Center for Research on Economic and Social Theory
CREST Working Paper

Taxes, Information and Corporate Financing Choices

Jeffrey K. MacKie-Mason

April 1986
Number 87--38

DEPARTMENT OF ECONOMICS
University of Michigan
Ann Arbor, Michigan 48109

Taxes, Information and Corporate Financing Choices

by

Jeffrey K. MacKie-Mason
University of Michigan and NBER

April 1986
Current version: August 10, 1987

Abstract. The paper uses a different approach from most capital structure studies, and a large new data set to study many hypotheses of the determinants of financial decisions. We focus on incremental financing choices by firms (new public issues) rather than the debt/assets ratio. We resolve some questions about the role of taxes, by obtaining strong and plausible results after controlling for confounding effects which have been ignored in previous studies. We also find strong support for several predictions of moral hazard and financial distress theories of optimal leverage ratios. Some evidence of signaling costs for equity issues emerges, but the extreme "pecking order" hypothesis (that firms have hierarchical preferences with no optimal debt ratio) is rejected.

Keywords. Capital structure, corporate taxes, asymmetric information

Address. Prof. Jeffrey K. MacKie-Mason, Department of Economics, University of Michigan, Ann Arbor, MI 48109

Taxes, Information and Corporate Financing Choices

Jeffrey K. MacKie-Mason

1. INTRODUCTION

In his Presidential Address to the American Finance Association, Stewart Myers rhetorically asked "How do firms choose their capital structures?" and answered "We don't know" (Myers [1984]). This paper presents new empirical evidence which helps to answer Myers's question. A new data source is used, and an econometric approach different from most empirical capital structure studies is employed. Some previous results are affirmed, but others are rejected. Most importantly, new light is thrown on the importance of taxes, and some progress is made on the debate over the "optimal leverage" and "hierarchy" paradigms.

Nearly everyone believes taxes must be important to financing decision, but no substantial support has ever been found in empirical analyses.[1] Although our analysis, like others before, is plagued by imperfect corporate tax data, we disentangle several confounding interactions to provide clear and robust evidence of substantial tax effects. The probability that a firm will issue debt to raise new funds decreases as the expected value of interest deductibility declines.

There has recently been substantial controversy over two competing paradigms of capital structure decisions. One view holds that optimal financial decisions lead the firm to an optimal long-run capital structure (or leverage ratio in a two-security world). The other view maintains that each financial decision is made in isolation, ignoring the existing capital structure, according to a hierarchical or "pecking order" set of preferences.[2] There have been virtually no direct tests between the two hypotheses. Our approach to the problem allows us to undertake direct tests of the extreme

---

I would like to thank Alan Auerbach, Rob Gertner, Roger Gordon, Jerry Hausman, Paul Healy, Myron Scholes, Greg Niehaus, Bob Pindyck, Jim Poterba, Jay Ritter, Nejat Seyhun, Glen Sueyoshi, and seminar audiences at MIT, Michigan and NBER for helpful comments and advice. Donna Lawson and Sue Majewski provided superb research assistance. The first version of this paper was prepared with financial support from the Alfred P. Sloan Foundation.

[1] "I know of no study clearly demonstrating that a firm's tax status has predictable, material effects on its debt policy. I think the wait for such a study will be protracted" (Myers [1984], p.588). A similar conclusion is reached by Poterba [1986]. Recent studies which fail to find plausible or significant tax effects include Ang and Peterson [1986], Long and Malitz [1985], Bartholdy, Fisher and Mintz [1985], Bradley, Jarrell and Kim [1984], Marsh [1982], and Williamson [1981].

[2] No one appears to hold the extreme hierarchy position to the exclusion of any balancing of the benefits and costs of leverage. No attempt to integrate the two approaches has yet appeared, however. Note that both views presume that financing matters; nearly all theoretical and empirical work, at least since the mid-1970's, rejects the Modigliani-Miller [1958] irrelevancy proposition.

positions, and provides some insight into what an eclectic combination might look like. Our results on this question are tentative, but represent one of the first attempts to embed many aspects of both views in one analysis.

We also provide evidence on various "financial distress" theories of borrowing costs. We find strong support for the theoretical prediction (Myers[1977]; MacKie-Mason [1986b]) that firms are more likely to issue debt the less that firm value depends on future discretionary investment decisions. Debt appears to be "safer", or "bonded", the greater the fixed or tangible fraction of firm assets. Other moral hazard stories, including a concern with concentration of ownership control are supported. We find only mixed evidence on Jensen's [1986] free-cash flow hypothesis. Overall, the principal-agent problem appears to be a substantial influence on financing decisions.

This paper adopts a different approach than most recent empirical capital structure studies. Rather than studying static characteristics of capital structure (*e.g.*, the debt/equity, or debt/assets ratios) and asking whether it appears the firm is trying to optimize on structure, we examine incremental financing choices made by firms.

We study a sample of financing decisions from a data source not previously utilized: new public-issue security registrations with the SEC. Studying new issue registrations directs the analysis at individual, incremental financing decisions. We construct a sample of 1449 observations from 1977–1984, including new registrations for 613 firms. The large size of the data set and the focus on well-defined individual financial decisions allow us to test a broad range of hypotheses. We are able to investigate both the particular determinants of optimal financial decisions, and whether or not a firm's financial decisions indicate that the firm is aiming for an optimal capital structure.

In the next section, we present our approach to analyzing corporate financial choices. We suggest a general formulation of the problem, and then discuss difficulties with looking for determinants of the debt/asset ratio, which is the standard empirical approach. We then describe the incremental choice approach of this paper, which helps to alleviate some problems, but creates new ones.

In Section 3, we describe the major theories of capital structure decisions, and their testable implications. Section 4 lists the explanatory variables we employ to explore the various hypotheses. The empirical results are discussed in Section 5.

2. MODELING CORPORATE FINANCIAL CHOICES

2.1 General Framework

We begin with a general model of corporate financial decisions. The firm has three types of decisions to make: what level of available funds to establish ("sources"); what to do with the available funds ("uses"); and what mix of contingent claims on the firm's assets to maintain (the "capital structure"). The firm seeks to maximize some expected value function over time,

$$V(x,t) = \max_{\mathcal{S},\mathcal{U},\mathcal{C}} \quad \mathop{\mathrm{E}}_{t} \int_{t}^{\infty} v(x,t;\mathcal{S},\mathcal{U},\mathcal{C})e^{-rt}dt$$

$$\text{s.t.} \quad \mathcal{S} = \mathcal{U}$$

where x is a vector of relevant stochastic state variables affecting the value of the firm, and r is the appropriate discount rate.[3] The constraint requires that sources of funds be equal to uses.

The first-order conditions for the firm's problem will in general yield a system of optimal activity functions,

$$\begin{aligned} \mathcal{S}_t^* &= f_1(x_1,t,\mathcal{U},\mathcal{C}) \\ \mathcal{U}_t^* &= f_2(x_2,t,\mathcal{S},\mathcal{C}) \\ \mathcal{C}_t^* &= f_3(x_3,t,\mathcal{S},\mathcal{U}) \end{aligned}$$

The firm's capital structure decision function, $\mathcal{C}$, is a vector of individual security supply functions for the different contingent claims the firm sells against its assets: debt, convertibles, preferred, common, etc.

It is useful to define $\mathcal{C}$ as a vector of new issues, new borrowings, and period dividends (or net retentions). Then, although we assume the firm makes optimal capital structure *decisions*, the model is general enough to test both the optimal *structure* and the hierarchy hypotheses. For instance, the firm's optimal capital structure decisions may be to change the supplies of outstanding liabilities only when there is an increase or decrease in the total capitalization of the firm, and then to follow a "pecking order" of internal funds first, followed by private debt if necessary, and only as a last resort to obtain public financing. At the other extreme, the optimal policy may be to make adjustments to all of the outstanding supplies of liabilities in order to maintain the firm at an optimal leverage ratio, or more generally a target set of ratios of different liabilities to total assets.

Differences in observed capital structure (*e.g.*, leverage) across firms, or within a firm over time, can be due to several things. An increase or decrease in total capitalization ($\mathcal{S}$) may lead the firm

[3] With the appropriate definition of the value function, $v(\cdot)$, this statement is quite general. For example, we need not assume that the firm's owners are risk-neutral. See, *e.g.*, MacKie-Mason [1986a] or Constantinides [1978].

to change the relative shares of outstanding liabilities because with transaction costs new issues are lumpy. Changes in the firm's investments ($\mathcal{U}$) may change the long-run optimal structure (a maturing growth firm may increase its leverage as more of its assets become tangible, according to one hypothesis described below). Or, for any given level of capitalization and portfolio of uses, changes in exogenous state variables such as tax policy may lead to changes in the mix of outstanding claims on the firm.

2.2 Analyzing Debt-Equity Ratios

As emphasized above, the firm's financial decisions consist of net supplies of liabilities offered (retired) during a period. A logical starting place for empirical analysis would be to look at the net changes in liabilities each period. However, a more common approach assumes that the firm's capital structure is in equilibrium, and estimates the determinants of the current debt/assets ratio.[4] There are at least two difficulties with the empirical implementation of this approach, however. First, the firm's optimal capital structure policy is only part of the simultaneous system of firm decision making functions. Second, the decision problem has a dynamic structure.

The simultaneity of uses and financing decisions is potentially important.[5] Nearly all of the hypotheses considered below imply that financial and investment decisions are joint. Unfortunately, econometrically specifying the joint determination of uses policy and financial policy does not seem to be a feasible task. The disaggregated investment and operating decisions of a firm are difficult to model theoretically, and almost no investment or operating data is available at the level of detail required to capture the effects of different uses policies on financial policy.

The dynamic structure of the firm's optimization problem also poses difficulties for an analysis of the quantities of new liability supplies (or retirements). Due to adjustment costs, firms will not typically adjust their debt/assets ratio continuously to optimal levels. This is apparent from casual observation. If, for instance, the change in the market value of the debt/assets ratio is the appropriate control variable, then adjustments should be made virtually every day, as stock price changes, inflation, and other unexpected economic events change the market value of the ratio. In fact, capital structure changes are lumpy, and relatively infrequent.

---

[4] Studies which adopt this approach include Auerbach [1985]; Bartholdy, Fisher and Mintz [1985]; Long and Malitz [1985]; Ang and Peterson [1986]; and Williamson [1981].

[5] This point has been emphasized recently by, *e.g.*, Scholes and Wolfson [1987]. The point is illustrated by Asquith, Brunner and Mullins [1987], who find that the share price effect of takeover announcements varies with the type of financing.

As far as we are aware, only Auerbach [1985] has explicitly modeled an adjustment process, by arbitrarily imposing the Koyck, or geometric lag structure. Measuring the debt/assets ratio at any given moment, as most studies do, will typically yield an out-of-equilibrium ratio, not the desired optimum. Although in cross-section, the measurement errors may tend to average out, this will not be true if firms sometimes face credit constraints. If credit was rationed when firms wanted to raise new debt financing, then observed debt/assets ratios will be systematically below optimal, and estimates of leverage determinants will be biased. More generally, systematic shocks which leave most firms on the same side of their optimal debt levels will bias static estimates of the determinants of debt policy.

An alternative approach to the dynamic problem has been to estimate the determinants of long-run debt levels, measured as several-year averages.[6] But, if the hierarchy model is sometimes the correct description of optimal financial decisions, then the firm's debt ratio will be nonstationary and path-dependent. When incremental financing decisions are made without regard to any target ratio, two firms which appear identical to the econometrician will likely have, and *should* have, quite different debt ratios depending on their characteristics and market expectations at the particular times when they actually raised new finance. Both firms may have preferred more debt, but one may have issued stock in a credit-rationed year, while the other sold bonds when credit was available. It would be exceptionally difficult to run a careful and statistically powerful test of the hierarchy hypothesis on data which represents the cumulation of a long history of separate financial decisions.[7]

Any of the hypotheses proposed generate predictions for the debt/assets ratio at a point in time, given the right data. However, dynamic adjustment, path dependency due to credit constraints and lexicographic preferences, and simultaneity with investment policy, combined with the less-than-crisp structural models presented in the theoretical literature, limit the reliability and statistical power of estimating the determinants of financial decisions with the debt/assets ratio as the dependent variable.[8] Nor is it easy to distinguish between the competing optimal leverage and hierarchy models using the debt-ratio approach.

---

[6] See, *e.g.*, Bradley, Jarrell and Kim [1984].

[7] Myers [1984] suggests that path-dependency is an important reason why the R^2 of debt/assets ratio studies is usually quite low.

[8] Gordon [1985] points out that researchers invariably seek to control for scale differences across firms by measuring explanatory variables as ratios, usually with respect to a measure of assets. Thus, assets appear both in the dependent (debt-asset ratio) and the explanatory variables, leading to coefficient estimates which are biased and inconsistent.

2.3 Incremental Choice Approach

In this paper we adopt an approach which ameliorates some of the problems discussed above, although we cannot solve them entirely. We look at the actual individual decisions that firms make: changes in the supplies of securities. By focusing on the incremental choices made by firms, we avoid the problems of specifying the structure of the dynamic adjustment process. We are interested in the direction of change, and need not know how far away the firm is from any targets.[9]

The incremental choice approach should be especially helpful in testing the optimal capital structure hypothesis against the hierarchy story. Since an analysis of the debt/assets ratio is estimating the determinants of that ratio, it would seem to beg the question of whether the firm even cares about the ratio. By studying incremental choices instead, we can test whether the firm is in fact aiming for an optimal capital structure, or is making each decision in isolation, as the hierarchy hypothesis predicts.

Rather than measure the net changes in liability supplies, we restrict the analysis further to the choice between debt and equity, conditional on the firm raising new capital with a public issue. This approach has two advantages in reducing the bias from ignoring the simultaneity of financial and investment decisions. First, we control in part for investment policy by restricting the sample to somewhat homogeneous decisions; namely, only new public issues. This conditions out some variation in uses policy by isolating instances in which the firm is taking on new investments and expanding its asset base.

Second, we further control for the role of investment policy by investigating only the choice between types of securities, rather than the amount of the change in security supplies.[10] Thus, we hope to obtain clearer, more powerful results by asking a more narrowly defined question: if a firm has already decided to raise new funds from the public, will it issue stock or bonds?

In order to obtain consistent, *unconditional* estimates of the determinants of the public debt-equity choice, financial decision making must be a nested process. One possibility is illustrated in Figure 1. First the firm determines whether to increase, decrease or leave unchanged its total available funds. If funds are to be increased, then the choice between private sources and public is made. If the firm decides to go public, then it decides whether to issue bonds or shares. In this

9 A few other papers use a similar approach. Marsh [1982] uses older, British data, and ignores any tax effects. Taub [1975], Baxter and Cragg [1970], and Martin and Scott [1974] are primarily classification studies; they test essentially none of the modern capital structure hypotheses.

10 With lumpiness in security issues, a major expansion decision may lead to a big change in the debt/assets ratio, even if the *optimal* ratio hasn't changed.

scheme, estimating the public debt-equity choice in isolation is appropriate.[11] The nested model assumes weak substitutability between alternatives on different branches; *e.g.*, that public debt and equity are more substitutable than are, say, public stock issues and bank debt.

Even if the nested decision-making model is not appropriate (or the true nesting does not isolate public issues in their own branch), our approach should still yield consistent, albeit conditional results. Suppose the financing choice is in fact made between public debt and equity, and bank debt, simultaneously with the investment policy. We can transform the system of simultaneous supply equations for the three sources of finance to a reduced form for the choice of debt or equity conditional on going public. That is, if the firm does issue publicly, a necessary and sufficient condition for optimality is that its chosen instrument, say debt, yield a higher value of the objective function than the other public alternative, equity. Since we are careful to employ only predetermined characteristics of the firm as explanatory variables in the debt-equity choice, a minimal statement about our estimates is that they represent a reduced form analysis of the choice between debt and equity, conditional on going to the public capital market.[12]

We adopt the following econometric model. Conditional on the firm raising new funds from the public, a necessary and sufficient condition is that it choose to issue the security which contributes the most to the decisionmaker's objective function. Let the increment to the value function from alternative i, $i \in \{\text{debt,equity}\}$, be

$$V_i = x_i'\beta_i + \epsilon_i$$
$$\epsilon \sim \mathcal{N}(0, \Sigma)$$

where x_i is a K-vector of choice characteristics and firm attributes, β_i a K-vector of parameters to be estimated, and ϵ a C-vector of unobservable disturbances following a multivariate normal distribution, where C is the number of choices available.

We observe the firm's choice, i^*, but not the realization of the incremental value of the choice, V_{i^*}. Let

$$y_i = \begin{cases} 1, & \text{if } V_i = \max\{V_1, V_2\} \\ 0, & \text{otherwise.} \end{cases}$$

[11] McFadden [1981] discusses the utility theory underlying a nested preference model of this sort. Terminal branches of the tree, such as the public issue branch of Figuré 1, can be consistently estimated with standard discrete choice methods, such as the probit technique employed below.

[12] There is one exception to the claim that we use only predetermined variables, which we discuss below.

The econometric problem is to estimate the β_i given N observations of debt or equity issues and the characteristics vector (y_i, x_i). The probability model is

$$\begin{aligned}\Pr(y_i = 1 \mid x) &= \Pr(V_1 > V_2)\\ &= \Pr(\epsilon_2 - \epsilon_1 < x'\beta)\end{aligned}$$

where $x \equiv x_1 - x_2$, and we assume the parameter vector β is identical across choices. Using the properties of the multivariate normal, define $\epsilon \equiv \epsilon_2 - \epsilon_1 \sim \mathcal{N}(0, \sigma^2)$, where $\sigma^2 = \sigma_1^2 + \sigma_2^2 + 2\sigma_{12}$. Then, for observations $n = 1, \ldots, N$ we have

$$\Pr(y_{1n} = 1 \mid x) = \int_{-\infty}^{x'_n\beta} \frac{1}{\sqrt{2\pi}\sigma} \exp\left[-\frac{1}{2}\left(\frac{\epsilon}{\sigma}\right)^2\right] d\epsilon = \Phi\left(\frac{x'_n\beta}{\sigma}\right)$$

We obtain estimates, $\hat{\beta}$, by maximizing the log of the likelihood function for the sample.[13]

In the next two sections we described the theories which generate the explanatory variables x, and the specific data we employ.

3. GENERAL HYPOTHESES

In this section we summarize the main themes of recent theoretical treatments of capital structure decisions, and present testable implications of the various theories. These theories can be grouped into two classes: those that predict capital structure targets for the firm ("optimal leverage"), and those which imply that optimal financial decisions do not result in optimal financial ratios. The latter paradigm is known as the hierarchy, or "pecking order" model (Myers [1984]), since it predicts that firms choose financial instruments lexicographically, without regard to past or current leverage. We shall discuss the hypothesized decision determinants in terms of their role in the contrasting models.

3.1 "Optimal Leverage"

The optimal leverage theory describes supply and demand functions for debt in a competitive capital market which clears in equilibrium.[14] The benefits and costs of outstanding debt determine the firm's debt supply function; the benefits and costs of holding debt determine the market demand. The firm's optimal debt level is determined as the market-clearing equilibrium quantity.

---

13 Since the likelihood function is globally concave, the estimates of β are unique, if bounded.

14 We use the term "leverage" because of its common use in the literature. With more than two securities, an optimal capital structure is a set of optimal security/assets ratios.

Miller [1977] inspired the most recent theories of optimal leverage by setting the firm's debt-level decision in the equilibrium supply and demand framework. Miller was especially concerned with the role of taxes in determining optimal debt ratios. Letting the personal tax rate on equity be zero, individuals will be indifferent between holding debt and equity if $r_e = r_d(1 - \tau_{pd})$, where the subscripts (d, e) distinguish between the risk-adjusted returns to debt and equity, and τ_{pd} is the personal tax rate on debt.[15] In terms of bond prices, $P_d = \frac{1}{r_d}$, personal taxes imply a downward sloping demand curve; to induce investors to hold larger quantities of bonds, price must fall because marginal investors will be those with increasingly high tax rates on the return to debt (see Figure 2).

On the supply side the tax deductibility of interest payments, but not payments to equity, subsidizes corporate borrowing. Firms can pay r_e or $r_d(1 - \tau_c)$, where τ_c is the corporate tax rate. Indifference between borrowing and issuing equity requires $P_d = P_e(1 - \tau_c)$. If all firms face the same corporate tax rate, the supply curve for bonds is perfectly horizontal (curve S_M in Figure 2). As with Modigliani and Miller's [1958] Proposition I, leverage is irrelevant to firm value, although in aggregate an optimal debt-equity ratio exists for the economy, determined by bond market equilibrium.

More recently, several papers have discussed supply-side costs of borrowing. For example, the marginal tax rate on interest deductions may be decreasing in the level of debt outstanding: $\tau_c = \tau_c(B), \quad \tau_c' < 0$, where B represents bonds outstanding. Other leverage-related costs of borrowing might include real wealth costs of bankruptcy, and costs of investment distortions induced by outstanding debt. We shall refer to all non-tax related costs of leverage as costs of financial distress. In the general model the margin between borrowing and issuing equity is determined by $r_e = r_d\,[1 - \tau_c(B)] + \Delta(B)$, where $\Delta(B)$ represents financial distress costs, and $\Delta' > 0$. The resulting supply curve is given by $P_d = P_e\,[1 - \tau_c(B)] \times \frac{r_e}{r_e - \Delta(B)}$. The supply price of debt is increasing in the debt level of the firm, so the firm in general has an optimal interior leverage ratio (see supply curve S^* in Figure 2).

We now discuss some of the specific determinants of an optimal debt ratio which have been proposed in the literature.

Taxes. Interest deductibility has value only if the firm is paying positive taxes. In an uncertain world, the higher are other tax shields, the greater is the probability that the firm will find itself in a non-tax status; hence the lower the expected value of the interest deduction (DeAngelo and

[15] The results go through as long as the personal tax rate on debt is greater than that on equity.

Masulis [1980]; Ross [1985]). The supply curve slopes upward since leverage increases the expected after-tax cost of borrowing ($\tau_c'(B) < 0$). The hypothesis predicts that the higher are a firm's available non-debt tax shields, the less likely it will be to issue debt.

Bankruptcy costs. Real wealth costs of bankruptcy may be a deterrent to firms seeking high debt ratios (see, *e.g.*, Miller and Modigliani [1963]). Recent evidence suggests that expected bankruptcy costs may be significant (Alman [1984]). Further, if financial decisions reflect the concerns of management as well as owners then the costs of bankruptcy as perceived by the financial decisionmaker may be quite high.[16]

The bankruptcy cost hypothesis suggests that debt issues should be less likely the more likely is severe financial distress. This suggests looking at measures of financial and operating risk, and other financial statistics used to predict bankruptcy.

Moral hazard. The recent literature on managerial economics is dominated by principal-agent models, in which managers are self-interested agents hired by principals (the shareholders). In general, problems of moral hazard may arise whenever it is possible and in management's interests to take actions which do not maximize firm value. If increasing debt raises increases the probability of such interest conflicts occurring, then rational investors will discount the value of that debt, thereby raising the costs of borrowing to the firm.

Myers [1977] and MacKie-Mason [1986b] examine one type of investment distortion that outstanding debt may induce. Management will commit new resources to a project only if the expected return is sufficient to pay off the outstanding debt liabilities, as well as earn an acceptable return on the new investment costs. The alternative is to abandon the project and default on the debt, which with limited liability has zero cost.[17] The first-best investment decision is to go ahead if the expected payoffs are sufficient to earn a return just on the incremental costs. Underinvestment results, which raises the equilibrium cost of borrowing.

Jensen and Meckling [1976] suggest that firms with high debt levels and limited liability will have an incentive to take on excessively risky projects. Risky projects with limited liability offer a call option to shareholders: high payoffs in good states, zero payoff in bad states. Taking on a risky project when debt is high can transfer wealth from bondholders to shareholders.

---

[16] Management costs of bankruptcy may be higher due to fixed human capital investment. Also, if it is not clear to outsiders whether bankruptcy was due to external events or to managerial incompetence, then even good managers may have difficulty selling what transferable skills they do have. See, *e.g.*, Donaldson [1969,1984], for the view that financial decisions primarily reflect self-interested managerial objectives.

[17] We are abstracting here from any real costs to owners and management of bankruptcy; clearly the two hypotheses have interactive effects.

Other costs of financial distress associated with borrowing include contracting, bonding and monitoring costs necessary to ameliorate both operating and investment decision agency problems (Jensen and Meckling [1976]); and unfavorable terms of trade with customers, workers and suppliers due to distorted liquidation incentives (Titman [1984]). Jensen [1986] argued managers may use uncommitted funds to further their own objectives, which may not maximize shareholder value. He predicts that firms are more likely to issue debt than equity when there are "free cash flows", because interest repayment restricts the managers' discretion over the uses of cash.

Financial distress hypotheses have generated numerous testable predictions. Myers [1977] and MacKie-Mason [1986b] point to managerial discretion over future investment decisions. The more firm value depends on such options, the greater may be the cost of borrowing. Tangible, in-place capital (plant and equipment) may serve as bonding against required debt payments. In the other direction, R&D and advertising represent investments in intangible, growth opportunities, and could discourage new debt issues (Long and Malitz [1985]).[18]

If problems of monitoring and control of management distort investment decisions and affect firm value, then we should expect that there would be a benefit to ownership structures which provided better control. There is no simple way to measure the monitoring/control potential of different ownership structures, but one thing to consider is ownership concentration. The larger a new issue is relative to outstanding equity, the less will be the concentration of ownership, in general. If there are benefits to concentration, large relative issue size should encourage a debt issue. Demsetz and Lehn [1985] found evidence in a study of 511 large corporations that ownership concentration does provide control benefits.

Demand Effects. The leverage theory also predicts that the firm's optimal debt ratio depends on the location of the market demand curve for bonds. If arbitrage ensures that a single risk-adjusted interest rate is offered, then each firm faces the same market (risk-adjusted demand curve. However, different shareholder clienteles may form based on the dividend payout rate, since variation in personal tax rates affects the desirability of receiving equity returns in the form of dividends rather than capital gains. Desired debt-ratios may vary with clientele, if high-tax-rate investors prefer to borrow on their own account to obtain interest deductions at their personal tax rate, rather than the lower corporate tax rate (Auerbach [1984]; Auerbach and King [1985]).

We undertake to test a clientele effect with an estimated clientele marginal tax rate. Alternatively, shifts in the demand curve over time might be identifiable. However, in a short panel of

[18] Since R&D and advertising are both expensed, they also can be viewed as non-debt tax shields, and thus can not distinguish between the role of the tax and the moral hazard hypotheses.

Page Missing
in Original
Volume

Page Missing in Original Volume

4. DATA.

Except when indicated in Section 5, we used data from the year prior to the year in which a new issue was registered. We did this to avoid problems with endogeneity. Since most of the data represent flows and come from year-end accounting reports, the data for, say, 1979, will have been generated at least in part simultaneously with, and even after a 1979 issue choice has been made.[21]

The various theories predict that the benefits and costs of different security types arise from expectations about the future.[22] We are using observed values as the information set on which expectations are based. For parsimony, we usually don't include more than one year's data for the explanatory variables.[23] Contemporaneous data might provide better forecasts of future values, but will be plagued by simultaneity. For instance, the debt/assets ratio in the year of a new issue will vary directly with whether the issue was debt.[24]

We now describe our dependent variable and a list of the variables which we consider as possible determinants of the debt-equity choice. Data sources and details of our sample selection are discussed in the appendix.

Dependent Variable. We collected a sample of 1418 observations on new, seasoned security offerings from the SEC Registered Offerings Statistics tape. Table 2 reports issue statistics for the universe of all primary public offerings[25] and the sample used in most of the econometric analysis. Based on the number of debt and equity issues, and the amount of money raised, our sample seems reasonably representative.

We classified convertible and straight debt as debt; preferred, convertible preferred and common stock are classified as equity. Although we would like to expand the choice menu, undertaking a multinomial analysis for the several different security types, not enough data are available. In the sample, 98% of the observations are either straight debt or common stock; no other type accounts for even 1% of the sample.

---

[21] In an extreme case of a January 2 issue date, the entire year's data will be preceded by the issue choice.

[22] For instance, the value of *future* interest deductions on a new debt issue depend primarily on *future tax shields*. See, however, Altshuler and Auerbach [1986] for the time-dependence of carryforwards and credits.

[23] See discussion of Table 6, however.

[24] We estimated some versions of the model using contemporaneous data, with expected results: clearly endogenous variables dominated, with other variables moving substantially closer to zero and becoming insignificant.

[25] The universe includes initial public offerings and unit offerings (*e.g.*, simultaneous offerings of more than one security type), which are excluded from the estimation sample; see the Appendix.

Non-Debt Tax Shields. A number of tax-related variables are available for firms in our sample. Unfortunately, nearly all of them are "book" measures; that is, they are the numbers reported on the accounting books, rather than components of actual tax liability.[26]

We have measures for investment tax credits (ITC), depreciation, research and development (R&D), and advertising. The latter two are tax shields because they are immediately expensed for tax purposes, but represent investments in assets which yield value over several years. The book depreciation variable usually has no relation to depreciation deductions actually claimed in a given tax year. As an alternative, we also utilize a measure of deferred taxes. Deferred taxes represent differences between actual tax payments and book tax liability due to timing differences. The major portion of deferred taxes is usually due to accelerated depreciation deductions, although many of timing differences contribute, not all of which are tax shields. We also have the firm's book tax loss carryforwards, which have the same effect as shields in lowering expected interest deductions. We expect that the higher are a firm's non-debt tax shields, the less likely it is to issue debt.[27]

It is possible to calculate the actual cash flow of taxes paid during a year from the accounting books. This is not the same as the firm's actual tax liability during the year; early and late payments, and differences between fiscal and tax years can completely undo the relationship. Nonetheless, we consider taxes paid divided by earnings before taxes as a proxy for a marginal tax rate.

Bankruptcy. We consider a number of indicators of the likelihood of bankruptcy. We estimated a CAPM "market model" to obtain "beta" and the standard error of regression ("sigma") as measures of systematic and nonsystematic volatility. We unlevered (with the ratio of book equity to book assets) these in order to obtain measures of operating, rather than share risk.

We also constructed two volatility measures based on accounting earnings. The first (VEARNA) is the standard deviation of the first difference in firm earnings, calculated over ten years, and scaled by a 10-year average of total assets.[28] The second is the standard deviation of the growth rate of earnings. Earnings are measured before interest, depreciation and taxes, to avoid confounding the measures with variability in tax shields.

---

[26] Careful attempts, such as Auerbach's [1985], to convert accounting numbers to actual cash flows do not seem to have succeeded in adding much explanatory power to debt/asset ratio analyses. See also the discussion of tax loss carryforwards in Section 5.

[27] Tax variables were scaled by net sales, to obtain a measure of shielded revenue.

[28] No fewer than six years when incomplete data was available. See Chaplinsky [1983] for a discussion of this measure. The measure has also been used by Bradley, Jarrell and Kim [1984], Auerbach [1985].

Financial analysts look at a number of accounting ratios when they evaluate a firm's prospects. As another indicator of financial distress, we have constructed Altman's [1966] ZPROB predictor of bankruptcy. Altman's multiple discriminant function correctly classified 94% of the firms that went bankrupt in the next year, and 97% of those that did not. Although his study is old, it is still widely cited as a good method for predicting financial distress, and has been tested with more recent data.[29]

Moral Hazard. If managers could be bound to make efficient decisions despite outstanding obligations, the moral hazard problem would be avoided. Future growth opportunities and investment options available for management to pursue or discard are decisions which are difficult to fully specify in contracts. We expect the costs of moral hazard to be related to the fraction of firm value which is accounted for by intangible, discretionary opportunities. We use the fraction of a firm's net book assets accounted for by net plant and equipment (FPLANT) as a (negative) indicator of discretionary opportunities.[30] We also employ expenditures on advertising and on research and development; Long and Malitz [1985], Bradley, Jarrell and Kim [1984] and Myers [1977] suggest that these represent investments in intangible growth opportunities.[31]

To test Jensen's [1986] free-cash-flow hypothesis, we construct a measure of cash flow as a percent of net sales. To capture the idea of *uncommitted* cash flows better, we also construct a cash-flow deficit variable first defined by Auerbach [1985]. This variable measures the cash flow available after capital expenditures and trend dividends are paid, assuming that the firm raises enough debt to pay for new investments while keeping its debt/assets ratio constant.

We create a dilution measure by dividing the value of an issue by the market value of equity. If dilution of ownership exacerbates moral hazard problems, then we expect that proportionally large issues will tend to be debt. This variable, unfortunately, is likely to be endogenous, to the extent that investment decisions and financing decisions are simultaneous. We are aware of little empirical evidence which convincingly demonstrates the extent to which choice of financing instrument affects the proportionate size of an issue. We estimate both with and without the variable because it provides substantial explanatory power without seeming to affect other coefficients dramatically.

[29] See, *e.g.*, Brealey and Myers [1984], p. 646, and Bartholdy, Fisher and Mintz [1985]. The function is retested in Altman, Haldeman and Narayanan [1977]. The calculation of ZPROB is detailed in the appendix.

[30] Myers [1977] suggests that managers may rely on book assets and liabilities when making financial decisions because book value is a better measure of fixed, or nondiscretionary value. Market values include the value of discretionary uses of assets.

[31] Note that we cannot distinguish between tax and moral hazard stories with these variables.

Signaling. To test the extreme hierarchy prediction, we construct both current and long-run debt/assets ratios (long-run defined as the average over the previous 10 years). These separately, and differenced, should be insignificant if the firm exhibits lexicographic preferences.[32]

We would like a measure of the degree of information asymmetry between insiders and outsiders. However, insider information is almost always unavailable to the econometrician. We might take realized future earnings, and invoke rational expectations to assert that insiders believe an unbiased forecast of earnings, while outsiders, with less information, have a biased forecast, and take the difference between true future earnings and a forecast as a measure of information differences.[33] However, since future realizations are endogenous to the issue choice, and at best represent the insiders' forecast with error, coefficient estimates will be biased and inconsistent.

A related approach which avoids simultaneity is to use just the forecast variance from a model of earnings, and assume that when the outsiders have poor information (large forecast variance), the *potential* value of insider information is greater, and thus the signaling cost of an equity issue will be greater.[34] To this end, we suppose that accounting earnings follow a random walk, which is a robust finding in the accounting literature.[35] Then, the forecast of tomorrow's earnings is equal to today's earnings, and the forecast variance is the variance of the first differences of earnings (MacKie-Mason [1986c]; Dierkens [1986]).

The variance of earnings first differences is precisely VEARNA, described above as a volatility measure expected to indicate potential financial distress costs. Under the financial distress hypothesis, the expected effect on choosing debt is negative; under the signaling hypothesis, the expected effect is positive.[36]

Bagnoli and Khanna [1987] suggest that market timing of equity issues follows from a signaling model with agency costs of borrowing. They describe a situation in which stock price and the likelihood of equity issue both rise for the same reason. To test this prediction, we calculate the change in the firm's stock price over the previous year.

---

[32] A high current debt-ratio may make it difficult for firms to obtain more debt. We view this as evidence of financial distress costs under the optimal leverage hypothesis. Credit-rationing usually results when security demanders don't know something about the firms seeking credit.

[33] This technique was used by Ang and Peterson [1986].

[34] Although this avoids simultaneity, measurement error remains a problem.

[35] See Healy and Pelapu [1986] and Watts and Zimmerman [1986], ch. 6 for summaries of the relevant studies.

[36] Bradley, Jarrell and Kim [1984] used this variable in a debt/assets ratio regression, and obtained a negative sign. Auerbach [1985] used the same variable in his debt/assets analysis and obtained a positive sign.

It is also possible that our dilution variable is an indicator of signaling costs, since greater dilution provides a greater opportunity for transferring wealth from new investors to current shareholders. The resulting stock price drop may be larger. Further, to the extent that managers' compensation is tied to stock prices (through stock options and other incentive schemes) there may be strong motivation to avoid large price drops. This story might explain why stock issues are more frequent, but smaller in value than debt issues (see Table 2).

Other Variables. We use industry dummy variables to control for various fixed effects which might be present. One such effect might be inter-industry variation in the degree of hidden information. We also estimate year dummies to capture any unobserved system-wide effects, such as changes in tax policy or other general economic conditions.

Net assets of a firm are included. We have no strong priors on this variable. Since some of the moral hazard costs of financial distress can be modeled as options, it has been suggested that firm value should have a negative effect on debt issuance.

We summarize the predicted effects of our different explanatory variables under the different major hypotheses in Table 1. Sample descriptive statistics are reported in Table 3.

5. RESULTS.

We now present the results of our analysis. Our main set of estimates is presented in Table 4. Our "preferred" specifications are in columns 4 and 6, for reasons we discuss below. For clarity, the discussion is organized by general hypothesis. In addition to the many specific results, one point to notice is the importance of controlling for many different effects.

Taxes. The first column of Table 4 presents a first pass at the data, incorporating most of the predicted effects identified in Table 1. (This column is intentionally misspecified to emphasize some points made below.) The results on tax effects are typical of those published in previous studies; *viz.*, unencouraging. The coefficients on tax loss carryforwards (TLCF), investment tax credits (ITC), and R&D all have the predicted negative sign, none of them exceed any standard level of statistical significance. The clientele tax rate and advertising have the wrong sign under the tax shield hypothesis, but are also insignificant.

We address some problems with this preliminary estimation in columns 2 and 3. In column 2 we include the one-year change in the firm's stock price (ΔP), and our measure of the new issue's ownership dilution potential (relative issue size).[37] We shall discuss these two variables below. The

[37] Some authors use "dilution" to indicate a reduciton in price per share due to news or other events. By ownership dilution we mean a reduction in ownership concentration.

dramatic improvement in the likelihood and the strong effect on many other coefficients provide ample evidence that they should be included in the analysis.

The effect on TLCF is substantial; the coefficient is now significant and attains a magnitude which is consistent throughout the remaining analyses. Much of the improvement in TLCF results from controlling for its dual role as a tax shield and an indicator of poor firm performance. ΔP incorporates the market valuation of the firm's performance during the year; what remains in TLCF is a measure of future crowding out of interest deductions.[38]

Adding potential ownership dilution to the analysis also dramatically affects the coefficients on R&D and advertising. We don't have a clear interpretation of the significant positive coefficients, since both the tax and moral hazard hypotheses predict these items will discourage debt issues. We mention below a possible signaling interpretation of R&D; we can think of no similar explanation for the role of advertising, however.

It has been typical in debt/assets ratio studies for the coefficient on various tax shields to be positive, contrary to expectations.[39] Previous authors suggest that since high ITC occurs when a firm makes large investments in equipment, the result may indicate an increase in the firm's debt capacity when tangible, easily re-sold capital is a large fraction of firm assets, consistent with the moral hazard hypothesis. An innovation in our work is to seek to disentangle the two roles of ITC—as indicator of tax shields, and of tangible assets—so that we may determine the effect of tax policy. The results of our efforts appear in columns 3 – 6 of Table 4.

We wish to test the hypothesis that by crowding out interest deductions, tax shields discourage debt. Thus, the effect of tax shields should be greater the more likely the firm is to enter a zero-tax status. We interact an indicator of financial distress to obtain the desired effect: ITC alone will be correlated with the level of tangible capital equipment, while ITC interacted with a financial distress indicator will measure the potential for "crowding out".

[38] Auerbach and Poterba [1986] suggest that the TLCF variable in COMPUSTAT may be inappropriate for studying U.S. tax policy, in part because book TLCF may include foreign carryforwards which are not applicable to U.S. taxable income. They created a revised data series on TLCF for the years 1981–1984; we followed their approach to revise the data for the other years in our sample. We re-estimated column 4 utilizing the revisions, with the resulting coefficient on TLCF negative but insignificant. We replaced TLCF wherever possible with revised data, and included a dummy variable to check for bias from splicing the two series. There appear to be problems in the construction of the revised data, since the revision requires searching the footnotes of a firm's 10-K. Correct TLCF data is unavailable for most observations, because firms are not required to report true tax TLCF. Also, the mean for TLCF actually rose (despite the expectation that foreign carryforwards were biasing book TLCF upwards), and the standard error grew substantially. We use book TLCF, acknowledging that it is an imperfect, but apparently informative measure of one tax shield.

[39] See, for example, Bradley, Jarrell and Kim [1984]; Auerbach [1985], and Ang and Peterson [1986].

ZPROB is our indicator of financial distress. The results in column 3 include ZPROB individually, and interacted with ITC and VEARNA.[40] The effect on ITC is striking, and as predicted: ITC by itself is positive and significant, as the moral hazard hypothesis suggests, but ITC/ZPROB is negative and significant, as we expect from the tax shields story.

We also estimated specifications (not presented here) which included book depreciation, deferred taxes, and taxes paid, as well as these terms interacted both with ZPROB, and with VEARNB (one of the earnings variance measures, and another potential indicator of financial distress). These variables, all of which are measured with substantial error relative to the desired definitions, always have the predicted signs, but enter insignificantly, and without important effects on the other estimated coefficients.

Columns 5 and 6 further support the robustness of our results. Column 5 replicates column 4, without the ownership dilution effect. Recall that the dilution variable, which is the value of issue divided by the market value of equity, may be endogenous if issue value is chosen jointly with security type. Given the huge change in the likelihood function, the effect on the tax variable coefficients is not very big. TLCF loses some of its magnitude, and is no longer significant at a 10% level, but the significance loss is due to the shift in the coefficient towards zero (the standard error is about 1.3 in both cases). ITC/ZPROB loses half of its magnitude, but is still significant at 10%, and its standard error actually declines. Controlling for the relative size of a new issue is important for prediction, but even in a fully reduced form, the tax effects are still important.

Column 6 adds 16 industry dummies to the specification of column 4 (see Table 5 for the estimated dummy coefficients). This specification controls for industry-specific effects, which could have been correlated with the various tax variables, leading to spurious results. We find, however, that the magnitudes of the TLCF and ITC/ZPROB coefficients are virtually unchanged, and the estimate for ITC is still quite precise.

To summarize, we find that when firms are relatively likely to be in a no-tax status, high tax shields are associated with a strong and significant decrease in the probability that a firm will choose to issue debt. We appear to have obtained plausible and significant results where others have failed because we control for more confounding effects; in particular, the correlation of TLCF with firm performance, and the correlation of ITC with tangible capital which diminishes the costs of moral hazard.

Financial Distress, Moral Hazard. Advertising enters the model very significantly with a positive sign, while R&D is unstable but strongly positive and significant in the final specification

[40] A lower value of ZPROB indicates a higher probability of bankruptcy. To ease interpretation, we use its inverse.

(with industry dummies). These results are contrary to both the tax and moral hazard predictions, and directly contradict the Long and Malitz (L-M) [1985] and Bradley, Jarrell and Kim (B-J-K) [1984] studies of debt/assets ratios. Their papers estimate very sparse regressions, focusing on R&D and advertising as indicators of the presence of discretionary managerial opportunities, and conclude that their results provide strong support for the moral hazard hypothesis. We also find support for this hypothesis with other variables, but it appears that the L-M and B-J-K estimates may not be reliable due to omitted variable bias. As an example of this bias, R&D has a negative sign in both columns 1 and 5 when important variables are excluded.

A number of risk measures test the proposition that greater risk of financial distress discourages debt issuance. This test is usually associated with bankruptcy and other financial distress costs. However, the tax shield hypothesis makes the same prediction.

"Beta" and "sigma", the estimates of systematic and firm-specific risk from the market model regressions, both have the predicted negative sign but no explanatory power except in column 1, when ΔP and the dilution variable are excluded. Since we have a plethora of risk measures, and the earnings variance variables provide substantially more explanatory power, we leave "beta" and "sigma" out of the preferred specifications.

The coefficients on both earnings variance measures (VEARNA and VEARNB) have the predicted sign in column 2, but VEARNA is insignificant. With an interaction between VEARNA and ZPROB (column 3), VEARNA becomes very important, and quite statistically significant. Both earnings variance measures support the financial distress hypothesis. We have no ready interpretation for the large positive and significant coefficient on VEARNA/ZPROB, however. This variable appears to indicate that if the firm is *very* likely to enter bankruptcy soon (high ZPROB and variable earnings), then it will prefer to issue debt. Since the inclusion of this interacted variable was suggested by the signaling hypothesis, we defer further discussion to that section.

We estimate a coefficient for FPLANT, which is the fraction of a firm's book assets accounted for by net plant and equipment. The effect is positive, as predicted, and very significant. Other than the bias towards zero when the dilution effect is excluded (columns 1 and 5), the magnitude is consistent throughout. We take this as strong evidence supporting Myers's [1977] conjecture that debt issuance is supported by "bonding" in the form of tangible assets.

We also test Jensen's [1986] "free cash flow" hypothesis that firms with excess cash tend to issue debt to reduce discretion over future cash flows. We report the results for our estimate of the firm's cash flow deficit; the coefficient is nearly always positive, but almost never significant. The sign is opposite to that predicted by Jensen: the lower the cash deficit, the *less* likely is a debt issue.[41]

The potential ownership dilution variable is extremely important. As predicted by both the moral hazard and signaling hypotheses, dilution is strongly associated with a higher probability of debt issue. This effect is plausible if concentration of ownership has a beneficial value in terms of improving monitoring of management. However, a signaling interpretation also appears plausible (see below).

To summarize, we find support for several predictions from the financial distress and moral hazard stories. A greater probability of financial distress is associated with a lower probability of borrowing, as is a higher fraction of firm value held in tangible assets. This latter effect is directly measured in FPLANT, and is consistent with the positive sign on ITC (without the ZPROB interaction), and possibly the positive sign on our measure of cash deficit. Further, we obtain some evidence that ownership concentration has value, so that potentially large dilutions are issued as debt.

From our results on tax effects and the costs of financial distress and moral hazard, we conclude that on average, firms balance the costs and benefits of borrowing, and tend to move towards an optimal debt ratio.

As a direct test of the optimal leverage hypothesis versus the extreme hierarchy theory, we estimate the effect of the difference between the current and the long-run debt/assets ratios. The estimated coefficient is strongly significant and negative, indicating that if the current debt ratio is above the long-run norm for the firm, then the new issue is likely to be equity. The estimates in all specifications clearly reject the hierarchy prediction that incremental choices will ignore the leverage ratio.

We also included the current debt/assets ratio separately. The coefficient is negative and significant, which supports the various optimal leverage ratio hypotheses.

Signaling. MacKie-Mason [1986c] and Dierkens [1986] predict that the variance of first differences of earnings might indicate information asymmetries between insiders and outside investors. This interpretation might explain the positive coefficient estimated elsewhere for accounting variance measures.[42] Our results do not support this measure of signaling costs. We obtain a strongly negative and significant coefficient on VEARNA, which is consistent with the standard view that

---

41 There may be a problem with the measure: the deficit measure is bigger, the higher were capital expenditures the previous year, and thus we may be picking up more of the "bonding" effect. We also estimated the model using a total cash flow measure; the results were not noticeably different from those reported with the deficit measure. However, see the discussion under "Specification Analysis," below.

42 For example, Auerbach [1985], and Ang and Peterson [1986].

high earnings variance increases the potential for financial distress, and thus decreases the likelihood of debt issuance.

We also interacted VEARNA with ZPROB, in an attempt to separate the signaling and financial distress hypotheses (columns 3–6). VEARNA by itself remains negative, and VEARNA/ZPROB is positive and significant. This suggests that when the probability of financial distress is especially high (large ZPROB and volatile earnings), the firm issues debt. We leave the search for observable measures of information asymmetries to further research.

We find the same market timing phenomenon as other researchers: firms are more likely to issue equity when their stock price is up.[43] Previous empirical researchers have not tried to explain this apparent violation of efficient markets.[44] However, Bagnoli and Khanna [1987] argue that this behavior is consistent with a signaling equilibrium if a shift in, say, technology or market conditions improves both the expected value of assets in place (increasing the stock price) and the value of future projects (decreasing the signaling cost of equity relative to costs of borrowing). Thus, the timing effect may be evidence in favor of signaling costs.

The coefficient on R&D is positive (though not generally significant), contrary to the predictions of both the tax shield and moral hazard hypotheses. With so many other indicators of these effects in our rich specification, R&D may be indicating a greater potential for divergence between insider and outsider information. This conjecture is supported when we add industry dummies to the model in column 6. Once we control for industry, firms which have high R&D are even more likely to issue debt. We do not want to push *ex post* rationalizations, especially since the coefficient on R&D is unstable. The result does suggest another direction in which to look for the effects of asymmetric information.

The important ownership dilution effect may be due in part to the signaling problem, as well as to the value of control, if big issues lead to unusually large drops in stock price. An issue value effect on stock price drops has been previously rejected by Marsh [1979] and Hess and Frost [1982], but was supported by Asquith and Mullins's [1986] study of announcement date (rather than issue date) price effects. The estimated sign on dilution is consistent with this notion, but we cannot distinguish between the signaling and moral hazard hypotheses with this variable.

The direct tests of the hierarchy versus the optimal leverage hypothesis (using the current and long-run debt/assets ratios) show that firms use new issues to move towards their long-run average

[43] See, *e.g.*, Marsh [1982], Taggart [1977], Asquith and Mullins [1986].

[44] A new issue should be priced at its expected value; firms shouldn't be able to win by selling when the price is high.

debt ratio. This result does not rule out hierarchical financing preferences for all firms, at all times, but it provides substantial evidence that firms usually have a preferred debt ratio, and are not prevented by credit rationing from pursuing it. An appropriate conclusion seems to be that signaling generates costs for equity issues, but that typically these costs are balanced against the costs of borrowing, rather than leading to a lexicographic preference ordering.

Other Variables. We include net assets as a measure of firm size, although we have no strong priors on the role this variable should play. Clearly, larger firms are more likely to issue bonds.

We include a dummy for regulated firms (trucks, trains, airlines and telephones), which is negative and significant, and include 16 other two-digit SIC code industry dummies in the column 6 specification (see Table 5 for the dummy coefficients). Industries without their own dummy are those for which all or nearly all issues were equity, so the other dummies should be interpreted relative to a strong preference for equity.[45] Regulated firms are more likely to issue equity. However, the telephones firms (SIC 4800) are relatively more likely to issue debt. The only other significant industry dummy is for oil refining and paving, indicating a debt preference. The important results is that inclusion of industry dummies does not materially affect the magnitudes or significance of the other variables in the model.

Year dummies are included to capture system-wide variations, such as changes in the market demands for securities, or in tax policies. We don't interpret these, since many things may be relevant in each year.

Summary of main results. We consider columns 6 and 4 to be the preferred specifications (with and without industry dummies). The χ^2_{16} likelihood ratio statistic for the industry dummies is 41.4, which rejects exclusion at the 0.001 level. These are essentially the most complete models analyzed, minus variables which seem inappropriate or redundant. The likelihood ratio χ^2_4 statistic for the four exclusions between column 3 and 4 is 2.8, which fails to reject the exclusions at even the 35% level.

The summary goodness-of-fit statistics for the model are quite good for a discrete choice analysis of the behavior of many diverse firms over several years. The ρ^2 statistic indicates the percentage of the minimum possible likelihood value we are able to explain with the model, and thus is analogous to the R^2 measure from a minimum-distance estimator. $\bar{\rho}^2$ involves a correction for degrees of freedom (based on the Akaike Information Criterion), analogous to $\bar{R}^2$. The M-ρ^2 statistic indicates the percentage of likelihood explained by variables other than the constant. A naive forecast of

[45] However, note that we also have dummy variables for 1978–1984, so the constant represents the mean for equity-preferring firms in 1977.

debt-equity issues would predict based on the observed mean (24% debt issues); column 4 is able to improve the likelihood value by 35% relative to this naive model.[46]

Another summary measure is the ability of the model to correctly classify the observed choices in the sample. The estimates in column 4 correctly predict 74% of the debt issues, and 90% of the equity issues in the sample, with an overall prediction rate of 86%. By contrast, Marsh [1982] and Martin and Scott [1974] obtain a 75% correct prediction rate. Marsh calculates a pseudo-R^2 statistic of 0.37; the same statistic for column 4 is 0.48.[47]

Specification Testing. The optimal leverage theory has strong support in our analysis (although not to the exclusion of elements of hierarchical behavior). We rely on the optimal leverage model to extend our analysis in this section. We wish to see whether we can exploit more available information to predict the debt-equity choice.

Suppose that a firm is precisely at its optimal debt ratio. It will either issue debt and equity in that ratio, or given lumpiness, be indifferent about which security to issue.[48] Our success in predicting incremental choices implies that firms are often not at their long-run optimum. There are two general reasons why firms may not be at their optimal debt ratio: (1) the optimum remained the same, but the firm moved away from it (due to market revaluations of outstanding securities, or previous lumpy capital structure changes); or, (2) the optimum has moved away from the firm's debt ratio (due to changes in the characteristics which determine the optimum).

Suppose the second cause of deviations from optimal debt ratios is the primary one. If the characteristics determining the optimal leverage ratio have changed, then the value to the firm of issuing securities so as to move towards the new optimum may depend on the changes in the characteristics. For example, high tax shields may not imply the firm should issue equity to lower its debt ratio; the current debt ratio may in fact be optimal for an even higher level of tax shields. The decision to issue equity may follow from an increase in tax shields, however, rendering the old debt ratio suboptimal. Therefore, the correct specification of the firm's value function, $x'\beta$, may be for the x's to be *changes* in the firm's characteristics, not current values.

---

46 The statistics are calculated as: $\rho^2 = 1 - \left\{l(\hat{\beta})/l(0)\right\}$, where $l(\hat{\beta})$ is the value of the likelihood function at the estimated parameter vector, and $l(0)$ is the value if no parameters are estimated; $\bar{\rho}^2 = 1 - \left\{[l(\hat{\beta}) - K]/l(0)\right\}$, where K is the number of parameters estimated; and M-$\rho^2 = 1 - \left\{l(\hat{\beta})/l(c)\right\}$, where $l(c)$ is the likelihood value if just a constant is estimated. The latter measure was suggested by McFadden [1974]; for a discussion of the first two, see Ben-Akiva and Lerman [1985].

47 The R^2 is defined as $\left\{1 - \exp\left(\frac{2}{N}[l(c) - l(\hat{\beta})]\right)\right\} / \left\{1 - \exp\left(\frac{2}{N}l(c)\right)\right\}$.

48 Unless transactions costs are quite different.

Both the levels and differences specifications are special cases of the most general model: that optimal security choice depends on the entire history of the firm's characteristics and market conditions. The firm should be choosing its new security based on its expectations of the future; managers may use more than one year of data to form expectations. With finite sample sizes and limited histories of available data, we do not try to include all historical values. We have sufficient data to test a more extensive specification, however.

The results are in Table 6. We suppose that managers and investors look at two years of public data when forming supply and demand decisions for securities. Within this specification we can test for more parsimonious models. In particular, we test for the acceptability of the model in Table 4, and for a model which restricts the coefficients so that *changes* (first differences) in the explanatory variables, rather than levels, are relevant.

Column 1 of Table 6 repeats the specification of Table 4.[49] Column 2 repeats the analysis using data for current levels (as opposed to already differenced variables, or long-run averages) for the previous two years, rather than one; column 3 estimates the model with first differences. (The lag is indicated by the number in parentheses.)

The first step is to consider the likelihood ratio tests for the coefficient restrictions in columns 1 and 3 relative to column 2. The χ^2_8 statistic for our original model against the expanded specification is 10.0; we cannot reject the zero restrictions on the second lags at even the 25% level. The χ^2_8 statistic for the first-differences specification is 67.0, so we can reject this version well below the 1% level. The more parsimonious specification with one year of data does not cost a statistically significant degree of explanatory power, while the first-differences specification is easily rejected.

Although we do not find support for either the expanded or first-differences specifications, there are interesting results to consider in columns 2 and 3. First, it is evident from both columns that the first difference in net assets has substantial explanatory power in the model. Thus, a growing firm is more likely to issue debt. This appears to contradict the moral hazard hypothesis, which predicts that firms with substantial growth opportunities are more likely to issue equity. On the other hand, a growing firm may have a greater potential for insiders to obtain information about the firm's prospects that outsiders do not have. These firms might face larger signaling costs for new equity issues, and thus exhibit more hierarchical financing preferences.

The substantial significance increase and the negative sign on the first-differenced cash flow deficit coefficient is also interesting (column 3). Although still not significant at the usual levels,

[49] The sample size is smaller due to missing data.

the result is suggestive. A *decrease* in the deficit appears to increase the probability of debt issue. This accords with Jensen's [1986] free cash flow hypothesis: firms with an increase in discretionary cash, should issue debt to commit themselves not to use the money on managerial perks, etc. This result softens our earlier rejection of the hypothesis.

The plentiful data on incremental choices allows us to test more extensive specifications with the finding that financing decisions depend on a large number of interacting factors. A major conclusion we draw is that studies which specify few effects due to data limitations may produce seriously biased estimates because they omit important factors.

Prediction. As a further test of the robustness of our results, we constructed predictions for a small hold-out sample. We excluded any "unit offerings" from the estimation sample; i.e, registrations for offerings which combined more than one type of security. There were 61 total securities issued in 35 unit bundles which met our other sample selection criteria. Our prediction results are in Table 7.

Using the coefficients from column 6 of Table 4, we calculated predicted values for the probability of each individual issue being debt. Using the cutoff which minimized the sum of Type I and Type II error in the estimation sample (0.37), we assigned predicted probabilities to debt or equity. We obtained 89% correct predictions, which is actually better than the in-sample classification (86%). Although the hold-out sample is small, this result is quite encouraging because the hold-out sample is more difficult to classify than the estimation sample (the debt-equity split is much closer to 50–50).

Many of the unit offerings were bundles of more than one debt type, so our theoretical model which predicts that firms will issue just debt or equity at a given time is not wholly inappropriate for the units. However, many unit issues combine debt and equity. Because of this, we also combined units into single "pseudo-securities", with the choice between debt and equity measured as the debt fraction of the total issue value. We then calculated a Spearman rank correlation coefficient between the continuous actual debt variable and the continuous predicted probability of issuing debt (both variables are bounded by zero and one). The Spearman coefficient for the 35 unit offerings was 0.42, indicating that our model does a good job of predicting the "strength" of the debt preferences, as well as the specific outcome.

Economic Importance of Results. It has been our intention to undertake somewhat of a "kitchen sink" study. There are numerous theoretical hypotheses on the table, and little progress had been made on sorting them out. We developed what we believe is a more powerful approach to the problem, only to come away with the conclusion that the problem is quite messy at this level:

we threw everything plus the kitchen sink in, but unfortunately, we found that very little could be taken back out of the model.

Despite our preoccupation with testing competing hypotheses for significance, we can say something about the economic magnitude of our results. Table 8 presents "standardized derivatives" for the major explanatory variables, based on column 4 of Table 4. The standardized derivative measures the percentage change in the probability of firms choosing debt, given a one standard deviation change in an explanatory variable. We evaluate the changes at the sample means of the data; thus, the results can be viewed as predictions of the change in the percentage of issues that would be debt if there was a shift in one of the variables.

Taken individually, the tax shield effects are as economically important as any others except for the ownership dilution effect, and the second earnings variance measure. For instance, a one-standard-deviation increase in ITC/ZPROB is predicted to lower the percentage of debt issues by over 13 points (from about 24% of issues to 11%). The dramatic increase in corporate tax shields during the early 1980's (*e.g.*, ACRS, safe-harbor leasing, R&D tax credits, etc.) may in part explain the dramatic decline in the proportion of debt issues (see Table 2). Similarly, the recent reduction in tax shields (abolishing the ITC and slowing depreciation) may have the opposite effect, although the decrease in the corporate tax rate also makes interest deductibility less valuable. Also, general equilibrium effects must also be considered, as our results demonstrate: decreasing the ITC may reduce the purchase of tangible assets, which will tend to reduce firms' debt capacities.

6. CONCLUSION

One of our primary findings is that no single story can explain all corporate financing decisions. Even restricting the decisions to new public issues, the evidence above clearly demonstrates that managers are concerned with a number of costs and benefits of their security choice. Our specification is almost unwieldy, yet a number of examples made clear that more parsimonious models are likely to yield biased or uninformative results.

We provide some of the first strong evidence that tax policy does significantly affect financing decisions. We succeeded by controlling for confounding effects ignored in previous studies. However, tax effects seem important primarily for firms approaching a state of financial distress (positive loss carryforwards, or high tax shields when the bankruptcy predictor is high).

Other costs of borrowing appear to affect nearly all firms through the costs of moral hazard, or conflicts of interest between managers and various claimants on the firm. Some costs, like taxes, are related to distress; this is evident from the importance of earnings volatility. Other costs are associated with a more pervasive shareholder inability to control managerial discretion. More-or-less binding commitments in the form of tangible assets raise the firm's debt capacity. It also appears that firms are better off issuing debt than substantially diluting ownership, which might reduce monitoring and control of management.

Our results are more mixed for the various tests of the hierarchy hypothesis. Our suggested indicator of the severity of information asymmetries behaved like a financial distress measure instead. We did confirm the market timing result reported elsewhere; the only theoretical explanation of this phenomenon we are aware of relates timing to a signaling problem. The very strong ownership concentration effect may reflect a signaling cost of equity, consistent with the finding elsewhere that when new shares are issued, the price drop varies directly with the size of the issue. Finally, we uncovered a strong tendency for recently growing firms to take on more debt, which can be interpreted as an avoidance of signaling costs.

In summary, we find that taxes matter, especially for firms near financial distress. Various moral hazard problems appear to be an ever-present cost of corporate enterprises, and strongly affect financing decisions. Signaling imposes a cost on equity issues, but no evidence for strongly hierarchical preferences emerges. Firms appear quite willing to issue equity when its benefits (net of signaling costs) exceed the net benefits of debt.

What can be said in general is that nearly everything seems to matter to financing, under some circumstances. This is not surprising. Our contribution in part is to clarify some of the relevant circumstances, especially for tax effects. Our approach appears to be more statistically powerful than the debt/assets ratio analysis, in that we are able to test a richer specification, and control for confounding effects that previous studies have left unresolved. One conclusion to take away is that to better understand the determinants of financing, it would be wise to look for narrower, more carefully controlled "experiments". To study financing choices in general, even restricted to new public issues, requires that a long list of effects be incorporated, and subtle inferences about specific predictions are unlikely to be possible.

7. REFERENCES

Altman, E. I. (1968) "Financial Ratios, Discriminant Analysis, and the Prediction of Corporate Bankruptcy," *Journal of Finance*, **23**, 589–609.

Altman, E. I., R. G. Haldeman, and P. Narayanan (1977) "ZETA Analysis: An New Model to Identify Bankruptcy Risk of Corporations," *Journal of Banking and Finance*, **1**, 29–54.

Altman, E. I. (1984) "A Further Empirical Investigation of the Bankruptcy Cost Question," *Journal of Finance*, **39**, 1067–1089.

Altshuler, R. and A. J. Auerbach (1986) "The Significance of Tax Law Asymmetries: An Empirical Investigation," Working paper, University of Pennsylvania.

Ang, J. S. and D. R. Peterson (1986) "Optimal Debt Versus Debt Capacity: A Disequilibrium Model of Corporate Debt Behavior," in *Research in Finance, vol. 6*, ed. Chen, A. W.. Greenwich, CT: JAI Press.

Asquity, P., R. F. Bruner, and D W. Mullins (1987) "Merger Returns and the Form of Financing," Harvard Business School Working Paper.

Asquith, P. and D. W. Mullins (1986) ""Equity Issues and Offering Dilution"," *Journal of Financial Economics*, **15**, 61–89.

Auerbach, A. J. (1983) "Stockholder Tax Rates and Firm Attributes," *Journal of Public Economics*, **21**, 107–27.

Auerbach, A. J. (1985) "Real Determinants of Corporate Leverage," in *Corporate Capital Structures in the United States*, ed. Friedman, B. M.. Chicago: University of Chicago Press.

Auerbach, A. J. and J. M. Poterba (1986) "Tax Loss Carryforwards and Corporate Tax Incentives," Working paper, Dept. of Economics, MIT.

Auerbach, A. J. and M. A. King (1985) "Taxation, Portfolio Choice and Debt Equity Ratios: A General Equilibrium Model," *Quarterly Journal of Economics*, **98**, 587–609.

Bagnoli, M. and N. Khanna (1987) "Equilibrium with Debt and Equity Financing of New Projects: Why More Equity Financing Occurs When Stock Prices are High," Working Paper, Dept. of Economics, University of Michigan.

Bartholdy, J., G. Fisher, and J. Mintz (1985) "Some Theory of Taxation and Financial Policy with Application to Canadian Corporate Data," Paper presented at the Econometric Society Fifth World Congress, Cambridge, MA, August 17–24, 1985.

Ben-Akiva, M. and S. R. Lerman (1985) *Discrete Choice Analysis: Theory and Application to Travel Demand.* Cambridge, MA: MIT Press.

Bradley, M., G. A. Jarrell, and E. H. Kim (1984) "On the Existence of an Optimal Capital Structure: Theory and Evidence," *Journal of Finance*, **39**, 857–878.

Brealey, R. and S. C. Myers (1984) *Principles of Corporate Finance.* New York: McGraw-Hill.

Chaplinsky, S. (1983) "The Economic Determinants of Leverage: Theories and Evidence," Unpublished Ph.D. dissertation, University of Chicago.

Constantinides, G. M. (1978) "Market Risk Adjustment in Project Valuation," *Journal of Finance*, **33**, 603–616.

Constantinides, G. M. and B. Grundy (1986) "Optimal Investment with Stock Repurchase and Financing as Signals," Working paper, University of Chicago.

DeAngelo, H. and R. W. Masulis (1980) "Optimal Capital Structure Under Corporate and Personal Taxation," *Journal of Financial Economics*, **8**, 3–29.

Demsetz, H. and Lehn, K. (1985) "The Structure of Corporate Ownership: Causes and Consequences," *Journal of Political Economy*, **93**, 1155–77.

Dierkens, N. (1986) "Equity Issues and Asymmetric Information," Draft, Sloan School of Management, MIT.

Donaldson, G. (1969) *Strategy for Financial Mobility*. Boston, MA: Harvard Business School.

Donaldson, G. (1984) *Managing Corporate Wealth: The Operation of A Comprehensive Financial Goals System*. New York: Praeger.

Gale, D. and M. Hellwig (1985) "Incentive-Compatible Debt Contracts: The One-Period Problem," *Review of Economic Studies*, **52**, 647–64.

Gordon, R. (1985) "Comment," in *Corporate Capital Structures in the United States*, ed. Friedman, B. M.. Chicago: University of Chicago Press.

Healy, P. M. and K. Palepu (1986) "Corporate Financial Decisions and Future Earnings Performance: The Case of Initiating Dividends," Preliminary draft, Sloan School of Management, MIT.

Hess, A. C. and P. A. Frost (1982) "Tests for Price Effects of New Issues of Seasoned Securities," *Journal of Finance*, **36**, 11–25.

Jensen, M. C. (1986) "Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers," *American Economic Review*, **76**, 323–329.

Jensen, M. C. and W. H. Meckling (1976) "Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure," *Journal of Financial Economics*, **3**, 305–60.

Leland, H. E. and D. H. Pyle (1977) "Informational Asymmetries, Financial Structure and Financial Intermediation," *Journal of Finance*, **32**, 371–387.

Long, M. S. and I. B. Malitz (1985) "Investment Patterns and Financial Leverage," in *Corporate Capital Structures in the United States*, ed. Friedman, B. M.. Chicago: University of Chicago Press.

MacKie-Mason, J. K. (1986a) "Nonlinear Tax Policies and the Risk-Taking Behavior of Firms," Chapter 1, unpublished Ph.D. dissertation, Dept. of Economics, MIT.

MacKie-Mason, J. K. (1986b) "Long-Term Contracts and Sequential Economic Decisions," Chapter 2, unpublished Ph.D. dissertation, Dept. of Economics, MIT.

MacKie-Mason, J. K. (1986c) "Taxes, Information and Corporate Financing Decisions," Chapter 3, unpublished Ph.D. dissertation, Dept. of Economics, MIT.

Marsh, P. R. (1982) "The Choice Between Equity and Debt: An Empirical Study," *Journal of Finance*, **37**, 121–144.

Marsh, P. R. (1979) "Equity Rights Issues and the Efficiency of the U.K. Stock Market," *Journal of Finance*, **34**, 839–62.

Martin, J. D. and D. F. Scott (1974) "A Discriminant Analysis of the Corporate Debt-Equity Decision," *Financial Management*, **Winter**, 71–79.

McFadden, D. (1974) "Conditional Logit Analysis of Qualitative Choice Behavior," in *Frontiers in Econometrics*, ed. Zarembka, P.. New York: Academic Press.

McFadden, D. (1981) "Econometric Models of Probabilistic Choice," in *Structural Analysis of Discrete Data with Econometric Applications*, ed. Manski, C. F. and D. McFadden. Cambridge, MA: MIT Press.

Miller, M. H. (1977) "Debt and Taxes," *Journal of Finance*, **32**, 261–275.

Modigliani, F. and M. H. Miller (1958) "The Cost of Capital, Corporation Finance, and the Theory of Investment," *American Economic Review*, **48**, 261–97.

Modigliani, F. and Miller, M. H. (1963) "Corporate Income Taxes and the Cost of Capital: A Correction," *American Economic Review*, **53**, 433–43.

Myers, S. C. (1984) "The Capital Structure Puzzle," *Journal of Finance*, **39**, 572–592.

Myers, S. C. (177) "Determinants of Corporate Borrowing," *Journal of Financial Economics*, **5**, 147–175.

Myers, S. C. and N. S. Majluf (1984) "Corporate Financing and Investment Decisions When Firms have Information that Investors Do Not Have," *Journal of Financial Economics*, **13**, 187–221.

Poterba, J. M. (1986) "Taxation and Corporate Capital Structure," Comments prepared for the IV John Deutsch Roundtable of Economic Policy, The Impact of Taxation on Business Activity, Ottawa, November 11–13, 1985.

Ross, S. A. (1985) "Debt and Taxes and Uncertainty," *Journal of Finance*, **40**, 637–656.

Scholes, M. S. and M. A. Wolfson (1987) "Issues in the Theory of Optimal Capital Structure," in *Frontiers of Modern Finance*, ed. Bhattacharya, S. and G. Constantinides. : Rowman and Littlefield.

Stiglitz, J. E. and A. Weiss (1981) "Credit Rationing in Markets with Imperfect Information," *American Economic Review*, **71**, 393–410.

Titman, S. (1984) "The Effect of Capital Structure on a Firm's Liquidation Decision," *Journal of Financial Economics*, **13**, 137–152.

Watts, R. L. and J. L. Zimmerman (1986) *Positive Accounting Theory*. Englewood Cliffs, NJ: Prentice-Hall.

Williamson, S. (1981) "The Moral Hazard Theory of Corporate Financial Structure: An Empirical Test," Unpublished Ph.D. dissertation, Sloan School of Management, MIT.

Williamson, S. D. (1987) "Costly Monitoring, Loan Contracts, and Equilibrium Credit Rationing," *Quarterly Journal of Economics*, **102**, 135–146.

8. APPENDIX

Data Definitions

For each firm in the sample, we estimated a variant of the "market model" for stock price returns. The model has been previously estimated by Auerbach [1983], based on theoretical work by Auerbach and King [1983] and Brennan [1970]. We estimated

$$g_t = \alpha_0 + \alpha_1 d_t + \alpha_2 m_t + \alpha_3 r_t \qquad A.1$$

where g_t is the 1-day capital gain in stock price, d_t the dividend yield on date t (calculated on ex-dividend days), m_t the 1-day return on the equally-weighted index of all NYSE and AMEX stocks, and r_t the return on government T-bills during the week containing day t. Daily data were obtained from the CRSP tapes. Use of daily data avoids confounding of tax effects with the information effects associated with dividend announcements; Miller and Scholes [1982] criticize earlier work for using monthly dividend returns. There is no reason to believe that the coefficients on (A.1) will be unvarying for a given firm over time; since many firms appear more than once in the sample, we estimated (A.1) on the most recent three years of daily data preceding the filing date of the registration statement for each registration in the sample.

The model is a standard CAPM except that it assumes individual investors have differing marginal tax rates. If taxes on dividends were zero, then the stock price should change one-for-one with dividend payouts on ex-days, so α_1 would be -1. The estimated $\hat{\alpha}_1$ is thus an estimate of an aggregated marginal tax rate ($\alpha_1 = \tau_c - 1$) for the clientele of investors holding the firm's stock. The estimated $\hat{\alpha}_2$ is analogous to the usual "beta" of a market model regression. Details of the estimates can be found in MacKie-Mason [1986c].

In addition to "beta" and the clientele tax rate, we use the standard errors of regression ("sigma") as an indicator of firm-specific, diversifiable risk.

The COMPUSTAT tape provides financial statement data on several thousand large or otherwise "important" firms. All dollar-denominated variables were deflated to constant (1982) dollars, using the GNP deflator for gross private domestic investment. The definitions in the paper follow the COMPUSTAT definitions, unless otherwise noted.

We use book values of firm assets and liabilities. Auerbach [1985] and others attempt to approximate market values, but the results have usually indicated that book debt is just as appropriate as a determinant of financial decisions. Myers [1977, 1984] suggests that managers may rely on book measures because book value represents the fixed, or sunk value of firm assets. Market values include the value of intangible assets and future discretionary investments, which are predicted to reduce the firm's debt capacity.

We list below the definitions of variables used in the analysis.

Market value of equity = shares outstanding × stock price (as of 12/31)

Tax loss carryforward = book tax loss carryforward / market value of equity.[50]

Investment tax credit = investment tax credits / net sales.

ZPROB: Altman's [1968] ZPROB included the ratio of market equity to book debt. We have excluded that term since we are studying precisely capital structure, and enter the debt ratio directly into the analysis.

---

50 We scale by market equity because TLCF is ill-behaved when scaled by net sales; TLCF is generally high when sales are low, distorting the attempt to get a scale-free measure.

$$ZPROB = 3.3\frac{\text{EBIT}}{\text{total assets}} + 1.0\frac{\text{sales}}{\text{total assets}} + 1.4\frac{\text{retained earnings}}{\text{total assets}} + 1.2\frac{\text{working capital}}{\text{total assets}}$$

where EBIT is earnings before interest and taxes.

Research and development = R&D / net sales. If R&D is missing, the variable is coded as zero. A specification test indicated no significant bias from this recoding.

Advertising = advertising expenditures / net sales. Recoding was done as for R&D.

EBIDT = earnings before interest, depreciation and taxes.

Earnings variance, Type A = standard deviation of $(EBIDT_t - EBIDT_{t-1})$, divided by the mean of total assets, for 10 years prior to registration (at least six years if data are missing).

Earnings variance, Type B = standard deviation of $[(EBIDT_t - EBIDT_{t-1})/|EBIDT_{t-1}|]$, for 10 years prior to registration (at least six years if data are missing).

Fraction of assets in plant & equipment = (plant – accumulated depreciation) / (total assets – current liabilities).

Cash deficit = (capital expenditures + average dividends - (cash flow + capital expenditures × [total debt/net assets])) / net sales, where average dividends is the mean of total dividend payments over the previous 10 years. See Auerbach [1985].

Current debt/assets ratio = book long-term debt / total assets.

Δ *Debt/assets* = current debt/assets ratio – (mean of debt/assets ratio over previous 10 years).

Dilution = issue value / market value of equity.

Δ *stock price* = (end-of-year price in year previous to registration) – (end-of-year price two years previously).

Net assets = total assets – current payables.

Taxes paid = (current payables two years ago) + (provision for income taxes one year ago) – (current deferred taxes one year ago) – (current payables one year ago).

Sample Selection

The initial source of data was the Registered Offerings Statistics (ROS) tape from the SEC. This file contains financial and other information reported for all public security registrations. The tape contained 68,316 registered offerings covering 1970–1984. Because this data source is not well-known, we describe our sample selection procedure in some detail.

Issues were dropped if: (1) the issuing firm is not on the COMPUSTAT tape; (2) the registration is for an initial public offering; (3) the registration is for a noncash transaction; (4) the issuing firm was not listed on the NYSE or AMEX; (5) the security was registered before January 1, 1977; (6) the security was not one of straight debt, convertible debt, preferred stock, convertible preferred, or common stock.

Some of these restrictions are necessary to obtain stock market information and data on firm characteristics. Initial offerings were dropped because historical firm data are unavailable, and the IPO decision is likely to be fundamentally different from ongoing financing decisions. Noncash offerings are mostly exchanges, conversions and other transaction types which are not obviously intended to raise new capital. Only the five major security types were retained because most of the theory is concerned only with broad distinctions among contingent claims. Pre-1977 issues were deleted because the SEC did not collect information on some relevant variables during 1970–1976.

Registrations by foreign firms, registrations with warrants to purchasers (0.1% of the subsample), and registrations for rights offerings (0.6%) were also dropped. The final selection dropped gas and electric utilities, financial services, and real estate firms, and firms for which required data was missing.[51] We dropped the selected industries because their capital market interactions are known to be quite different than other firms, due to regulation or the financial nature of the business.

[51] An extensive hand search of Moody's Industrial Manual and individual 10K reports recovered enough missing data to keep about 200 observations in the sample.

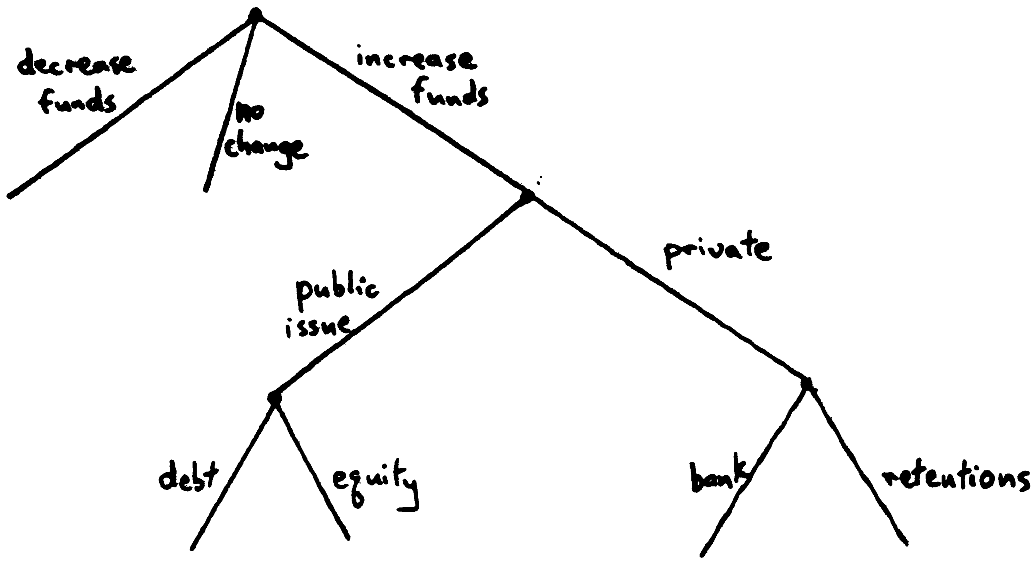

Figure 1.

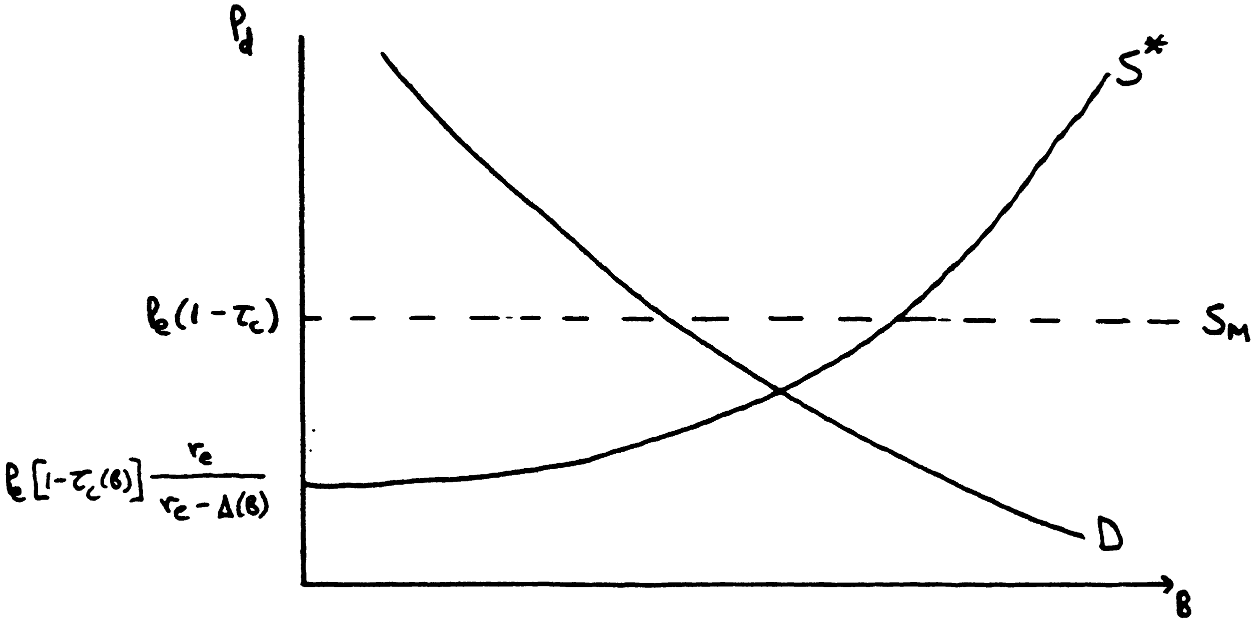

Figure 2.

TABLE 1

Summary of Hypothesized Effects

(Change in Probability of Choosing Debt)

Variable	Tax Hypothesis	Financial Distress (Moral Hazard)	Signaling
Tax loss carryforwards	−		
Investment tax credit	−		
Deprec., Deferred taxes	−		
Taxes paid	+		
Clientele tax rate	−		
Research & Development	−	−	+
Advertising	−	−	
Unlevered "Beta"		−	
Unlevered "Sigma"		−	
Earnings variance, Type A	−	−	+
Earnings variance, Type B	−	−	
Fraction assets in plant		+	
(Free) Cash flow		+	
Dilution		+	+
Debt/Assets		−	0
Current D/A - Long-run D/A		−	0
Change in stock price			−

TABLE 2

Population and Sample Issue Statistics

	Number of Issues								
	1977	1978	1979	1980	1981	1982	1983	1984	Total
ALL OFFERINGS									
Total Issues	662	440	439	1033	1260	936	1899	1112	7781
Debt Issues	330	252	200	395	300	349	335	271	2432
% Debt	49.8%	57.3%	45.6%	38.2%	23.8%	37.3%	17.6%	24.2%	31.1%
ESTIMATION SAMPLE									
Total Issues	129	159	147	223	190	237	209	124	1418
Debt Issues	26	35	25	76	48	69	41	23	343
% Debt	20.2%	22.0%	17.0%	34.1%	25.3%	29.1%	19.6%	18.5%	24.2%
	Value of Issues (billion $)								
	1977	1978	1979	1980	1981	1982	1983	1984	Total
ALL OFFERINGS									
Total Issues	18.5	12.5	17.5	35.5	31.2	29.4	48.8	31.4	224.9
Debt Issues	14.3	10.7	14.3	26.9	21.6	21.1	22.4	24.4	155.7
% Debt	77.5%	85.5%	81.6%	75.6%	69.0%	71.8%	45.9%	77.6%	69.2%
ESTIMATION SAMPLE									
Total Issues	4.32	3.68	3.86	11.6	9.86	11.8	9.23	5.63	60.0
Debt Issues	2.77	2.39	2.61	8.53	7.43	8.78	5.38	3.25	41.1
% Debt	64.0%	64.7%	67.5%	73.6%	75.3%	74.4%	58.2%	57.6%	68.5%

Source for population statistics: *SEC Monthly Statistical Review*

"All Offerings" includes only primary public offerings of bonds, convertible bonds, preferred stock, convertible preferred and common stock.

Population and estimation sample exclude state-regulated utilities and finance companies.

1977 population statistics are estimated by applying the overall ratio of public to private offerings to the non-utility, non-finance totals

TABLE 3

Descriptive Statistics

(1418 observations)

Variable	Mean	Std. Dev.
Debt/Equity Choice	0.242	0.183
Tax loss carryforwards	0.0140	0.123
Investment tax credits	0.00494	0.00618
ITC / ZPROB	0.00274	0.00574
Depreciation	0.0430	0.0471
Deferred taxes*	0.00945	0.0196
Current taxes paid*	0.0321	0.0360
Clientele tax rate	0.347	2.07
Research & development	0.0158	0.226
Advertising	0.0142	0.0244
Unlevered "beta"	0.560	0.417
Unlevered "sigma"	0.0160	0.0407
Earnings variance, Type A	0.0447	0.0435
VEARNA / ZPROB	0.0204	0.0265
Earnings variance, Type B	0.551	2.37
Fraction plant	0.508	0.212
1 / ZPROB	0.451	0.274
Cash flow	0.103	0.0776
Cash flow deficit	-0.0359	0.0684
Current debt/assets	0.229	0.131
Current D/A – Long-run D/A	0.00220	0.0902
Relative issue size	0.183	0.456
Change in stock price	0.127	0.468
Net Assets	0.0924	0.309
Regulated firm	0.0451	0.208

Variables are reported as scaled in the analysis. See Appendix for details.

* Indicates statistics based on 1409 observations.

TABLE 4

Determinants of Debt-Equity Choice

(Choice = 1 if debt, 0 if equity)

Variable	(1)	(2)	(3)	(4)	(5)	(6)***
Constant	-1.08 (5.06)	- 1.78 (6.09)	-1.69 (4.99)	-1.863 (7.06)	-1.14 (5.75)	-2.04 (4.20)
Tax Loss Carryforwards	-1.47 (1.17)	- 1.94 (1.83)	-2.73 (2.03)	-2.74 (2.05)	-2.21 (1.62)	-2.50 (1.62)
Investment Tax Credit	-5.01 (0.587)	4.95 (0.560)	75.3 (2.72)	69.2 (2.69)	28.4 (1.33)	72.4 (2.58)
ITC/ZPROB			-106.7 (2.60)	-103 (2.69)	-56.7 (1.76)	-104 (2.45)
Clientele Tax Rate	0.00199 (0.0762)	-0.00739 (0.227)	-0.0190 (0.583)			
Research and Development	-1.43 (0.708)	5.12 (1.96)	4.35 (1.63)	3.69 (1.42)	-3.19 (1.61)	9.92 (2.78)
Advertising	1.83 (1.22)	5.44 (2.87)	5.36 (2.76)	5.26 (2.73)	1.69 (1.12)	7.23 (2.91)
Beta	-0.282 (2.04)	-0.188 (1.01)	-0.196 (1.073)			
Sigma	-2.27 (1.62)	-2.06 (0.975)	-2.40 (1.18)			
Earnings Variance (Type A)	0.389 (0.363)	- 1.31 (0.877)	-10.6 (2.58)	-11.0 (3.27)	-5.49 (2.51)	-13.4 (3.61)
VEARNA/ZPROB			18.4 (2.98)	18.4 (3.81)	11.6 (3.43)	21.0 (4.00)
Earnings Variance (Type B)	-0.0954 (1.23)	-0.720 (3.35)	-0.825 (4.21)	-0.823 (4.28)	-0.0970 (1.24)	-0.743 (3.57)
Fraction of assets in plant & equip	1.06 (4.47)	2.05 (6.59)	1.90 (6.00)	1.88 (5.99)	0.857 (3.47)	1.87 (5.00)

Continued

TABLE 4						
Continued						
Variable	(1)	(2)	(3)	(4)	(5)	(6)***
Cash Deficit	1.49	1.49	0.338	0.284	1.39	-0.0415
	(1.70)	(1.96)	(0.268)	(0.237)	(1.62)	(0.0321)
1/ZPROB			0.00281			
			(0.00618)			
Debt/Assets	0.0993	-0.932	-1.07	-0.913	0.278	-0.851
	(0.243)	(2.04)	(2.06)	(1.97)	(0.690)	(1.52)
Δ Debt/Assets	-1.31	-1.88	-1.52	-1.41	-1.17	-1.62
	(2.32)	(2.80)	(2.13)	(2.09)	(2.10)	(2.11)
Relative Size		3.65	3.80	3.78		3.74
(Ownership Dilution)		(21.4)	(22.3)	(22.5)		(19.8)
Δ Stock Price		-0.483	-0.487	-0.492	-0.222	-0.447
		(3.92)	(3.87)	(3.97)	(2.17)	(3.52)
Net Assets	0.446	0.648	0.683	0.684	0.447	0.493
	(5.00)	(8.20)	(8.58)	(8.81)	(4.92)	(5.23)
Regulated	-0.699	-1.00	-0.905	-0.861	-0.543	-1.77
	(3.12)	(4.43)	(3.74)	(3.85)	(2.41)	(2.56)
1978	0.0779	-0.314	-0.354	-0.320	0.00512	-0.341
1979	-0.180	-0.439*	-0.431*	-0.383	-0.168	-0.399
1980	0.381**	0.136	0.113	0.159	0.413**	0.179
1981	0.0560	0.0353	-0.00113	0.0329	0.0696	-0.00489
1982	0.174	-0.164	-0.192	-0.143	0.118	-0.141
1983	-0.0813	-0.438**	-0.470**	-0.416**	-0.0661	-0.448**
1984	-0.117	-0.461*	-0.525**	-0.479**	-0.133	-0.486**
ln $\mathcal{L}$	-727.4	-522.0	-511.6	-513.0	-721.3	-492.3
M-ρ^2	0.0728	0.335	0.348	0.346	0.0806	0.373
ρ^2	0.260	0.469	0.480	0.478	0.266	0.499
$\bar{\rho}^2$	0.237	0.444	0.451	0.454	0.243	0.459
% Right Debt	6.7%	72.0%	73.2%	74.3%	17.8%	69.1%
% Right Equity	98.8%	89.3%	90.1%	90.0%	95.9%	91.1%
% Right Total	76.5%	85.1%	86.0%	86.2%	77.0%	85.8%

1418 observations. Asymptotic t-statistics in parentheses.
* Indicates year dummy significant at 10% level.
** Indicates year dummy significant at 5% level.
*** This specification included 16 industry dummy variables. See Table 5.

TABLE 5

Industry Dummy Variables

SIC Coverage	Obs.	Description	Coefficient
1000–1299	18	Mining	0.260 (0.437)
1300–1399	59	Oil & gas production	-0.0461 (0.112)
2000–2199	91	Food, beverages & tobacco	0.167 (0.401)
2200–2399	15	Apparel	0.707 (0.983)
2600–2799	86	Paper, publishing	0.0578 (0.145)
2800–2899	164	Chemicals	-0.259 (0.627)
2900–2999	48	Petroleum refining, paving	0.794 (1.88)
3000–3299	36	Rubber, plastics, leather, glass, cement, ceramics	-0.00296 (0.00578)
3300–3499	79	Iron, steel, metalworking	0.512 (1.20)
3500–3599	76	Industrial machinery	0.0298 (0.0170)
3600–3699	177	Electronics, elec. machinery	-0.175 (0.411)
3700–3799	60	Transportation machinery	0.565 (1.27)
3800–3899	97	Measurement devices	-0.555 (1.24)
4800–4899	45	Telephones	1.26 (2.06)
5000–5999	151	Wholesale & retail	0.264 (0.655)
7000–8999	142	Hotels, services, misc.	-0.0205 (0.0530)

Results are from specification reported in Table 4, column 6.
Public utilities (SIC 4900–4999) and Financial & Real Estate services (SIC 6000-6999) are excluded from the estimation sample (1017 and 268 observations, respectively.)

TABLE 6

Specification Analysis of Debt-Equity Choice

(Choice = 1 if debt, 0 if equity)

Variable	Lag 1	Lags 1 and 2	First Differences
Constant	-1.70	-1.75	-0.799
	(6.10)	(6.17)	(3.75)
Tax Loss Carryforwards (1)	-3.05	-1.54	
	(2.15)	(0.708)	
Tax Loss Carryforwards (2)		-1.24	
		(0.640)	
Tax Loss Carryforwards (D)			0.724
			(0.434)
Investment Tax Credit (1)	68.3	69.5	
	(2.65)	(1.92)	
Investment Tax Credit (2)		-12.2	
		(0.367)	
Investment Tax Credit (D)			36.9
			(1.28)
ITC(1)/ZPROB(1)	-101	-91.0	
	(2.67)	(1.89)	
ITC(2)/ZPROB(2)		-2.34	
		(0.0615)	
ITC(D)/ZPROB(D)			-34.3
			(0.976)
Research and Development(1)	1.94	11.2	
	(0.688)	(0.825)	
Research and Development(2)		-9.08	
		(0.643)	
Research and Development(D)			0.507
			(0.0405)
Advertising(1)	4.98	0.252	
	(2.47)	(0.0185)	
Advertising(2)		4.55	
		(0.327)	
Advertising(D)			-2.04
			(0.154)
Earnings Variance (Type A)(1)	-13.3	-12.9	-10.5
	(3.22)	(2.97)	(2.84)
VEARNA(1)/ZPROB(1)	16.8	15.9	12.6
	(2.88)	(2.39)	(2.17)
Earnings Variance (Type B)(1)	-0.689	-0.723	-0.825
	(3.13)	(3.21)	(4.31)
Fraction of assets in plant & equip(1)	1.92	2.85	
	(6.10)	(2.51)	
Fraction of assets in plant & equip(2)		-0.880	
		(0.777)	
Fraction of assets in plant & equip(D)			2.32
			(2.19)

Continued

TABLE 6

Continued

Variable	(1)	(2)	(3)
Cash Deficit(1)	0.165	-0.937	
	(0.132)	(0.620)	
Cash Deficit(2)		1.06	
		(0.866)	
Cash Deficit(D)			-1.44
			(1.57)
Δ Debt/Assets	-1.18	-1.42	-2.25
	(1.74)	(2.00)	(3.76)
Current Debt/Assets	-1.02	-1.00	-0.0938
	(2.14)	(2.01)	(0.221)
Relative Size	3.69	3.72	3.38
(Ownership Concentration)	(21.9)	(21.6)	(22.4)
Δ Stock Price	-0.485	-0.446	-0.529
	(3.83)	(3.46)	(4.15)
Net Assets(1)	0.624	7.91	
	(7.59)	(3.34)	
Net Assets(2)		-7.49	
		(3.09)	
Net Assets(D)			14.3
			(7.58)
Regulated	-0.828	-0.770	-0.418
	(3.42)	(3.09)	(1.92)
1978	-0.366	-0.331	-0.327
1979	-0.388	-0.365	-0.331
1980	0.0898	0.1159	0.170
1981	0.0153	0.0223	0.174
1982	-0.152	-0.127	0.0198
1983	-0.403*	-0.389*	-0.210
1984	-0.437*	-0.446*	-0.336
$\ln \mathcal{L}$	-502.3	-497.3	-530.8
M-ρ^2	0.339	0.345	0.301
ρ^2	0.460	0.465	0.429
$\bar{\rho}^2$	0.439	0.431	0.403
% Right Debt	75.0%	71.2%	70.0%
% Right Equity	89.3%	91.4%	87.9%
% Right Total	85.7%	86.4%	83.4%

1341 observations. Asymptotic t-statistics in parentheses.

* Indicates year dummy significant at 10% level.

** Indicates year dummy significant at 5% level.

TABLE 7

Predictions For Hold-Out Sample of "Unit" Offering Registrations

Individual Security Predictions

(N = 61. Actual no. debt = 40. Prediction cutoff = 0.37)

	% Right Predictions
Debt	85%
Equity	95%
Total	89%

Combined Security Predictions

(N = 35. See text for definitions)

Debt fraction of issue value	Actual	Predicted
Mean	0.859	0.800
Standard deviation	0.275	0.351
Spearman rank correlation coef.		0.407

TABLE 8 Standardized Marginal Effects *(Choice = 1 if debt, 0 if equity)*		
Variable	Coefficient *(Table 4, Col. 4)*	Standardized Derivative *(In percent)*
Tax Loss Carryforwards	-2.74 (2.05)	-7.68
Investment Tax Credit	69.2 (2.69)	9.72
ITC/ZPROB	-103 (2.69)	-13.4
Research and Development	3.69 (1.42)	1.90
Advertising	5.26 (2.73)	2.91
Earnings Variance (Type A)	-11.0 (3.27)	-10.8
VEARNA/ZPROB	18.4 (3.81)	11.1
Earnings Variance (Type B)	-0.823 (4.28)	-44.3
Fraction of assets in plant & equip	1.88 (5.99)	9.07
Current Debt/Assets	-0.913 (1.97)	-2.71
Δ Debt/Assets	-1.41 (2.09)	-2.90
Relative Issue Size	3.78 (22.5)	39.2
Δ Stock Price	-0.492 (3.97)	-5.23
Net Assets	0.684 (8.81)	4.81

Asymptotic t-statistics in parentheses.

The standardized derivative is calculated as the change in the mean probability of issuing debt given a one standard deviation change in the variable ($\bar{x}$ is mean of x matrix).

$$\text{std. deriv. for } x_j = [\frac{\partial\Phi(\bar{x}'\beta)}{\partial x_j} \cdot \sigma_j]/\Phi(\bar{x}'\beta)$$

Recent CREST Working Papers

87–1: Jeffrey K. MacKie-Mason, "Nonlinear Taxation of Risky Assets and Investment, With Application to Mining" September, 1984.

87–2: Jeffrey K. MacKie-Mason, "Sequential Decision Problems and Asymmetric Information" September, 1985.

87–3: Michelle J. White, "Contract Breach and Contract Discharge due to Impossibility: A Unified Theory" July 29, 1987.

87–4: Ted Bergstrom, "Systems of Benevolent Utility Interdependence" May 19, 1987.

87–5: Ted Bergstrom, "A Fresh Look at the Rotten Kid Theorem—and Other Household Mysteries" November, 1986.

87–6: Michelle J. White, "The Corporate Bankruptcy Decision" July, 1987.

87–7: Michelle J. White, "Location Choice and Commuting Behavior in Cities with Decentralized Employment" July, 1987.

87–8: Lawrence E. Blume and David Easley, "Implementation of Walrasian Expectations Equilibria" December, 1985.

87–9: Lawrence E. Blume, "Lexiocographic Refinements of Nash Equilibrium" April, 1986.

87–10: David Lam, "Lorenz Curves, Inequality, and Social Welfare Under Changing Population Composition" June 16, 1987.

87–11: Mark Bagnoli and Naveen Khanna, "Equilibrium with Debt and Equity Financing of New Projects: Why More Equity Financing Occurs When Stock Prices are High" June, 1987.

87–12: Mark Bagnoli and Barton L. Lipman, "Provision of Public Goods: Fully Implementing the Core through Private Contributions" March, 1987.

87–13: Mark Bagnoli and Barton L. Lipman, "Successful Takeovers without Exclusion" August, 1987.

87–14: Mark Bagnoli and Michael McKee, "Controlling the Game: Political Sponsors and Bureaus" May, 1987.

87–15: Mark Bagnoli and Michael McKee, "Can the Private Provision of Public Goods be Efficient?—Some Experimental Evidence" March, 1987.

87–16: Mark Bagnoli, "Non-Market Clearing Prices in a Dynamic Oligopoly with Incomplete Information" January, 1986.

87–17: John Laitner, "Bequests, Gifts, and Social Security" February 28, 1986.

87–18: John Laitner, "Dynamic Determinacy and the Existence of Sunspot Equilibria" May 12, 1986.

87–19: David Lam, "Does a Uniform Age Distribution Minimize Lifetime Wages?" August 12, 1987.

87–20: David Lam, "Assortative Mating with Household Public Goods" April, 1987.

87–21: Jeffrey A. Miron and Stephen P. Zeldes, "Production, Sales, and the Change in Inventories: An Identity that Doesn't Add Up" June 1987.

87–22: Jeffrey A. Miron and Stephen P. Zeldes, "Seasonality, Cost Shocks, and the Production Smoothing Model of Inventories" December, 1986.

87–23: Hal R. Varian, "Differences of Opinion in Financial Markets" March, 1985.

87–24: Roger H. Gordon and Hal R. Varian, "Taxation of Asset Income in the Presence of a World Securities Market" August, 1986.

87–25: Hal R. Varian, "Measuring the Deadweight Costs of DUP and Rent Seeking Activities" November, 1982.

87–26: Hal R. Varian, "Price Discrimination" January, 1987.

87–27: Roger H. Gordon and Hal R. Varian, "Intergenerational Risk Sharing" October, 1985.

87–28: Hal R. Varian, "Three Papers on Revealed Preference" August, 1987.

87–29: Hal R. Varian, "Optimal Tariffs and Financial Assets" April, 1987.

87–30: Jonathan Cave and Stephen W. Salant, "Cartels That Vote: Agricultural Marketing Boards and Induced Voting Behavior" August, 1987.

87–31: Stephen W. Salant and Donald H. Negri, "Pastures of Plenty: When is the Standard Analysis of Common Property Extraction Under Free Access Incorrect?" July 10, 1987.

87–32: Stephen W. Salant, "When is Inducing Self-Selection Sub- optimal for a Monopolist?" February, 1987.

87–33: Stephen W. Salant, "Treble Damage Awards in Private Lawsuits for Price-Fixing" August, 1987.

87–34: Stephen W. Salant and Roy Danchick, "Air Force Academy Attrition: A New Perspective on the College Dropout Problem" August, 1987.

87–35: Stephen W. Salant and Eban Goodstein, "Committee Voting Under Alternative Procedures and Preferences: An Experimental Analysis" April 20, 1987.

87–36: Robert B. Barsky and Jeffrey A. Miron, "The Seasonal Cycle and the Business Cycle" June, 1987.

87–37: Robert B. Barsky, N. Gregory Mankiw, Jeffrey A. Miron and David N. Weil, "The Worldwide Change in the Behavior of Interest Rates and Prices in 1914" July, 1987.

87–38: Jeffrey K. MacKie-Mason, "Taxes, Information and Corporate Financing Choices" April 1986.

MacKie-Mason, Jeffrey
Taxes, Information, and Corporate Financing Choices