable are presented in Table 7 (the SPSS computer output for this specification, and those which follow, are contained in Appendix E).

Table 7

Regression Results

Variable	Coefficient	Standard Error	F
ad	.719	.096	55.777
corr	.246	.211	1.357
g	-1.234	1.785	.477
cv	-1.116	.640	3.039
dr	1.934	.749	6.671

The asset duration variable was significant at the .05 level and the hypothesized positive sign was obtained. The debt ratio was also statistically significant and produced the expected positive sign. The other variables were not statistically significant, although the R^2 of the specification was .46. A multicollinearity problem was present due to the correlation between the growth and coefficient of variation regressors (.56). Deletion of these variables (in turn) in two additional regressions did not alter their insignificance (nor that of the correlation variable).

An additional regression was done using the ratio of liability to asset duration (ld/ad) as the dependent variable. Defining the dependent variable in this manner recognizes that whether liability maturity structure is relatively short or long might only be meaningful when considered in conjunction with asset maturity structure.

Similar to the case with the original regression equation, when a lagged dependent variable was included, the results were dominated by it and the other variables were not significant. Therefore, the following equation was estimated:

$$ld/ad = b_0 + b_1[corr] + b_2[g] + b_3[cv] + b_4[dr] \qquad (7)$$

The results obtained with equation (7) are contained in Table 8.

Table 8

Regression Results With Ratio Form Dependent Variable

Variable	Coefficient	Standard Error	F
corr	-.425	.226	3.519
g	-4.406	1.891	5.432
cv	-.561	.713	.619
dr	1.825	.833	4.805

The coefficient of variation and correlation variables remain insignificant with the redefined dependent variable. The growth and debt ratio variables were statistically significant and the expected signs were obtained. The R^2 of .22 for this specification is lower than before because asset duration is not an explanatory variable in equation (7).

There are multicollinearity concerns within equation (7) involving the coefficient of variation and growth variables (their correlation was .56). Since the former was not statistically significant, it was the choice for exclusion and, following customary procedure, a regression was estimated using the remaining variables (the other variables were not highly collinear as indicated by the correlation matrix in Table 4, page 45; also, results of separate simple regressions of the independent variables did not alter the signs or significance of the coefficients). The results are contained in Table 9.

Table 9

Regression Results With Ratio Form Dependent Variable, Omitting a Collinear Variable

Variable	Coefficient	Standard Error	F
corr	-.463	.220	4.404
g	-5.212	1.586	10.806
dr	1.801	.830	4.704

This specification yields the same R^2 (.22) as obtained with equation (7). The adjusted R^2 was .19. Importantly, the correlation variable was statistically significant using the ratio form dependent variable.

The final test to be reported involves the similarity of variable rate debt and short term (fixed rate) debt in net income variability reduction. This regression uses the variable rate debt ratio (vrdr) as the dependent variable, defined as the sum of short term, interest-bearing debt and long term variable rate debt divided by total debt. The explanatory variable is the correlation between net operating income and interest rates. The estimated equation was:

$$vrdr = .0878 + .0059(corr) \tag{8}$$

The correlation variable was not statistically significant (t - statistic of .26) in equation (8).

Next, the correlation variable was measured without taking first differences (thus, without autocorrelation correction) in the net operating income and interest rate data. The results of re-estimating regression equation (5) were essentially unchanged, and this was also the case with regression equation (6). However, different results were obtained upon using the ratio of asset to liability duration as the dependent variable (equation (7)). The debt ratio, which was significant in conjunction with the correlation variable measured with changes in the raw data, now drops from significance. Interestingly though, the correlation variable without changes in the raw data was statistically significant.

Finally, regression equations were estimated (for both dependent variables, liability duration and the ratio of liability to asset duration) using an interaction term for the correlation and debt ratio explanatory variables. The interaction term, defined as the product of the correlation and debt ratio variables, was not significant in regressions involving either dependent variable specification. Further, the basic finding regarding the lack of significance of the correlation variable with the liability duration dependent variable was unchanged, as was the demonstration of significance of the correlation variable with the ratio form dependent variable. The significance of the debt ratio was preserved, regardless of the dependent variable specification.

C. ADDITIONAL STATISTICAL CONSIDERATIONS

One important assumption of ordinary least squares regression is that the dispersion of disturbances is similar for small and large values of particular explanatory variables (homoskedasticity).[23] One method used to detect violation of this assumption (heteroskedasticity) involves a visual inspection of plotted disturbances; this can only be done, however, if one has several observations of the dependent variable for each specific value of the explanatory variable believed to cause the heteroskedasticity. The data in this research do not meet the requirement for the visual inspection method and an alternative method, the Goldfield-Quandt test, was employed to test for heteroskedasticity. This test involves arranging the variable thought to be heteroskedastic (here, asset duration) in ascending order, deleting a portion of the central observations (about 25% of the sample size), and performing separate regressions with the high and low groupings of the explanatory variable. Then, an F-ratio is formed using the sum of squared errors (SSE) from the regressions of the high and low asset duration groups. The SSE from the regression using the upper values of asset duration was 13.902; the SSE from the regression of the lower values was 11.596. The resulting ratio (1.199) is not significant at the .05 level, indicating absence of a serious heteroskedasticity problem.

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[23]Another assumption, nonautocorrelation, is unlikely to be violated in cross-sectional regressions.

Another important aspect of ordinary least squares involves overly influential observations. The residual plots for the two dependent variable specifications are contained in Appendix F. The residual plot for the regression using liability duration as the dependent variable indicates five cases of potentially overly influential observations. Deletion of these outliers in another regression did not alter the significance or sign of any coefficient (the computer output for this regression is contained in Appendix G). Inspection of the residual plot for the regression using the ratio form dependent variable shows three outlying cases. Deletion of these outliers in another regression caused the correlation variable to drop from statistical significance (the computer output for this regression is also contained in Appendix G).

The next statistical consideration to be addressed is the "errors in variables" problem. The correlation variable was shown earlier to be quite free of measurement error; however, the asset duration variable involves certain assumptions which may lead to measurement error, notably surrounding the life of fixed assets. The group means method was used to verify the consistency of the relationship between asset duration and liability duration. This method calls for determination of the slope coefficient based on the average asset duration of the lower and upper halves of the asset duration observations (arranged in ascending order) and the paired liability duration observations. The group means method provides a positive slope of 1.565, which is consistent with the coefficient for asset duration in the multiple regressions (.719), and is also consistent with the coefficient obtained in a simple regression of liability duration and asset duration (.676). Thus, the group means diagnostic test supports the role of the asset duration explanatory variable.

CHAPTER V

DISCUSSION OF RESULTS AND CONCLUSIONS OF THE STUDY

This first section of this chapter contains a discussion of the statistical results provided by this research. The second section offers the contributions of the study in terms of conclusions and implications regarding firm-specific influences on liability maturity structure.

A. DISCUSSION OF RESULTS

This research endeavored to identify characteristics of firms which systematically influence liability maturity structures. The regression results indicate two variables are very strongly related to liability duration: (1) asset duration and (2) debt ratio. Asset duration is the most powerful individual variable; it alone explains 37% of the variation in the liability durations. Virtual matching of liability to asset maturity would be inferred from a coefficient of unity for asset duration; although the measured coefficient (.719) was in this vicinity, the confidence interval of .527 to .911 implies some departure from matching. The debt ratio variable was also strongly and positively related to liability maturity structure and was significant regardless of dependent variable specification (liability duration or the ratio of liability to asset duration).

The regressions provide mixed results with respect to the maturity structure role of the growth and correlation variables. Both were significantly related to the ratio of liability to asset duration, but they were not related to liability duration alone. Although these considerations could be indicating spurious relationships, the ratio form directly reflects the <u>relative</u> length of liability maturities and thereby clearly adds to the meaning and content of the basic measure of liability maturity structure. Further, the correlation variable was sensitive to outlying observations. Thus, it is not possible to make absolutely definitive statements about the importance of the correlation variable.

The results appear to rule out the importance of one variable. The coefficient of variation, included as a risk variable, was not significantly related to liability duration or to the ratio of liability to asset duration. Also, the use of the variable rate debt ratio in the simple regression did not draw out the importance of the correlation variable (however, in certain multiple regressions, this variable was shown to be related to liability maturity structure). Thus, the conceptual equivalence of short term and variable rate debt has not been empirically demonstrated.

The regression formulation which performed best among those considered was equation (7), using the ratio of liability to asset duration as the dependent variable. The correlation, growth rate, and debt ratio measures were significant and the R^2 of the equation was .22.[24]

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[24] Of course, in the original regression equation with the asset duration as a strong independent variable, the R^2 was higher (.46).

The regression results support three of the five hypotheses stated in Chapter II. The first hypothesis about asset maturity structure is upheld, as are the third and fifth hypotheses, which address the volume of asset acquisitions and debt level, respectively. The tests of the hypothesis concerning income-interest rate patterns is marginally supported; the hypothesis about net operating income variability as a risk measure in the context of maturity decisions must be rejected.

B. CONCLUSIONS

This research indicates the existence of several firm-specific influences on liability maturity decisions. A comprehensive measure of liability maturity structure at the level of individual firms was constructed for the first time in this study, and several hypothesized relations were demonstrated statistically. The habitat theory, under which firms make liability maturity decisions in light of asset maturities was upheld. Furthermore, agency problems serve to influence maturity decisions, appearing via growth rate differentials among firms. The proposition about reduction in net income variability by maturity choice is, however, not conclusively resolved by this research; additionally, the research provides no evidence that firms view the similarity between short term debt and variable rate debt investments in this regard. The interplay of debt level and maturity structure was demonstrated, suggesting that both are required to adequately describe financial leverage. The research does not support the variability of net operating income as a risk measure in the context of this research. Future research could be directed toward development of a measure of financial leverage which would incorporate both debt amount and debt maturity, thereby adding maturity content to the traditional debt ratio. Additionally, future studies might concern the extent to which financial futures markets are used by firms to effectively alter balance sheet maturities. The results of this study provide considerable information concerning factors important to firms when liability maturity decisions are made.

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APPENDIXES

APPENDIX A

APPLICATION OF THE TRADITIONAL CAPM TO THE MATURITY STRUCTURE DECISION

According to the capital asset pricing model, the expected return on security j is:[1]

$$E(R_j) = r_f + \ \mathrm{cov}\ (R_j, R_m) \tag{A-1}$$

where,

r_f = risk-free rate

R_m = return on the market portfolio

$\lambda = [E(R_m) - r_f]/\sigma^2_{R_m}$

Letting E(R) = E(NI)/V, where NI is net income and V is the market value of the firm's equity,

$$E(R_j) = r_f + \lambda \mathrm{cov}\ \left(\frac{NI}{V}, R_m\right)$$

$$= r_f + \frac{\lambda}{V} \mathrm{cov}\ (NI, R_m)$$

$$= r_f + \frac{\lambda}{V} \mathrm{cov}\ [NOI(1-T) - I\ (1-T), R_m] \tag{A-2}$$

where,

NOI = net operating income
T = tax rate
I = interest expense

$$= r_f + (1-T)\ \frac{\lambda}{V}\ [\mathrm{cov}(NOI,R_m) - \mathrm{cov}\ (I, R_m)] \tag{A-3}$$

Then, letting I = B·r, where B is debt amount and r is the rate on the firm's debt, expected return is:

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[1]This proof is from Morris [15], pages 33-34.

$$E(R_j) = r_f + (1\text{-}T)\,\frac{\lambda}{V}\,[\text{cov}(NOI,\ R_m) - B \cdot \text{cov}\ (r,\ R_m)] \tag{A-4}$$

If the firm selects long term debt, interest expense is constant and cov (I, R_m) in (A-3) (or equivalently cov (r, R_m) in (A-4)) is zero. Therefore, expected return with long term debt is:

$$E(R_j) = r_f + (1\text{-}T)\,\frac{\lambda}{V}[\text{cov}\ (NOI,\ R_m)] \tag{A-5}$$

However, if the firm selects short term (e.g., one year) debt, and if cov(I, R_m) in (A-3) is positive (or cov(r, R_m) in (A-4) is positive), expected return will be lower than that for longer term debt, equation (A-5).

APPENDIX B

APPLICATION OF AN EXTENDED CAPM TO THE MATURITY STRUCTURE

This analysis employs the extended or generalized CAPM attributed to Long [10] to show how liability maturity structure decisions affect equilibrium equity returns in a discrete time, multi-period world where interest rates and consumption good prices are uncertain.

Long's expression for the expected return on security j is:

$$E(R)_j) = r_1 + [E(R_m) - r_1]\,\beta_{jm} + \sum_{k=1}^{K}\gamma_{jk}\,[(1 + \bar{i}_k) - (1 + r_1)\frac{F_{ko}}{\Pi_{ko}}]$$

$$+ \sum_{m=2}^{T}\delta_{jm}\,[E(R_{bm}) - r_1] \quad j = 1, 2, \ldots, N \qquad \text{(B-1)}$$

where,

r_1 = short term interest rate during period 1.

R_m = return on the market portfolio

β_{jm} = $\mathrm{cov}(R_j, R_m)/\sigma^2_{R_m}$

$\bar{i}_k$ = expected rate of inflation for the k^{th} consumption good

γ_{jk} = $\mathrm{cov}(R_j, \tilde{i}_k)/\sigma^2_{\tilde{i}_k}$

F_{ko} = current price of a futures contract (or an equivalent, duplicating portfolio of securities) on the k^{th} consumption good

Π_{ko} = current price of the k^{th} consumption good

δ_{jm} = $\mathrm{cov}(R_j, R_{bm})/\sigma^2_{R_{bm}}$ for bonds maturing from time period m=2 through m=T

R_{bm} = return on an m-period bond during period 1.

This "multi-beta" pricing model contains as many coefficients as consumption goods and bond maturities, plus the traditional one. Using a price index rather than price levels for individual consumption goods, equation (B-1) becomes:

$$E(R)_j = r_1 + [E(R_m) - r_1]\,\beta_{jm} + [E(I^*) - r_1]\,\beta_{jI^*}$$

$$+ \sum_{m=2}^{T} \delta_{jm}\,[E(R_{bm}) - r_1] \quad j = 1, 2, \ldots., N \tag{B-2}$$

where,

I^* = a price index (e.g., the consumer price index or other suitable index)

β_{jI^*} = $\mathrm{cov}(R_j, I^*)/\sigma^2_{I^*}$

Now, define

$$\lambda_1 = [E(R_m) - r_1]/\sigma^2_{R_m}$$

$$\lambda_2 = [E(I^*) - r_1]/\sigma^2_{I^*}$$

$$\lambda_{3m} = [E(R_{bm}) - r_1]/\sigma^2_{R_{bm}} \qquad m = 2, 3, \ldots, T$$

Then, the second term in (B-2) becomes:

$$\lambda_1 \,\mathrm{cov}(R_j, R_m) \tag{B-3}$$

The third term in (B-2) is:

$$\lambda_2 \,\mathrm{cov}(R_j, I^*) \tag{B-4}$$

And the fourth term in (B-2) is:

$$\sum_{m=2}^{T} \lambda_{3m} \,\mathrm{cov}(R_j, R_{bm}) \tag{B-5}$$

Following Morris [15], letting $E(R) = E(NI)/V$, where NI = net income and V = market value of equity, and substituting (B-3), (B-4), and (B-5) into (B-2), one obtains the following expression for expected return:

$$E(R_j) = r_1 + \lambda_1 \text{ cov } (\frac{NI}{V}, R_m) + \lambda_2 (\text{cov } \frac{NI}{V}, I^*)$$

$$+ (\sum_{m=2}^{T} \lambda_{3m}/V) \cdot \text{cov } (\frac{NI}{V}, R_{bm}) \qquad \text{(B-6)}$$

Then, since NI = (NOI-I) (1-T) = NOI (1-T) - I(1-T)

where NOI, I, and T are, respectively, net operating income, interest expense, and tax rate, (B-6) can be rewritten:

$$E(R_j) = r_1 + \frac{\lambda_1}{V} \text{cov}(NOI\ (1-T) - I\ (1-T), R_m)$$

$$+ \frac{\lambda_2}{V} \text{cov}(NOI\ (1-T) - I\ (1-T), I^*)$$

$$+ (\sum_{m=2}^{T} \lambda_{3m}/V) \cdot \text{cov}(NOI\ (1-T) - I\ (1-T), R_{bm}) \qquad \text{(B-7)}$$

$$= r_1 + (1-T) \frac{\lambda_1}{V} [\text{cov}(NOI, R_m) - \text{cov } (I, R_m)]$$

$$+ (1-T) \frac{\lambda_2}{V} [\text{cov}(NOI, I^*) - \text{cov } (I, I^*)]$$

$$+ (1-T) [(\sum_{m=2}^{T} \lambda_{3m}/V) \cdot \text{cov}(NOI, R_{bm}) - \text{cov}(I, R_{bm})]$$

$$m = 2, 3, \ldots, T \qquad \text{(B-8)}$$

Then, letting $B \cdot r = I$, where B is debt amount and r is the rate on the firm's debt, (B-8) can be written:

$$E(R_j) = r_1 + (1-T) \frac{\lambda_1}{V} [\text{cov}(NOI, R_m) - B \cdot \text{cov}(r, R_m)]$$

$$+ (1-T) \frac{\lambda_2}{V} [\text{cov}(NOI, I^*) - B \cdot \text{cov}(r, I^*)]$$

$$+ (1-T) [(\sum_{m=2}^{T} \lambda_{3m}/V) \cdot \text{cov}(NOI, R_{bm}) - \text{cov}(r, R_{bm})]$$

$$m = 2, 3, \ldots, T \qquad \text{(B-9)}$$

If the firm chooses long term debt, interest expense is constant and $\text{cov}(I, R_m) = \text{cov}(I, I^*) = \text{cov}(I, R_{bm}) = 0$ in (B-8); equivalently, $\text{cov}(r, R_m) = \text{cov}(r, I^*) = \text{cov}(r, R_{bm}) = 0$ in (B-9). Expected return, with long term borrowing will be:

$$E(R_j) = r_1 + (1-T)\,\frac{\lambda_1}{V}\,[\text{cov}(NOI, R_m)]$$

$$+ (1-T)\,\frac{\lambda_2}{V}\,[\text{cov}(NOI, I^*)]$$

$$+ (1-T)\,[(\sum_{m=2}^{T} \lambda_{3m}/V) \cdot \text{cov}(NOI, R_{bm})] \qquad m = 2,3, \ldots T \qquad \text{(B-10)}$$

If the firm chooses short term (e.g., one year) debt, the direction of change in expected return will be according to the signs and relative magnitudes of $\text{cov}(I, R_m)$, $\text{cov}(I, I^*)$, and $\text{cov}(I, R_{bm})$ in (B-8) (or the signs and magnitudes of $\text{cov}(r, R_m)$, $\text{cov}(r, I^*)$ and $\text{cov}(r, R_{bm})$ in (B-9)).

APPENDIX C

LIABILITY AND ASSET DURATION EXAMPLES

The durations used in this research were obtained by application of the duration measure to balance sheet items. The basic data for the liability durations were obtained from financial statement footnotes in the annual reports of each firm. The asset duration data were taken from Compustat. This appendix provides an example of the two calculations[1] using the duration measure, D:

$$D = \sum_{t=1}^{T} t(CF_t)/(1 + r)^t \Big/ \sum_{t=1}^{T} CF_t/(1 + r)^t$$

where,

t = years in coded units

CF_t = cash flow, year t

r = discount rate

T = final time period

I. Liability Duration

The maturity dates and amounts (in millions of dollars) of Dupont's liabilities for 1980 are presented in Table 10.

[1]The calculations are the durations for Dupont, one of the firms included in the sample.

Table 10

Liability Items for DuPont

Liability Item	Maturity	Amount
Accounts Payable (AP)	1.5 months	\$574.0
Short Term Debt (STD), 11%[a]	6 months	\$399.0
Accruals and Other Current Liabilities (OCL)	1 year	\$955.0
Long Term Debt:		
(i) 8.45% Debenture (\$13.8 annual sinking fund payments from 1985-2004; semiannual interest)	1985-2004	\$286.4
(ii) 8.5% Debenture (\$11.85 annual sinking fund payments from 1987-2006; semiannual interest)	1987-2006	\$264.0
(iii) 8% Notes (semiannual interest)	1986	\$100.0
(iv) 10% Notes	1984	\$150.0
(v) 9.5% Notes	1981	\$42.0
(vi) 10.5% Debentures	1995	\$58.0
(vii) 6.4% Term Loan (2.6% annual payments from 1981-2001)	1981-2001	\$51.0
(viii) 13.2% Pollution Control Bonds (\$39 annual payments from 2005-2010)	2005-2010	\$117.0

The measurement of liability duration involves complete debt service specification. Principal payments for each future date (including semiannual payments) were combined with interest due on the remaining balance of the liability at each date. The average

[a]The rate on short term debt is the 1980 commercial paper rate.

corporate AAA bond rate in 1979 and 1980 (12%) was used as the discount rate.

The numerator of liability duration for Dupont is:

$$.125(AP)/(1+.12)^{.125} + .5(STD)/(1+.12)^{.5} + 1(OCL)(1+.12)^{1}$$

$$+ \sum_{t=5}^{23} t(13.8)/(1+.12)^{t} + \sum_{t=.5}^{23} t(RB_{t} \cdot .0845)/(1+.12)^{1}$$

$$+ \sum_{t=7}^{25} t(11.85)/(1+.12)^{t} + \sum_{t=.5}^{25} t(RB_{t} \cdot .085)/(1+.12)^{t}$$

$$+ 6(100)/(1+.12)^{6} + \sum_{t=.5}^{6} 6(100 \cdot .08)/(1+.12)^{t}$$

$$+ 4(150)/(1+.12)^{4} + \sum_{t=1}^{4} t(150 \cdot .10)/(1+.12)^{t}$$

$$+ 1(42)/(1+.12)^{1} + 1(42 \cdot .095)/(1+.12)^{1}$$

$$+ 15(58)/(1+.12)^{15} + \sum_{t=1}^{15} t(58 \cdot .105)/(1 +.12)^{t}$$

$$+ \sum_{t=1}^{20} t(2.6)/1+.12)^{t} + \sum_{t=.5}^{20} t(RB_{t} \cdot .064)/(1+.12)^{t}$$

$$+ \sum_{t=25}^{30} t(39)/(1+.12)^{t} + \sum_{t=.5}^{30} t(RB_{t} \cdot .132)/(1+.12)^{t}$$

The denominator of liability duration is determined by deleting the years in coded units, preceding the cash flows in the numerator of each term. The calculated liability duration for Dupont is 2.633 years.

II. Asset Duration

Measurement of the asset duration variable involved maturities and corresponding dollar amounts (in millions) for individual asset items. The information for Dupont is presented in Table 11.

Table 11

Asset Items for DuPont

Asset Item	Maturity in Years	Amount
Cash and Marketable Securities	Zero	\$219
Accounts Receivable (AR)	Average Collection Period[a]	\$2,110
Inventory (INV)	Inventory Turnover[a]	\$2,010
Other Current Assets (OCA)	1 year	\$151
Land	100 years	\$107
Plant and Equipment	Number of Years of Depreciation Remaining	\$4,414
Other Noncurrent Assets	Average of all other assets	\$380

Daily sales were \$37.922; thus, Dupont's average collection period is .155 years. Cost of goods sold was \$10,293, and the inventory turnover equals .195 years. The maturity of plant and equipment is determined by (RBV-L)/D, where RBV is remaining book

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[a]Expressed as a fraction of a year.

value, L is land, and D is annual depreciation ($804); thus, the maturity of plant and equipment is described by an annuity of $804 per year for 5.357 years.

The numerator of the asset duration for Dupont is:

$$0\cdot(\text{Cash})/1+.12)^{0} + .155(\text{AR})/(1+.12)^{.155}$$
$$+ .195(\text{INV})/1+.12)^{.195} + 1\cdot(\text{OCA})/(1+.12)^{1}$$
$$+ \sum_{t=1}^{5.357} t\cdot(\text{D})/(1+.12)^{t} + 100(\text{Land})/(1+.12)^{100}$$

The denominator of asset duration is based on the terms shown above, after deleting the years in coded units in the numerators of each term. The asset duration for Dupont is 1.218 years.

APPENDIX D

LIST OF FIRMS AND OBSERVATIONS

List of Firms in Sample

Firm #	Firm Name	Firm #	Firm Name
1	Asarco	24	Potlatch
2	Inco	25	St. Regis
3	Newmont	26	Scott Paper
4	Phelps-Dodge	27	3M
5	Eastern Gas	28	Gannett
6	Foster Wheeler	29	Time
7	CPC International	30	Macmillan
8	Kellogg	31	Allied Chemical
9	Nabisco	32	American Cyanimid
10	Borden	33	Dupont
11	Carnation	34	FMC Corporation
12	Lowenstein	35	Hercules
13	Springs Industries	36	PPG
14	Cluett Peabody	37	Rohm and Haas
15	VF	38	Celanese
16	Weyerhaeuser	39	Abbott Labs
17	Mohasco	40	Bristol-Myers
18	Boise Cascade	41	Pfizer
19	Champion International	42	Squibb
20	Crown Zellerbach	43	Sterling Drug
21	Federal Paper Board	44	Upjohn
22	Kimberly Clark	45	Warner Lambert
23	Mead	46	Colgate-Palmolive

Firm #	Firm Name	Firm #	Firm Name
47	Cheesebrough-Ponds	72	White Consolidated Ind.
48	Sherwin Williams	73	Zenith
49	B.F. Goodrich	74	Signal Companies
50	Uniroyal	75	Borg Warner
51	Armstrong	76	Fruehauf
52	Corning Glass	77	ACF Industries
53	Owens-Illinois	78	American Standard
54	National Gypsum	79	American Hospital Supply
55	U.S. Gypsum	80	Baxter Travenol
56	Armco, Inc.	81	AMF
57	Inland Steel	82	Questor
58	Interlake	83	Metromedia
59	U.S. Steel	84	Pittston
60	Alcan Aluminum	85	Kroger
61	Reynolds Metals	86	McDonalds
62	American Can	87	Phillip Morris
63	Continental Group	88	National Distillers
64	National Can	89	Stauffer
65	Stanley Works	90	Union Carbide
66	Cummins Engine	91	Merck
67	Clark Equipment	92	Crown Cork
68	Trane	93	NL Industries
69	Westinghouse	94	Chicago Pneumatic
70	Singer	95	Eaton
71	Whirlpool	96	General Signal

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FILE NONAME (CREATION DATE = 11/ 8/84)

CASE-N	LDLAG	LD	LW	CORR	CV	DR	G	AD	AW	LD/AD	INTERACT
1	2.508	3.029	7.730	.5582	.5646	.3574	.1076	2.227	6.592	1.360	.1995
2	3.547	3.412	5.758	.7888	.4107	.5331	.0957	2.612	4.740	1.306	.4205
3	3.033	2.155	3.072	.8022	.5651	.3624	.0647	2.509	9.690	.859	.2907
4	4.959	4.537	8.577	.6178	.2737	.4897	.0399	3.626	8.604	1.251	.3025
5	3.285	3.116	5.213	.0658	.3871	.5739	.0870	3.435	6.252	.907	.0378
6	.988	.878	1.129	-.1475	.5671	.7081	.1255	.406	1.428	2.163	-.1044
7	1.182	1.017	1.938	.1513	.3245	.5245	.0733	1.684	4.122	.604	.0794
8	1.324	1.138	1.316	-.5033	.3969	.3708	.1386	1.826	5.059	.623	-.1866
9	2.202	1.692	4.274	.2818	.3074	.5934	.0847	1.267	3.209	1.335	.1672
10	2.820	2.535	6.412	.4588	.3236	.5328	.0991	1.325	4.042	1.913	.2444
11	1.823	1.658	3.141	.1858	.3244	.4009	.0935	.659	1.875	2.516	.0745
12	2.736	2.914	4.907	.2706	.4653	.5462	.0178	.754	1.610	3.865	.1478
13	1.894	1.887	3.019	.7166	.2805	.3449	.0243	1.179	3.113	1.601	.2472
14	1.981	1.913	2.457	-.5381	.2761	.5103	.0277	.714	1.393	2.679	-.2746
15	1.855	1.454	2.842	.2756	.2955	.3864	.1024	1.031	2.553	1.410	.1065
16	3.875	3.724	6.895	.5671	.3616	.4585	.1189	2.600	5.216	1.432	.2600
17	2.630	2.448	4.193	-.2934	.1516	.5589	.0705	1.181	3.387	2.073	-.1640
18	3.780	3.880	7.783	.3835	.4724	.5219	.1173	3.052	6.785	1.271	.2001
19	4.571	4.355	8.620	.1648	.3959	.4750	.1232	3.033	8.177	1.436	.0783
20	3.597	3.046	6.280	.3767	.2849	.4989	.0850	2.486	5.140	1.225	.1879
21	4.243	4.021	6.102	.4293	.3530	.5608	.1280	3.110	6.272	1.293	.2408
22	1.995	2.319	4.148	.5179	.3082	.4361	.0983	2.680	5.879	.865	.2259
23	3.230	2.955	6.352	.4980	.4226	.5393	.0796	2.358	7.120	1.253	.2686
24	4.854	5.234	11.725	.1499	.3966	.4950	.1405	4.046	7.961	1.294	.0742
25	3.934	4.573	8.609	.7004	.4231	.4932	.1077	2.163	7.413	2.114	.3454
26	3.909	3.597	7.325	.3328	.3151	.4433	.0992	2.935	5.329	1.226	.1475
27	2.059	1.810	4.154	.5612	.4017	.3470	.1117	1.285	3.044	1.409	.1947
28	1.550	1.276	1.992	.3980	.7495	.3679	.1892	2.150	8.680	.593	.1464
29	3.139	2.876	7.512	.6390	.5852	.5245	.2049	2.244	4.573	1.202	.3352
30	2.218	2.172	4.879	-.3323	.1899	.5410	.0208	.466	1.239	4.661	-.1798
31	2.284	2.364	5.055	.5462	.6821	.5760	.0790	1.868	4.721	1.266	.3146
32	2.773	2.850	7.109	.6395	.2277	.5079	.0989	1.534	4.059	1.858	.3248
33	2.813	2.633	6.813	.1085	.3106	.4048	.1004	1.218	2.742	2.162	.0439
34	2.155	2.058	5.051	-.2589	.3192	.5240	.0886	1.448	7.855	1.421	-.1357
35	1.878	2.449	4.023	.4383	.2227	.4657	.0884	1.525	3.310	1.606	.2041
36	2.884	2.744	4.593	-.3225	.3720	.4688	.0854	2.130	7.130	1.288	-.1512
37	3.128	3.028	5.948	.6258	.3263	.4332	.0603	1.023	2.483	2.960	.2711
38	2.984	4.011	8.172	.3121	.2142	.5816	.0636	1.146	2.420	3.500	.1815
39	2.138	1.714	4.321	.4089	.5923	.5020	.1150	1.375	3.447	1.247	.2053
40	1.182	1.233	2.167	.2478	.3813	.3754	.1089	.847	2.346	1.456	.0930
41	2.273	2.001	3.720	.6720	.3575	.5324	.1058	.993	2.918	2.015	.3578
42	3.076	2.814	5.318	-.3823	.2291	.4690	.0814	1.559	5.911	1.805	-.1793
43	.997	1.024	1.309	.7031	.2517	.3668	.1344	.934	2.327	1.096	.2579
44	1.703	2.589	3.856	.6318	.3389	.4815	.1252	1.531	4.226	1.691	.3042
45	2.020	2.244	3.495	-.0557	.2498	.4965	.0961	1.204	3.130	1.864	-.0277
46	1.582	1.463	2.643	-.0691	.3927	.5058	.1316	.896	3.041	1.633	-.0350

FILE NONAME (CREATION DATE = 11/ 8/84)

CASE-N	LDLAG	LD	LW	CORR	CV	DR	G	AD	AW	LD/AD	INTERACT
47	1.057	2.334	3.813	.5536	.4382	.4545	.1595	.927	2.845	2.518	.2516
48	3.752	2.915	5.327	.5996	.2099	.6268	.0602	.960	2.530	3.036	.3758
49	2.122	2.184	3.860	.1072	.1807	.5616	.0498	1.539	3.885	1.419	.0602
50	2.687	2.557	4.415	-.0573	.1987	.6767	.0250	.610	19.992	4.192	-.0388
51	2.375	1.726	2.494	-.0715	.2466	.3398	.0654	1.649	4.678	1.047	-.0243
52	2.357	2.369	6.801	-.0198	.2344	.3914	.0717	1.385	3.398	1.710	-.0077
53	3.046	3.407	6.772	.4599	.2964	.5673	.0822	1.975	6.679	1.725	.2609
54	2.970	2.982	5.440	-.0586	.3700	.3805	.0406	1.713	4.285	1.741	-.0223
55	2.481	2.400	5.657	.1102	.4656	.3904	.0633	2.165	7.358	1.109	.0430
56	2.619	2.173	4.424	.6298	.3674	.4605	.0531	1.474	7.674	1.474	.2900
57	3.609	3.981	8.939	.3317	.2914	.5608	.0860	2.398	9.487	1.660	.1860
58	2.404	2.640	5.100	.2337	.3259	.5215	.0501	1.345	3.919	1.963	.1219
59	3.086	3.036	6.947	.6880	.3232	.5498	.0403	2.241	6.604	1.355	.3783
60	2.574	2.272	3.996	.6318	.6278	.5497	.0652	1.916	5.231	1.186	.3473
61	3.051	2.831	5.257	.7254	.4479	.5637	.0395	1.881	8.484	1.505	.4089
62	2.101	2.705	6.996	.2015	.2008	.6184	.0415	1.555	3.507	1.740	.1246
63	3.183	3.242	7.084	.5799	.2191	.5706	.0771	1.913	3.364	1.695	.3309
64	2.182	1.480	2.590	.3502	.4301	.6026	.1021	1.346	2.695	1.100	.2110
65	2.400	2.456	5.846	-.0717	.4108	.4247	.0919	1.086	2.904	2.262	-.0305
66	2.051	2.216	3.826	-.0184	.5203	.5963	.1361	1.338	2.751	1.656	-.0110
67	1.486	1.480	2.954	.1681	.3356	.4057	.0711	1.196	3.144	1.237	.0682
68	1.674	2.741	4.432	-.2027	.3618	.5005	.0859	.891	1.979	3.076	-.1015
69	1.212	1.231	1.989	-.1017	.1837	.6263	.0475	.930	2.622	1.324	-.0637
70	1.939	1.727	2.805	.1402	.1490	.7205	.0001	.595	1.534	2.903	.1010
71	1.533	1.580	2.640	-.4917	.2541	.3265	.0519	.634	1.809	2.492	-.1605
72	2.467	2.909	5.350	.0657	.2961	.5703	.0999	1.172	3.268	2.482	.0375
73	1.677	3.551	7.601	-.3615	.3138	.5560	.0773	.715	3.026	4.966	-.2010
74	2.592	2.736	5.567	.0973	.4640	.5767	.0549	.782	3.772	3.499	.0561
75	.928	.886	1.089	-.0172	.2827	.3933	.0551	1.473	3.268	.601	-.0068
76	2.151	1.931	3.197	.0459	.4485	.6530	.1396	1.588	4.678	1.216	.0300
77	3.314	3.602	5.554	.3981	.3169	.6604	.0839	2.819	5.859	1.278	.2629
78	1.748	2.612	6.247	.5727	.4189	.5970	.0271	1.015	2.856	2.573	.3419
79	2.468	2.333	7.138	.4367	.4357	.3831	.1872	1.111	3.871	2.100	.1673
80	2.609	2.710	5.221	.3807	.6130	.3964	.1862	1.709	3.684	1.586	.1509
81	1.952	1.813	2.508	-.3711	.1433	.5429	.0710	.951	3.471	1.906	-.2015
82	1.933	1.786	2.393	-.7947	.1787	.5770	.0226	.818	1.917	2.183	-.4585
83	2.577	2.381	3.430	-.1167	.5630	.7254	.0809	1.652	5.870	1.441	-.0847
84	1.360	1.389	3.670	-.0768	.6049	.5015	.1095	1.554	3.550	.894	-.0385
85	1.511	1.619	3.931	.5416	.4208	.6639	.1090	1.406	3.940	1.151	.3596
86	3.856	3.339	5.400	.2465	.6342	.5684	.3158	4.634	26.861	.721	.1401
87	3.924	3.311	5.854	.3043	.6046	.6127	.2556	1.970	5.662	1.681	.1864
88	3.097	2.876	4.316	.5806	.2548	.3644	.0533	1.205	5.564	2.387	.2116
89	3.146	2.681	5.721	-.2100	.4396	.5564	.1852	1.874	4.063	1.431	-.1168
90	3.345	3.250	7.630	.7365	.2830	.5055	.0902	3.378	13.364	.962	.3723
91	1.448	1.241	1.645	.5796	.3395	.3498	.1635	1.725	4.268	.719	.2027
92	.541	.500	.571	.5105	.3160	.3788	.0765	1.267	3.201	.395	.1934

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FILE NONAME (CREATION DATE = 11/ 8/84)

CASE-N	LDLAG	LD	LW	CORR	CV	DR	G	AD	AW	LOAD	INTERACT
93	2.504	2.102	3.892	.8069	.5498	.4628	.0688	1.538	5.071	1.367	.3734
94	1.645	1.783	2.595	.5108	.3648	.5631	.1153	.876	1.955	2.035	.2076
95	2.355	2.295	5.176	.2595	.3696	.5635	.1089	1.230	3.364	1.866	.1462
96	1.650	1.466	3.288	.4023	.7185	.4176	.1716	.807	2.411	1.817	.1680

Symbols not previously defined:

LDLAG = lagged liability duration

LW = liability weighted average maturity

AW = asset weighted average maturity

APPENDIX E

SPSS REGRESSION OUTPUT

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FILE NONAME (CREATION DATE = 11/ 8/84)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. LD

VARIABLE(S) ENTERED ON STEP NUMBER 1.. CORR
CV
DR
G
AD

MULTIPLE R	.67701
R SQUARE	.45834
ADJUSTED R SQUARE	.42824
STANDARD ERROR	.68558

ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
REGRESSION	5.	35.79427	7.15885	15.23096
RESIDUAL	90.	42.30180	.47002	

------------------ VARIABLES IN THE EQUATION ------------------

VARIABLE	B	BETA	STD ERROR B	F
CORR	.2461646	.09780	.21133	1.357
CV	-1.116086	-.16652	.64013	3.039
DR	1.934038	.20309	.74878	6.671
G	-1.233541	-.06808	1.78542	.477
AD	.7189167	.64987	.09626	55.777
(CONSTANT)	.7810260			

------------- VARIABLES NOT IN THE EQUATION -------------

VARIABLE	BETA IN	PARTIAL	TOLERANCE	F

ALL VARIABLES ARE IN THE EQUATION

STATISTICS WHICH CANNOT BE COMPUTED ARE PRINTED AS ALL NINES.

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FILE NONAME (CREATION DATE = 11/17/84)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * *   VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. LD

VARIABLE(S) ENTERED ON STEP NUMBER 1.. CORR
DR
G
AD

MULTIPLE R	.66336
R SQUARE	.44004
ADJUSTED R SQUARE	.41543
STANDARD ERROR	.69322

ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
REGRESSION	4.	34.36566	8.59142	17.87815
RESIDUAL	91.	43.73041	.48055	

------------------ VARIABLES IN THE EQUATION ------------------

VARIABLE	B	BETA	STD ERROR B	F
CORR	.1678977	.06671	.20881	.647
DR	1.884312	.19787	.75658	6.203
G	-2.855638	-.15760	1.54081	3.435
AD	.7221953	.65284	.09731	55.074
(CONSTANT)	.5606207			

------------- VARIABLES NOT IN THE EQUATION -------------

VARIABLE	BETA IN	PARTIAL	TOLERANCE	F

ALL VARIABLES ARE IN THE EQUATION
STATISTICS WHICH CANNOT BE COMPUTED ARE PRINTED AS ALL NINES.

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FILE NUNAME (CREATION DATE = 11/ 8/84)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 3

DEPENDENT VARIABLE.. LOAD

VARIABLE(S) ENTERED ON STEP NUMBER 1.. CORR
CV
DR
G

MULTIPLE R	.46955
R SQUARE	.22048
ADJUSTED R SQUARE	.18621
STANDARD ERROR	.76360

ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
REGRESSION	4.	15.00777	3.75194	6.43461
RESIDUAL	91.	53.06103	.58309	

------------------ VARIABLES IN THE EQUATION ------------------

VARIABLE	B	BETA	STD ERROR B	F
CORR	-.4246604	-.18072	.22639	3.519
CV	-.5607687	-.08962	.71289	.619
DR	1.825486	.20533	.83275	4.805
G	-4.406283	-.26047	1.89050	5.432
(CONSTANT)	1.551989			

------------- VARIABLES NOT IN THE EQUATION -------------

VARIABLE	BETA IN	PARTIAL	TOLERANCE	F

ALL VARIABLES ARE IN THE EQUATION
STATISTICS WHICH CANNOT BE COMPUTED ARE PRINTED AS ALL NINES.

FILE NONAME (CREATION DATE = 11/ 8/84)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 4

DEPENDENT VARIABLE.. LOAD

VARIABLE(S) ENTERED ON STEP NUMBER 1.. CORR
DR
G

MULTIPLE R	.46387
R SQUARE	.21518
ADJUSTED R SQUARE	.18959
STANDARD ERROR	.76202

ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
REGRESSION	3.	14.64698	4.88233	8.40807
RESIDUAL	92.	53.42182	.58067	

------------------ VARIABLES IN THE EQUATION ------------------

VARIABLE	B	BETA	STD ERROR B	F
CORR	-.4630096	-.19704	.22062	4.404
DR	1.801193	.20259	.83045	4.704
G	-5.212123	-.30811	1.58557	10.806
(CONSTANT)	1.442486			

------------- VARIABLES NOT IN THE EQUATION -------------

VARIABLE	BETA IN	PARTIAL	TOLERANCE	F

ALL VARIABLES ARE IN THE EQUATION

STATISTICS WHICH CANNOT BE COMPUTED ARE PRINTED AS ALL NINES.

APPENDIX F

RESIDUAL PLOTS

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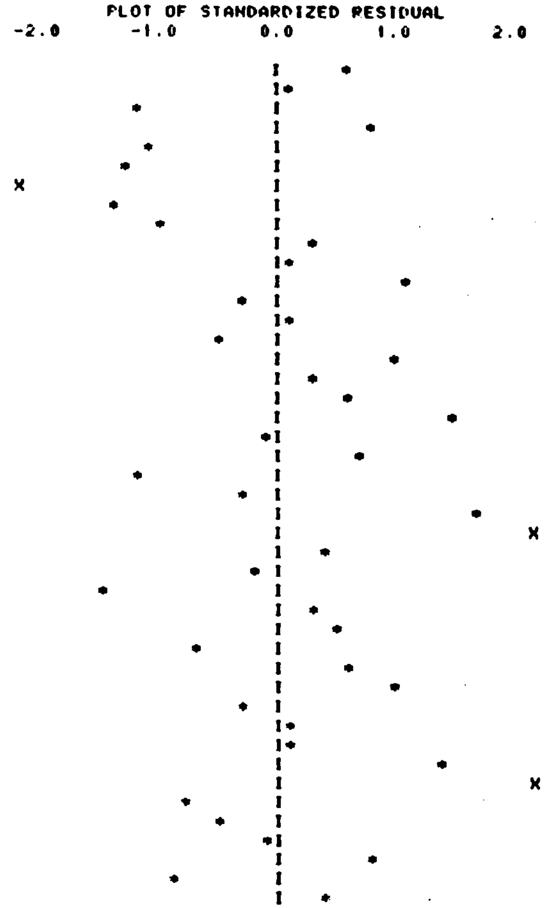
FILE NONAME (CREATION DATE = 11/17/84)

* M U L T I P L E R E G R E S S I O N *

DEPENDENT VARIABLE: LD FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED LD	PREDICTED LD	RESIDUAL
1	3.029000	2.628857	.4001428
2	3.412000	3.310675	.1013252
3	2.155000	3.005411	-.8504109
4	4.537000	3.949054	.5879456
5	3.116000	3.885375	-.7693753
6	.8780000	1.804966	-.9269658
7	1.017000	2.581204	-1.564204
8	1.138000	2.097758	-.9597579
9	1.692000	2.399234	-.7072340
10	2.535000	2.315528	.2194710
11	1.658000	1.556161	.1018385
12	2.914000	2.128970	.7850299
13	1.887000	2.112912	-.2259116
14	1.913000	1.868386	.4461429E-01
15	1.454000	1.787158	-.3331575
16	3.724000	3.057965	.6660349
17	2.448000	2.216092	.2319081
18	3.880000	3.477606	.4023941
19	4.355000	3.321942	1.033057
20	3.046000	3.116600	-.7059956E-01
21	4.021000	3.569927	.4510725
22	2.319000	3.124097	-.8050978
23	2.955000	3.136071	-.1810710
24	5.234000	4.039308	1.194692
25	4.573000	2.862115	1.710884
26	3.597000	3.288177	.3088234
27	1.810000	1.917747	-.1077476
28	1.276000	2.333116	-1.057116
29	2.876000	2.691715	.1842847
30	2.172000	1.801387	.3706129
31	2.364000	2.861156	-.4971559
32	2.850000	2.450458	.3995414
33	2.633000	1.934535	.6984649
34	2.058000	2.297261	-.2395609
35	2.449000	2.360644	.8835543E-01
36	2.744000	2.684244	.5975603E-01
37	3.028000	2.048586	.9794139
38	4.011000	2.354954	1.656045
39	1.714000	2.239919	-.5259189
40	1.233000	1.610317	-.3773170
41	2.001000	2.091669	-.9066436E-01
42	2.814000	2.273629	-.5403707
43	1.024000	1.660568	-.6365680
44	2.589000	2.322150	.2668502



45	2.244000	2.081926	.1620738
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47	2.334000	1.723989	.6100104
48	2.915000	2.363777	.5512228
49	2.184000	2.606097	-.4220968
50	2.557000	2.195262	.3617377
51	1.726000	2.193047	-.4670465
52	2.369000	2.090307	.2786926
53	3.407000	2.898409	.5085906
54	2.982000	2.388944	.5930554
55	2.400000	2.697549	-.2975494
56	2.173000	2.446970	-.2739701
57	3.981000	3.159274	.8217258
58	2.640000	2.410812	.2291874
59	3.036000	3.215487	-.1794871
60	2.272000	2.900043	-.6280437
61	2.831000	2.990252	-.1592523
62	2.705000	2.764215	-.5921561E-01
63	3.242000	2.894563	.3474368
64	1.480000	2.435419	-.9554192
65	2.456000	1.870721	.5852790
66	2.216000	2.258791	-.4279176E-01
67	1.480000	2.014019	-.5340196
68	2.741000	1.867863	.8731374
69	1.231000	2.259689	-1.028689
70	1.727000	2.371227	-.6442275
71	1.580000	1.402958	.1770424
72	2.909000	2.207409	.7015904
73	3.551000	1.843232	1.707768
74	2.736000	2.071622	.6643778
75	.8860000	2.205281	-1.319281
76	1.931000	2.546982	-.6159822
77	3.602000	3.668141	-.6614086E-01
78	2.612000	2.437350	.1746493
79	2.333000	1.623605	.7093949
80	2.710000	2.073993	.6360072
81	1.813000	2.005364	-.1923644
82	1.786000	2.040658	-.2546589
83	2.381000	2.869952	-.4889525
84	1.389000	2.302308	-.9133078
85	1.619000	2.606691	-.9876910
86	3.339000	4.117892	-.7788929
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88	2.876000	2.062785	.8132145
89	2.631000	2.398323	.2826769
90	3.250000	3.818794	-.5687943
91	1.241000	2.095956	-.8549566
92	.5000000	2.056675	-1.556675
93	2.102000	2.482426	-.3804255
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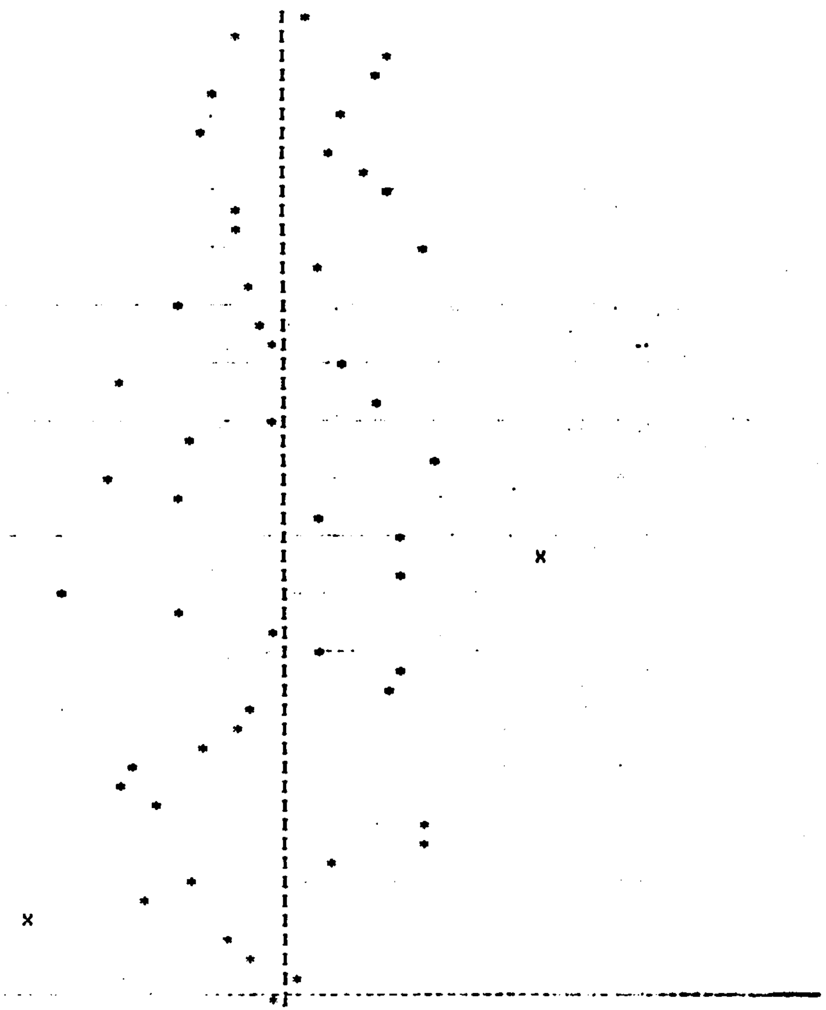
96	1.466000	1.507839	-.4183872E-01



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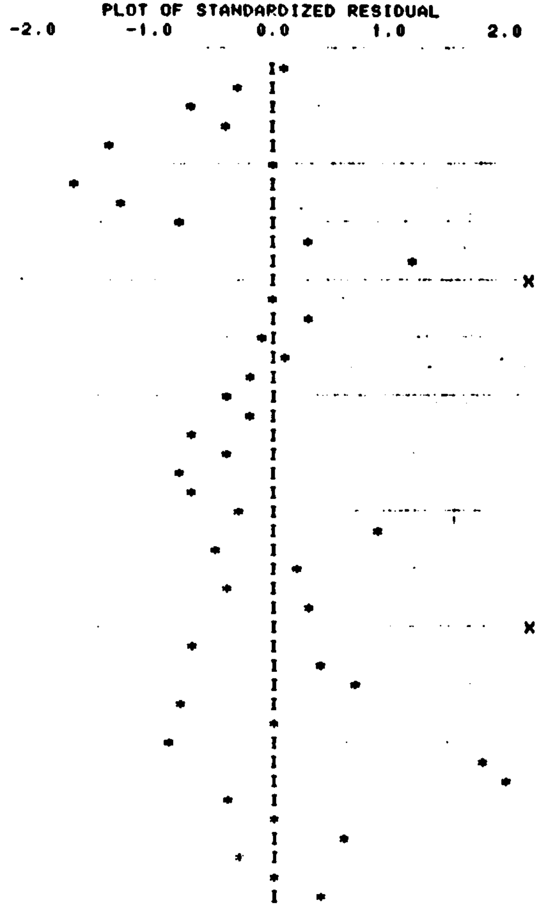
FILE NONAME (CREATION DATE = 11/17/84)

* M U L T I P L E R E G R E S S I O N *

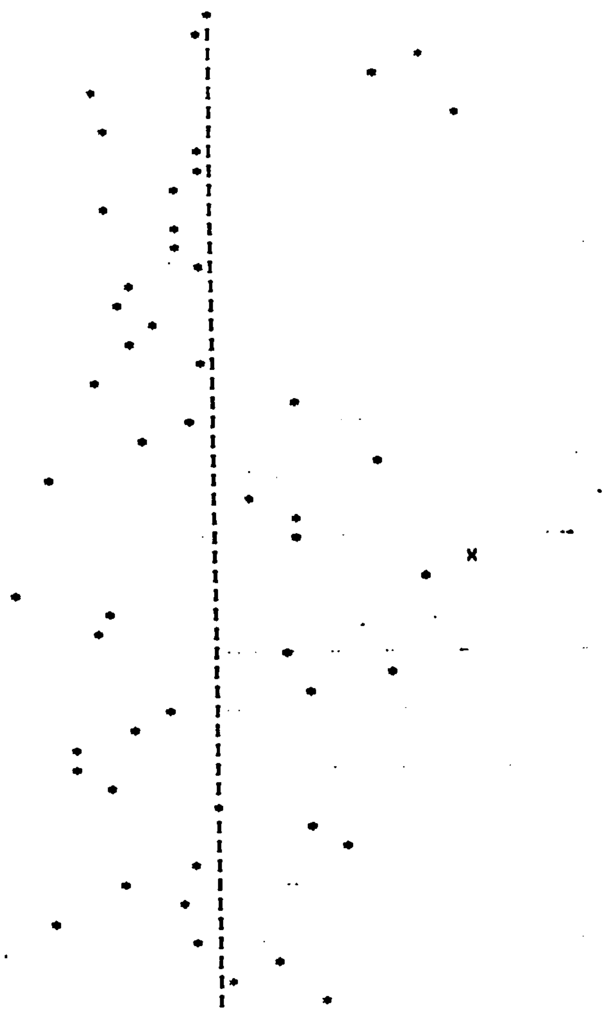
DEPENDENT VARIABLE: LOAD FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED LOAD	PREDICTED LOAD	RESIDUAL
1	1.360126	1.266956	.9316967E-01
2	1.306279	1.538680	-.2324010
3	.8589081	1.386587	-.5276794
4	1.251241	1.569913	-.3186719
5	.9071325	1.992270	-1.085137
6	2.162561	2.132083	.3047845E-01
7	.6039193	1.935109	-1.331190
8	.6232202	1.621001	-.9977806
9	1.335438	1.939371	-.6039327
10	1.913207	1.673211	.2399961
11	2.515933	1.591223	.9247096
12	3.864722	2.208231	1.656490
13	1.600509	1.605270	-.4760959E-02
14	2.679272	2.466404	.2128673
15	1.410281	1.477140	-.6685853E-01
16	1.432308	1.386039	.4626901E-01
17	2.072820	2.217565	-.1447452
18	1.271297	1.593582	-.3222849
19	1.435872	1.579615	-.1437432
20	1.225261	1.723655	-.4983934
21	1.292926	1.586673	-.2937469
22	.8652985	1.475842	-.6105433
23	1.253181	1.768405	-.5152246
24	1.293623	1.532368	-.2387445
25	2.114193	1.445197	.6689962
26	1.225554	1.569823	-.3442688
27	1.408560	1.225465	.1830955
28	.5934883	.9347333	-.3412449
29	1.281640	1.023384	.2582553
30	4.660944	2.462377	2.198566
31	1.265525	1.815319	-.5497947
32	1.857888	1.545738	.3121498
33	2.161741	1.598075	.5636656
34	1.421271	2.044390	-.6231192
35	1.605901	1.617612	-.1171108E-01
36	1.288263	1.991090	-.7028276
37	2.959922	1.618720	1.341202
38	3.500000	2.014063	1.485937
39	1.246546	1.557966	-.3114203
40	1.455726	1.436320	.1940634E-01
41	2.015106	1.538856	.4762498
42	1.805003	2.039987	-.2349839
43	1.096360	1.077112	.1924764E-01
44	1.691052	1.364673	.3263789

PLOT OF STANDARDIZED RESIDUAL



45	1.863787	1.861683	.2104627E-02
46	1.632813	1.699608	-.6679538E-01
47	2.517799	1.173472	1.344327
48	3.036458	1.980083	1.056375
49	1.419103	2.144837	-.7257339
50	4.191803	2.557580	1.634223
51	1.046695	1.746763	-.7000686
52	1.710469	1.782931	-.7246186E-01
53	1.725063	1.822928	-.9786454E-01
54	1.740805	1.943360	-.2025546
55	1.108545	1.764720	-.6561755
56	1.474220	1.703568	-.2293483
57	1.660134	1.850772	-.1906383
58	1.962825	2.012475	-.4965018E-01
59	1.354752	1.904182	-.5494305
60	1.185804	1.800242	-.6144381
61	1.505050	1.916072	-.4110218
62	1.739550	2.246744	-.5071943
63	1.694720	1.799892	-.1051724
64	1.099554	1.833581	-.7340266
65	2.261510	1.761656	.4999537
66	1.656203	1.815686	-.1594834
67	1.237458	1.724816	-.4873580
68	3.076319	1.990113	1.086205
69	1.323656	2.370085	-1.046429
70	2.902521	2.674810	.2277105
71	2.492114	1.987728	.5043855
72	2.482082	1.918595	.5634866
73	4.966434	2.208430	2.758003
74	3.498722	2.150037	1.348684
75	.6014936	1.871671	-1.270177
76	1.215995	1.869800	-.6538054
77	1.277759	2.010372	-.7326140
78	2.573399	2.111383	.4620147
79	2.099910	.9546171	1.145293
80	1.585722	1.009714	.5760037
81	1.906414	2.222116	-.3157013
82	2.183374	2.731934	-.5485594
83	1.441283	2.381444	-.9401600
84	.8938224	1.810616	-.9167933
85	1.151494	1.819410	-.6679169
86	.7205439	.7061636	.1438022E-01
87	1.680711	1.072964	.6077461
88	2.386722	1.552211	.8345109
89	1.430630	1.576616	-.1459866
90	.9621078	1.541849	-.5797409
91	.7194203	.9520007	-.2325804
92	.3946330	1.489684	-1.095051
93	1.366710	1.543881	-.1771713
94	2.035398	1.619274	.4161135
95	1.865854	1.769707	.9614681E-01
96	1.816605	1.113995	.7026097



APPENDIX G

SPSS REGRESSION OUTPUT,

DELETING OUTLIERS

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FILE NONAME (CREATION DATE = 11/17/84)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. LD

VARIABLE(S) ENTERED ON STEP NUMBER 1.. CORR
DR
G
AD

MULTIPLE R	.72889
R SQUARE	.53128
ADJUSTED R SQUARE	.50948
STANDARD ERROR	.59109

ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
REGRESSION	4.	34.05782	8.51445	24.37005
RESIDUAL	86.	30.04684	.34938	

------------------ VARIABLES IN THE EQUATION ------------------

VARIABLE	B	BETA	STD ERROR B	F
CORR	.1842557	.07861	.18195	1.026
DR	1.445841	.16513	.65348	4.895
G	-3.076775	-.18654	1.31725	5.456
AD	.7407519	.73020	.08349	78.717
(CONSTANT)	.7460137			

------------------ VARIABLES NOT IN THE EQUATION ------------------

VARIABLE	BETA IN	PARTIAL	TOLERANCE	F

ALL VARIABLES ARE IN THE EQUATION
STATISTICS WHICH CANNOT BE COMPUTED ARE PRINTED AS ALL-NINES.

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FILE    NONAME    (CREATION DATE = 11/17/84)

* * * * * * * * * * * * * * * * * * * * * * *  M U L T I P L E    R E G R E S S I O N  * * * * * * * * * * * * *     VARIABLE LIST   1
                                                                                                                    REGRESSION LIST   1

DEPENDENT VARIABLE..     LOAD

VARIABLE(S) ENTERED ON STEP NUMBER   1..     CORR
                                             DR
                                             G

MULTIPLE R            .40897          ANALYSIS OF VARIANCE     DF     SUM OF SQUARES      MEAN SQUARE          F
R SQUARE              .16725          REGRESSION                3.          7.33930          2.44643       5.95838
ADJUSTED R SQUARE     .13918          RESIDUAL                 89.         36.54229           .41059
STANDARD ERROR        .64077

----------------- VARIABLES IN THE EQUATION ------------------     ------------- VARIABLES NOT IN THE EQUATION -------------

VARIABLE               B          BETA     STD ERROR B        F     VARIABLE       BETA IN     PARTIAL   TOLERANCE         F

CORR           -.2290388       -.11772          .19047    1.446
DR              1.592972        .22234          .69923    5.190
G              -3.914627       -.28094         1.36210    8.260
(CONSTANT)      1.289029

ALL VARIABLES ARE IN THE EQUATION

STATISTICS WHICH CANNOT BE COMPUTED ARE PRINTED AS ALL NINES.
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VITA

Alan James Kirkpatrick received a Bachelor of Arts degree in Management from the University of South Florida in 1973. After graduation, he was employed by Trust Company Bank in Atlanta, Georgia. He received a Master of Business Administration degree in Finance from Georgia State University in 1976.

In the fall of 1977, he accepted a teaching assistantship at The University of Tennessee, Knoxville and began study toward a doctoral degree. He received the Doctor of Business Administration with a major in Finance in March 1985.

The author is a member of the American Finance Association, the Financial Management Association, and the Southern Finance Association. He is an Assistant Professor of Finance at Loyola University, New Orleans.