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Corporate Leverage and Nondebt Tax Shields: Evidence on Crowding-Out

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Abstract

A negative relationship between corporate leverage and tax shields has been predicted because a large nondebt tax shield reduces the expected value of interest tax savings and lessens the advantage of debt financing. Previous studies, however, have provided inconclusive and contradictory evidence on whether nondebt tax shields crowd-out debt financing. The analysis herein relies on unique constructs of discounted depreciation tax shields and presents evidence that crowding-out does not occur. Furthermore, it is shown that contradictory inferences may result from analysis of annual tax depreciation deductions instead of discounted tax shields. The findings suggest that firms with substantial cash flow from depreciation exploit their higher debt capacity by maintaining a capital structure with significantly more debt than otherwise.

Introduction

The preferential tax treatment of interest expense provides an incentive for corporations to rely exclusively on debt financing, but this incentive is limited by bankruptcy costs.[1] Of greater concern to this study, however, interest deductions generate tax savings only if they offset taxable income, and this is less likely the greater are nondebt tax deductions (DeAngelo and Masulis [9]). As Ross [21] points out, with substantial nondebt tax shields there is a decline in the expected value of interest tax savings, and the incentive to finance by debt is diminished. According to this argument, debt financing is *crowded-out* by nondebt tax shields, and thus a neg-

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ative relationship between leverage and nondebt tax shields could ensue.

An argument against the crowding-out effect also may be formulated. Scott [22] and Moore [17] argue that firms with substantial collateral assets, such as depreciable buildings, tend to have greater amounts of secured debt. Because secured debt is less risky than nonsecured, the former pays a lesser interest rate than the latter, and thus firms with secured debt possess a greater debt capacity. If the greater debt capacity exceeds the concomitant increase in nondebt tax shield, a positive relationship between leverage and nondebt tax shields could ensue.

Research examining whether nondebt tax shields crowd out debt financing is inconclusive and often contradictory. Evidence failing to support the crowding-out effect is presented by Boquist and Moore [3], Auerbach [1], and Bradley, Jarrell and Kim [5]. Other studies, for example Bowen, Daley, and Huber [4], Davis [8], Pilotte [19], and Givoly, et al [11], find evidence supporting the crowding-out hypothesis. The findings of Titman and Wessels [25] are particularly anomalous. For a sample of firms, they estimate the relationship between leverage ratios and several proxies for nondebt tax shields. When they regress the leverage ratio on the annual depreciation deduction as a proportion of total assets, the relationship is negative and crowding-out is supported. When they regress the leverage ratio on the annual depreciation deduction as a proportion of pretax cash flow (instead of total assets), the relationship is positive and crowding-out is refuted.

Related research by Zarowin [29] about the relationship between a firm's depreciation tax shield and its common stock inflation sensitivity establishes the importance of properly measuring the depreciation tax shield. Zarowin finds that the estimated relationship is statistically insignificant when the depreciation tax shield is measured by traditional book value techniques. When the tax shield proxy reflects the maturity structure of the stream of expected tax depreciation deductions, however, Zarowin finds a negative and statistically significant relationship between tax shields and common stock inflation sensitivity. Zarowin suggests that analyses ignoring the maturity structure of the depreciation tax shield may draw incorrect inferences.

The current study explicitly models the association between the nondebt tax shield and the maturity structure of expected tax depreciation deductions. Following Zarowin, the nondebt tax shield is measured as the present value of expected tax depreciation deductions. This approach is justifiable because the leverage ratio impounds the present value of the interest tax shield and represents a financing horizon substantially longer than one year. Consequently, relating the leverage ratio to an annual deduction, such as has been done in previous studies, may misrepresent the true extent of the crowding-out effect.

Discounted depreciation tax shields are computed for ten capital intensive industries throughout a seventeen-year sample period. The measures subsequently are related to leverage ratios. The findings are summarized as follows.

1) A positive and statistically significant relationship is found between the leverage ratio and discounted tax depreciation deductions as a proportion of either discounted pretax cash flow or total assets.
2) A negative and statistically significant relationship is found between the leverage ratio and the annual depreciation deduction as a proportion of total assets. When the annual depreciation deduction is scaled by discounted pretax cash flow, however, the relationship is positive and significant.
3) Regressing in the same equation the leverage ratio on both the discounted tax shield and the annual deduction variables (both scaled by either total assets or discounted pretax cash flow) shows that generally the coefficient on the annual tax deduction variable is insignificant, whereas that on the discounted tax shield variable is positive and significant.

Finding 1 provides direct evidence about the DeAngelo-Masulis crowding-out hypothesis. This positive and statistically significant relationship suggests that crowding-out does not occur. Finding 2 indicates that contradictory inferences may occur when the leverage ratio is regressed on the annual tax depreciation deduction instead of the discounted tax shield measure. Finding 3 establishes that, irrespective of scaling variable, the discounted tax shield variable dominates the annual tax deduction variable—a positive relationship exists between the leverage ratio and the nondebt tax shield.

The implication of these findings is that, contrary to the DeAngelo-Masulis hypothesis [9], crowding-out does not occur for these capital intensive industries. Alternatively, as suggested by Scott [22] and Moore [17], firms with substantial cash flow from depreciation exploit their higher debt capacity and maintain a capital structure with significantly more debt than otherwise.

The paper proceeds as follows. In the first section the leverage ratio model adopted from Titman and Wessels [25] is described. The second section describes the data, and the third section presents an analysis of the relation between leverage ratios and discounted tax depreciation deductions as a proportion of discounted pretax cash flow. In the fourth section alternative measures of depreciation tax shields are analyzed in order to glean insight on contradictory inferences. A brief summary closes the study.

The Leverage Ratio Model

An empirical analysis of the relationship between the leverage ratio and the depreciation tax shield should control for alternative determinants of leverage, or else there is the potential for an omitted variables problem. The omission of important variables biases estimated coefficients unpredictably. Recently, Titman and Wessels [25] presented a model in which the leverage ratio is a function of seven attributes that prior research has suggested are important. The seven attributes include the relative size of the nondebt tax shield, the availability of growth opportunities, the uniqueness of the product line, the structure of the asset side of the balance sheet (short-term relative to long-term assets), the producer's size, the profitability of the product line, and the volatility of earnings.

A modified version of the TW model is estimated herein for ten industry groups across a seventeen-year sample period. For every industry, the leverage ratio is modeled as a linear function of the seven attributes, as in

$$\alpha_s = \beta_o + \sum_{j=1}^{7} \beta_j X_s^j + \epsilon_s. \tag{1}$$

α_s is the industry's leverage ratio at time s; X_s^j is the proxy for attribute j at time s; β_o is the structural intercept, the β_j $(j = 1, \ldots 7)$ represents the structural coefficients that describe the relationship between α and X^j for the industry, and the ϵ symbolizes the residual error terms.

An advantage of this pooled-data approach is that it controls for cross-sectional as well as time series variation in factors affecting leverage. For example, Dammon and Senbet [7] show that production technology affects the incentive to increase leverage when nondebt tax shields decline. Inclusion of the asset structure, uniqueness, and profitability attributes provides some control for cross-sectional variation in production technologies because they reflect differences in capital intensity and factor utilization. Likewise, by relating time series observations for a specific industry's leverage ratio to its nondebt tax shield, the estimated coefficient is less susceptible than otherwise to biases induced by an omitted variables problem. Nonetheless, the model has its limitations. The chosen attributes may not reflect all determinants of leverage. For example, perhaps the variables do not measure completely the effects on leverage of bankruptcy, financial distress, or free-cash flow. Perhaps, too, the estimated coefficients are time varying due to structural changes in the environment.

The structural coefficients in equation (1) are estimated for ten manufacturing industries throughout the seventeen-year, 1969–85, annual sample period. The analysis is focused on industries rather than firms for several reasons. First, the capital expenditures data used to construct the stream of tax depreciation deductions are available at the industry level but not at the firm level. There also is precedent for industry analyses in leverage studies (e.g., see Bowen, Daley, and Huber [4]). Taggart [24] provides evidence that capital structure attributes are similar for firms within the same industry, and he suggests that inferences from industry level analyses provide insight about firm level determinants of capital structure. Finally, the pooled regression method employed below requires fewer cross-sectional than time series observations, and this is facilitated at the industry level of analysis. The seventeen years analyzed are, for the sources relied upon herein, the earliest year (on the 1990 *Compustat* tape) and latest year (the Bureau of Economic Analysis, BEA [26]) with available data.

The ten industry equations are contemporaneous, and there is potential for cross-equation residual correlation. A procedure for estimating the structural coefficients that takes account of this cross-equation bias is the seemingly unrelated regression techniques (SUR). This technique has been employed in the analysis of contemporaneous market data by Binder [2], et al. The resulting system of ten equations for ten industries (SIC = 20, 22, 26, 28, 29, 30, 32, 33, 35, 36) and seventeen years ($s = 1969, \dots, 1985$) is given by

$$
\begin{aligned}
\alpha_s^{20} &= \beta_0^{20} + \beta_1^{20} X_s^{1,20} + \beta_2^{20} X_s^{2,20} \\
&\quad + \beta_3^{20} X_s^{3,20} + \beta_4^{20} X_s^{4,20} \\
&\quad + \beta_5^{20} X_s^{5,20} + \beta_6^{20} X_s^{6,20} \\
&\quad + \beta_7^{20} X_s^{7,20} + \epsilon_s^{20} \\
\alpha_s^{22} &= \beta_0^{22} + \beta_1^{22} X_s^{1,22} + \beta_2^{22} X_s^{2,22} \\
&\quad + \beta_3^{22} X_s^{3,22} + \beta_4^{22} X_s^{4,22} \\
&\quad + \beta_5^{22} X_s^{5,22} + \beta_6^{22} X_s^{6,22} \\
&\quad \beta_7^{22} X_s^{7,22} + \epsilon_s^{22} \\
\dots &= \dots \\
\alpha_s^{36} &= \beta_0^{36} + \beta_1^{36} X_s^{1,36} + \beta_2^{36} X_s^{2,36} \\
&\quad + \beta_3^{36} X_s^{3,36} + \beta_4^{36} X_s^{4,36} \\
&\quad + \beta_5^{36} X_s^{5,36} + \beta_6^{36} X_s^{6,36} \\
&\quad + \beta_7^{36} X_s^{7,36} + \epsilon_s^{36}
\end{aligned}
\tag{2}
$$

The added superscript denotes the industry two-digit SIC code.

The dependent variable is α^{sic}, the industry leverage ratio. The independent variables and their relation to leverage are described briefly below. For a more exhaustive discussion of the relation between leverage and the seven attributes, as well as citations of studies explaining the justification for the attributes, see Titman and Wessels [25].

X^1, *nondebt tax shield*: This is the primary variable of interest for the current study. β_1 is negative if the DeAngelo-Masulis [9] crowding-out effect is true, β_1 is positive if, as suggested by the Scott-Moore [22, 17] secured debt effect, firms exploit their greater capital intensity by maintaining a capital structure with more debt than otherwise.

X^2, *GROWTH:* Growth opportunities add to firm value, but they are not collateral assets. For this reason, β_2 is expected to be negative.

X^3, *UNIQUENESS:* An industry producing a unique product and employing specialized capital and labor likely bears relatively high liquidation costs. For this reason, β_3 is expected to be negative.

X^4, *STRUCTURE:* This attribute is an increasing function of the extent to which a firm's assets can be used as collateral. Thus, β_4 is expected to be positive.

X^5, *SIZE:* Relatively large firms generally are more diversified and less prone to bankruptcy and, therefore, β_5 is expected to be positive.

X^6, *PROFITABILITY:* If firms prefer to raise capital first from internal financing and second from issuing debt, then firms with high profit margins will issue less debt. Thus, β_6 is expected to be negative.

X^7, *VOLATILITY:* To the extent that a firm's optimal debt level is a decreasing function of their earnings volatility, β_7 is expected to be negative.

The Data

The variables used in estimating equation system (2) are constructed as described below. For the seven attributes, the TW procedure is used with only slight modification, except for the nondebt tax shield attribute, which is novel. Like TW, the (six) attributes are constructed with data from the industry sample of firms on *Compustat*. The industry measure is an average of the specific firm averages.[2] All variables all constructed from contemporaneous data. The growth variable equals the ratio of capital expenditures to total assets. The uniqueness variable equals selling expense divided by sales. The asset structure variable equals the sum of inventory and gross plant divided by total assets. The size variable equals the logarithm of sales. The profitability variable equals operating income divided by sales. The volatility variable equals the standard deviation of profitability for all firms in an industry in a given year.

While several alternative measures for leverage ratios have appeared in the literature, the recent study by Pilotte [19] finds that for four different leverage measures the results are qualitatively the same. Herein, only one leverage measure is employed: the market value of the industry's debt divided by the market value of its debt plus equity. This market-value-based leverage ratio should directly reflect variation in the present value of the interest tax shield. Estimating its relationship with nondebt tax shields therefore provides insight about the crowding-out effect.

In constructing the leverage ratio, the market value of equity is from *Compustat* and equals the number of common shares outstanding times year-end price per share.[3] The debt is valued according to the procedure used by VonFurstenberg, Malkiel, and Watson (VMW [28]). This procedure obtains from *Compustat* the industry sum of short-term and long-term debt. For the leverage ratio, short-term debt is valued at par. The industry sum of long-term debt from *Compustat* is converted from book to market value by multiplying with price-to-book ratios. These ratios vary by year and by industry. The price-to-book ratios for 1969–78 are obtained from VMW. For 1979–85, the ratios are constructed herein by following their procedure. This extension required sampling from *Moody's Bond Record* about 650 bond price quotations per year. Column 1 of Table 1 lists the leverage ratio for a representative industry, Food Products (SIC 20), throughout the 1969–85 annual sample period. Column 1 of Table 2 lists the mean leverage ratio for the ten industries.

One of the nondebt tax shield variables constructed by TW is based on measuring the current tax deduction associated with the tax depreciation of real assets. Zarowin [29] presents evidence that empirical inferences based on such measures are biased because they ignore the maturity structure of the depreciation tax shield. He improves on the current tax deduction methodology by constructing measures of depreciation tax shields that are sensitive to variation in the present value of expected depreciation tax savings. His interpolations, however, assume that a 180 percent declining balance tax depreciation schedule applies for every year, 1969–82, and that all capital expenditures are depreciated by this schedule. For the analysis herein, expenditures are allocated among different asset classes (structures versus equipment), and capital expenditures are depreciated by the tax schedules in use at time of investment.

Annual capital expenditures data are available for each industry from the BEA [26] for two asset types, structures and equipment, for the 1941–85 sample period. The two capital expenditures types are depreciated with the applicable tax schedules for each year into the future, thereby yielding the stream of expected tax depreciation deductions. The streams are constructed separately for each asset type and are then added to arrive at the stream of total deductions promised to that particular industry. Subsequently, the present value of the stream of expected tax depreciation deductions is found by discounting with the industry's weighted average financing rate. More formally, the present value at time s of the depreciation deductions promised by the fixed net asset stock, denoted $PVDEP_s$, is

$$PVDEP_s = \sum_{t=1}^{\infty} (1 + r_s)^{-t} \sum_{j=t}^{\infty} E_{s+t-j} z_{s+t-j,j}. \tag{3}$$

The capital expenditures at time s is E_s. The weighted average financing rate is r, and $z_{s,t}$ denotes the proportion

TABLE 1

Attributes of Depreciation Tax Shields in the Food Products Industry (SIC 20)

This table presents representative data, 1969–85, for one industry. The leverage ratio (α) is the market value of debt divided by the market value of debt plus equity; *PVDEP* is the present value of expected tax depreciation deductions for the industry's fixed assets, *PVCF* is the present value of discounted pretax cash flow embodied within the fixed assets; *TA* is the industry's total assets; and *DEP* is the annual tax depreciation deduction for fixed assets.

year	leverage ratio (α) -1-	discounted deductions ÷ discounted pretax cash flow (PVDEP/PVCF) -2-	discounted deductions ÷ total assets (PVDEP/TA) -3-	annual tax deduction ÷ total assets (DEP/TA) -4-
1969	0.2367	0.4015	0.2184	0.0376
1970	0.2720	0.3971	0.2084	0.0366
1971	0.2522	0.4158	0.2074	0.0392
1972	0.2460	0.4202	0.2064	0.0359
1973	0.3292	0.4320	0.1991	0.0347
1974	0.4581	0.4402	0.1971	0.0327
1975	0.3648	0.4361	0.2064	0.0344
1976	0.3788	0.4619	0.2133	0.0343

1977	0.4016	0.4536	0.2158	0.0354
1978	0.4512	0.4611	0.2208	0.0357
1979	0.4825	0.4403	0.2188	0.0370
1980	0.4847	0.3916	0.2110	0.0367
1981	0.4775	0.4319	0.2120	0.0360
1982	0.4166	0.4387	0.2312	0.0374
1983	0.4133	0.4575	0.2322	0.0390
1984	0.4063	0.4317	0.2130	0.0383
1985	0.3657	0.4896	0.1989	0.0390
mean	0.3787	0.4353	0.2124	0.0365
coefficient of variation	0.2241	0.0585	0.0473	0.0504

Matrix of correlation coefficients

	α	PVDEP/PVCF	PVDEP/TA	DEP/TA
α	1.0000			
PVDEP/PVCF	0.3420	1.0000		
PVDEP/TA	0.2403	0.0649	1.0000	
DEP/TA	−0.2136	−0.0197	0.3832	1.0000

Note:

Data sources and the construction of all variables are discussed in the Data Appendix.

TABLE 2

Summary of Depreciation Tax Shield Measures for Ten Industries

This table presents arithmetic average of the annual (1969–85) data for the ten industries analyzed. The leverage ratio (α) is the market value of debt divided by the market value of debt plus equity; *PVDEP* is the present value of expected tax depreciation deductions for the industry's fixed assets; *PVCF* is the present value of discounted pretax cash flow embodied within the fixed assets; *TA* is the industry's total assets; and *DEP* is the annual tax depreciation deduction for fixed assets.

	Sample means for industry 1969–85				Simple correlation coefficients between an industry's:		
Industry (SIC No.)	α -1-	PVDEP ÷PVCF -2-	PVDEP ÷TA -3-	DEP ÷TA -4-	(DEP÷TA)& (PVDEP÷TA) -5-	(DEP÷TA) &(PVDEP ÷PVCF)	(PVDEP÷TA) &(PVDEP ÷PVCF) -7-
Food Products (20)	0.3787	0.4353	0.2124	0.0365	0.3832	−0.0197	0.0649
Textile Products (22)	0.5632	0.4476	0.1985	0.0400	0.2403	−0.3259	0.5221
Paper Products (26)	0.3738	0.4415	0.3087	0.0455	0.7323	0.5851	0.5901
Chemical Products (28)	0.2964	0.3902	0.2270	0.0483	−0.1446	−0.7213	0.3898
Petroleum Products (29)	0.4929	0.4004	0.2947	0.0513	0.6823	0.1124	0.5181
Rubber & Plastics (30)	0.4528	0.4313	0.2413	0.0432	−0.1598	−0.7296	0.6434
Stone, Clay & Glass (32)	0.4061	0.4415	0.2805	0.0447	0.5161	0.3841	0.2303
Primary Metals (33)	0.5451	0.4612	0.2435	0.0405	0.0313	0.0194	0.8071
Nonelectrical Machinery (35)	0.4144	0.4422	0.1555	0.0379	0.2413	−0.1766	−0.0257
Electrical Machinery (36)	0.2991	0.4105	0.1567	0.0525	0.6235	−0.1680	0.3093

Note:

Data sources and the construction of all variables are discussed in the Data Appendix.

of a time s investment that is scheduled to be deducted for tax purposes at time $s + t$. The Data Appendix provides additional detail on the construction of the weighted average financing rate and the tax depreciation schedules.

The crowding-out hypothesis as formulated by DeAngelo-Masulis [9] argues that the nondebt tax deduction diminishes the incentive for debt financing because there are constraints on the availability of pretax cash flow. As *PVDEP* increases relative to pretax cash flow, the likelihood of using the interest tax shield is reduced and the present value of expected interest tax deductions diminishes.[4] It thus may be more appropriate to measure the nondebt tax deductions relative to pretax cash flow rather than relative to total assets. For this reason, several previous studies scale their nondebt tax shield proxy by pretax cash flow. Scaling with one period's pretax cash flow, however, introduces a problem alluded to earlier: Linking an annual cash flow measure to a leverage ratio reflecting long-term financing sources misrepresents the true extent of the crowding-out effect. In obtaining a proxy for the relative size of the depreciation tax shield, the most relevant measure may be discounted tax depreciation deductions as a proportion of discounted pretax cash flow.

Estimates of the discounted value of pretax cash flow are generated over the seventeen-year sample period for the ten industry groups as outlined below and as described in detail in the Data Appendix. The methodology, based on the one presented by Downs [10], assumes a constant returns to scale technology and zero net present value investment equilibrium in the capital goods market. The pretax cash flow is partitioned into two components. The first component, $c_{s,t}$, represents the pretax cash flow generated per unit of real capital and is related to the user cost of capital (Jorgenson [15]). The second component, $K_{s,t}$, represents the quantity of future capital services promised by existing assets and is constructed by extrapolating historical real investment into the future according to its capacity depreciation schedule. The discounted value at time s of expected pretax cash flow (earnings before depreciation, interest, and taxes), denoted $PVCF_s$, is given by

$$PVCF_s = \sum_{t=1}^{\infty} (1 + r_s)^{-t} c_{s,t} K_{s,t}. \tag{4}$$

Column 2 of Table 1 lists discounted tax depreciation deductions from the Food Products industry as a proportion of discounted pretax cash flow. This ratio, *PVDEP/PVCF*, ranges between 39 and 49 percent. Its sample mean, 0.4353, indicates that on average about 43 percent of pretax cash flow in the Food Products industry is sheltered from taxation by the depreciation tax shield. The lower panel of Table 1 shows that there is a slight positive correlation between the leverage ratio and *PVDEP/PVCF*. Table 2 provides similar information about the other nine industries in the analysis. The sample mean values for *PVDEP/PVCF* range from 0.3902 in Chemical Products to 0.4612 in Primary Metals.

Estimation of the Leverage Ratio Model

Insight on the crowding-out hypothesis is gleaned by estimating equation system (2) with *PVDEP/PVCF* as the proxy for the nondebt tax shield. All coefficients are allowed to vary between industries but are assumed constant across time. Those results are presented in Table 3. The goodness of fit (R^2) varies between industries from 0.923 in Petroleum Products (SIC 29) to 0.612 in Primary Metals (SIC 33). The weighted R^2 for the system is 0.836, and inspection for each equation of the Durbin-Watson or Ljung-Box statistics (not listed) indicates that there is no serial correlation among residuals. The absence of residual correlation suggests an absence of problems associated with omitted variables or specification error.

Discussion about the different attributes is presented later and, for the moment, attention is turned to the relationship between the leverage ratio and the discounted depreciation tax shield variable. The slope coefficient on *PVDEP/PVCF* is positive in nine of the ten industries and is statistically distinguishable from zero at the ten percent significance level in eight of these. The coefficient is negative and significant in one industry. The test of the hypothesis that the coefficients of

PVDEP/PVCF across the ten industries are jointly equal to zero is summarized below:

$H1_o$: $\beta_{pv}^{SIC} = 0.0$; SIC = 20, 22, . . . , 36; coefficients on PVDEP/PVCF jointly equal zero; Outcome: Rejected.

A Wald test statistic for this hypothesis is computed by estimating restricted versions of equation system (2). The Wald statistic is distributed Chi-Square with nine degrees of freedom. For hypothesis $H1_o$ the Wald test statistic equals 143.7. The critical value at the 1 percent significance level is 21.6, and the hypothesis is rejected at the 0.001 significance level. The coefficients linking the leverage ratio to the nondebt tax shield variable as proxied by *PVDEP/PVCF* are jointly distinguishable from zero, and the variable adds significant explanatory power to the equation system.

There likely is significant cross-sectional variation in the estimated coefficients if there is a problem with omitted variables or model specification. In order to deduce whether the relationship between *PVDEP/PVCF* and the leverage ratio exhibits interindustry variation, a version of equation system (2) is estimated in which there is a cross-equation restriction equating the coefficient β_{pv}. All other coefficients are allowed to vary. The following hypothesis is examined:

$H2_o$: $\beta_{pv}^{20} = \beta_{pv}^{22}$; coefficients on PVDEP/PVCF are equal across industries; Outcome: Not Rejected.

Results from the estimation of the restricted equation (listed in the next to the bottom row in Table 3) yield a slope coefficient on *PVDEP/PVCF* equal to 0.696 with a t-statistic of 9.31. The coefficient is statistically different from zero at the 0.0001 significance level. An F-statistic is computed in order to test hypotheses $H2_o$ and, at 0.81,[5] the statistic is well below the 5 percent critical value of 1.98. The hypothesis of a uniform positive relationship across industries between the leverage ratio and the discounted depreciation tax shield is supported.

Insight is gleaned about the attributes besides the nondebt tax shield variable by estimating their coefficients with an equality constraint across industries. The restriction is enforced on each variable independently, and a hypothesis analogous to $H2_o$ is tested for each es-

TABLE 3

Regression Results When Nondebt Tax Shields Are Proxied by PVDEP/PVCF

This table presents coefficients from the estimation of equation system (2), given that the nondebt tax shield variable is proxied by the ratio of discounted tax depreciation deductions (*PVDEP*) relative to discounted pretax cash flow (*PVCF*). The dependent variable is the industry leverage ratio (α) throughout the 1969–85 annual sample period (seventeen observations per industry). The ten industries are stacked, and the system is estimated with the Seemingly Unrelated Regression Technique. Results in the bottom two rows are obtained by imposing an equality constraint across industries on the stipulated coefficient.

$\alpha = \beta_o + \beta_{pv}$ PVDEP/PVCF + β_2 GROWTH + β_3 UNIQUENESS + β_4 STRUCTURE + β_5 SIZE + β_6 PROFITABILITY + β_7 VOLATILITY

SIC	β_o	β_{pv}	β_2	β_3	β_4	β_5	β_6	β_7	R^2
20	0.216	−0.543	0.931	−3.410	−0.258	0.184	0.352	−25.540	0.919
	(0.46)	(−2.06)^a	(1.00)	(−5.18)^c	(−0.66)	(7.17)^c	(0.23)	(−1.76)	
22	0.461	1.292	−2.486	−4.158	0.146	0.069	−0.879	−40.019	0.796
	(0.41)	(5.45)^c	(−3.65)^c	(−2.20)^a	(0.24)	(0.86)	(−0.60)	(−2.44)^b	
26	−0.556	0.282	0.653	−0.184	−0.299	0.176	−0.819	21.186	0.807
	(−0.79)	(1.57)	(0.97)	(−0.16)	(−0.58)	(5.19)^c	(−1.09)	(2.26)^b	
28	−1.979	0.905	2.544	−0.013	0.404	0.185	2.005	−0.898	0.918
	(−4.10)^c	(4.88)^c	(4.20)^c	(−0.03)	(1.23)	(6.94)^c	(2.10)^a	(−0.20)	
29	−0.496	0.436	0.141	−2.332	0.462	0.056	−0.036	10.692	0.923
	(−2.42)^b	(4.44)^c	(0.47)	(−4.00)^c	(3.51)^c	(4.08)^c	(−0.10)	(2.40)^b	

30	0.363 (0.57)	1.332 (6.53)^c	1.509 (2.25)^b	−5.567 (−5.00)^c	0.198 (0.37)	0.137 (4.01)^c	−4.511 (−5.00)^c	−32.804 (−3.34)^c	0.907
32	1.755 (2.32)^b	0.651 (2.91)	0.159 (0.40)	−3.423 (2.16)^a	−1.155 (−1.77)	0.090 (2.01)^a	−2.887 (−4.13)^c	−7.402 (−1.58)	0.839
33	−2.082 (−3.83)^c	0.255 (1.83)^a	−1.331 (−3.16)^b	8.642 (3.85)^c	0.436 (2.32)^b	0.158 (5.55)^c	4.886 (4.62)^c	−23.308 (−4.71)^c	0.612
35	0.128 (0.13)	0.964 (3.21)^c	−0.082 (−0.06)	−0.652 (−0.40)	−0.603 (−0.96)	0.098 (1.75)	0.485 (0.42)	−22.734 (−1.07)	0.711
36	−2.609 (−2.42)^b	0.902 (1.97)^a	0.472 (0.19)	−1.259 (−0.58)	2.645 (4.07)^c	0.177 (1.38)	2.698 (1.11)	−70.930 (−2.84)^b	0.740
slope coefficients restricted across industries:									
	ur	0.696 (9.31)^c	ur	ur	ur	ur	ur	ur	0.822
	ur	0.678 (12.71)^c	−0.048 (−0.40)	−0.832 (−7.24)^c	0.325 (4.78)^c	0.105 (11.88)^c	−0.376 (−2.47)^b	−9.80 (−7.66)^c	0.523

Notes:

Industries are identified by SIC code in Table 2.

T-statistics for zero equality are in parentheses.

Superscripts a, b, and c denote significance levels of 10, 5, and 1 percent, respectively.

"ur" indicates the estimated coefficient is unrestricted and varies across industries.

timated slope coefficient. The hypothesis that the estimated slope coefficient is equal across industries cannot be rejected at the 5 percent significance level for any one attribute. This finding reflects a combination of two effects. First, there are not statistically significant interindustry differences in the estimated relationships between the leverage ratio and any one attribute. Second, the power of the estimated system is low because from 170 observations there are, in the unrestricted system, 80 estimated coefficients. The power for rejecting alternative specifications is low, yet it is high enough to reject the simultaneous equality constraint on all seven attributes. For this specification, the F-statistic testing the joint equality across industries of the seven slope coefficients equals 2.72, and it exceeds the critical value at the 1 percent significance level of 1.71.

The consistency of the estimated coefficients with Titman and Wessels is examined next. To facilitate a comparison of these estimates with TW, an equality restriction across industries is forced on the seven coefficients simultaneously.[6] The coefficients in the restricted equation exhibit the predominant characteristic of the underlying relationship.

The estimates for the restricted equation are listed in the bottom row of Table 3. A negative and statistically significant relationship is found between the leverage ratio and *UNIQUENESS, PROFITABILITY*, and *VOLATILITY*. TW likewise report negative coefficients between these attributes and the market based leverage ratio. Table 3 also shows that a positive and statistically significant relationship is found between the leverage ratio and *STRUCTURE* and *SIZE*. The estimates in TW for these attributes generally are statistically indistinguishable from zero.[7] The coefficient in Table 3 on the *GROWTH* attribute, while negative, is indistinguishable from zero. Likewise, in TW this coefficient is negative and statistically insignificant.

For the six attributes besides the nondebt tax shield variable, the findings by TW and the current study are very consistent and never contradictory. This high degree of consistency should increase confidence about the estimated coefficients obtained herein. The estimated coefficients obtained by TW for the nondebt tax shield variable generally are insignificant, leading them to conclude that the "results do not provide support for an effect on debt ratios arising from nondebt tax shields. . ." [25, p. 17]. The estimates obtained in the current study and presented in Table 3, on the other hand, indicate a positive and statistically significant relationship between leverage and the discounted depreciation tax shield. These findings support the hypothesis that crowding-out does not occur.

Insight on the time series stability of β_{pv} is obtained by reestimating the equation system for rolling eleven-year sample periods (with ten industries, the minimum estimable time series length is eleven years). The restricted coefficient on *PVDEP/PVCF* is 0.678 for the full 1969–85 sample period, as shown in the bottom row of Table 3. When the sample period is 1969–79, the coefficient is 0.850. For 1970–80, the coefficient is 0.974. For each subsequent rolling eleven-year sample period, the restricted coefficient on *PVDEP/PVCF* is 0.887, 0.897, 0.801, 0.740, and for 1975–85 it is 0.431. In all cases the coefficient is statistically different from zero at the 0.0001 significance level. If the coefficient were constant, which it is not, then there would be a high degree of confidence that the coefficient for the full sample period is an unbiased estimate of the association between leverage and nondebt tax shields. Nonetheless, for six of the seven eleven-year windows the estimated coefficient is between 0.740 and 0.974, and it is always highly significant. Even though there is apparent drift in the estimated coefficient as the rolling estimation period moves along, the relatively "small" range of coefficient estimates suggests that there is not a problem with multicollinearity.[8] The estimated coefficients are unambiguously positive and statistically significant.

The findings presented above suggest that the leverage ratio is related positively to discounted tax depreciation deductions as a proportion of discounted pretax cash flow. This implies that the DeAngelo-Masulis [9] crowding-out effect is dominated by the Scott-Moore [22, 17] secured debt effect. Support is offered for the hypothesis that firms with substantial fixed assets exploit their higher debt capacity and maintain a capital structure with significantly more debt than otherwise.

Further Investigations

This section checks the robustness of the inferences to changes in the nondebt tax shield proxy. First, the nondebt tax shield is proxied by discounted tax depreciation deductions (*PVDEP*) as a proportion of total assets (*TA*). The *PVDEP* variable is the one constructed in the previous section, and *TA* is constructed from the *Compustat* industry sample.[9] Column 3 of Table 1 lists *PVDEP/TA* for the Food Products industry, 1969–85. This variable ranges between 19.7 and 23.2 percent, it exhibits slightly less variation than *PVDEP/PVCF*, and, as listed in the lower panel, these two variables are virtually uncorrelated ($\rho = .06$). Similar summary statistics for the other nine industries are presented in columns 3 and 7 of Table 2.

Equation system (2) is estimated with *PVDEP/TA* as the proxy for nondebt tax shields; all other variables are the same as in the previous section. The results presented in Table 4 show that replacement of *TA* for *PVCF* as the scaling variable on *PVDEP* does not significantly change the qualitative results. The goodness-of-fit remains more or less the same for each industry, as well as for the system at large; the system weighted R^2 is 0.804. The coefficient on *PVDEP/TA* is positive in nine of ten industries, and in seven industries the coefficient is statistically significant. The null hypothesis that the ten coefficients on *PVDEP/TA* jointly equal zero has a Wald statistic equal to 71, and it is rejected at the 0.0001 significance level. The coefficients on the other attributes, summarized in the bottom row of Table 4, are qualitatively the same as obtained with *PVDEP/PVCF* in Table 3.

Confidence in the inferences about the relationship between leverage and nondebt tax shields, as proxied by *PVDEP/TA*, are increased to the extent that there is uniformity across industries in the estimated coefficient. An equality restriction across industries is forced on β_{pv}. The estimated coefficient in the restricted system is 1.057, and it is statistically distinguishable from zero at the .0001 significance level (the t-statistic equals 6.70). The F-statistic testing for the equality of the coefficient across industries is 1.80 and the equality hypothesis is not rejected.[10] The significant positive relationship between the leverage ratio and discounted tax depreciation deductions is invariant to selection of *PVCF* or *TA* as the scaling variable.

Further analyses rely on the current annual depreciation deduction (*DEP*) as the proxy for the nondebt tax shield. This book-value-based measure is the standard used in several prior studies. As shown by Zarowin [29], however, the annual depreciation charge may not be a reliable indicator of long-term tax shields. Regardless, equation system (2) is reestimated with the same attributes as before, except for the nondebt tax shield variable.

The results listed in Table 5 employ *DEP/PVCF* in equation system (2) as the proxy for the nondebt tax shield. The estimated coefficient is positive in eight of ten industries and is statistically significant in three of those. Estimation with *DEP/TA* as the proxy yields estimates (not presented) in which the coefficient is negative in nine of ten industries; again, only three are statistically significant.[11] These findings echo the anomalous results reported by TW: the estimated relationship between leverage and nondebt tax shields is negative and supportive of the DeAngelo-Masulis crowding-out hypothesis when *DEP* is scaled with *TA*, yet positive and a refutation of crowding-out when *DEP* is scaled by pretax cash flow.

In order to shed light on which inference regarding the crowding-out hypothesis may be dominant, a modified version of equation system (2) is estimated in which both the annual depreciation deduction and the discounted tax shield variables are employed. Estimation with both *DEP/PVCF* and *PVDEP/PVCF* in the same equation yields the results listed in Table 6. For the discounted tax shield variable, *PVDEP/PVCF*, the estimated coefficient is statistically significant in nine industries, and in all ten it is positive. For the annual deduction variable, *DEP/PVCF*, the estimated coefficient is statistically significant in three of ten industries; the coefficient is negative in four and positive in six industries.

Estimation with both *DEP/TA* and *PVDEP/TA* in the same equation yields similar results. The estimated

TABLE 4

Regression Results When Nondebt Tax Shields Are Proxied by PVDEP/TA

This table presents coefficients from the estimation of equation system (2), given that the nondebt tax shield variable is proxied by the ratio of discounted tax depreciation deductions (*PVDEP*) relative to industry total assets (*TA*). The dependent variable is the industry leverage ratio (α) throughout the 1969–85 annual sample period (seventeen observations per industry). The ten industries are stacked, and the system is estimated with the Seemingly Unrelated Regression Technique. Results in the bottom two rows are obtained by imposing an equality constraint across industries on the stipulated coefficient.

$\alpha = \beta_o + \beta_{pv}$ PVDEP/TA + β_2 GROWTH + β_3 UNIQUENESS + β_4 STRUCTURE + β_5 SIZE + β_6 PROFITABILITY + β_7 VOLATILITY

SIC	β_o	β_{pv}	β_2	β_3	β_4	β_5	β_6	β_7	R^2
20	1.531	1.939	2.848	−4.677	−1.582	0.104	−2.053	−8.685	0.941
	(3.62)^{c}	(3.71)^{c}	(3.64)^{c}	(−7.91)^{c}	(−4.13)^{c}	(4.70)^{c}	(−1.70)	(−0.74)	
22	−5.189	−3.977	1.379	5.000	3.874	0.318	9.369	−115.176	0.776
	(−3.88)^{c}	(−3.17)^{b}	(1.24)	(2.14)^{a}	(4.89)^{c}	(3.56)^{c}	(4.05)^{c}	(−5.18)^{c}	
26	−0.016	0.707	0.735	−0.777	−0.257	0.101	−1.156	5.756	0.793
	(−0.02)	(1.94)^{a}	(1.13)	(−0.74)	(−0.47)	(2.67)^{b}	(−1.49)	(0.56)	
28	−1.194	1.784	2.245	−1.237	−0.260	0.185	2.418	−3.034	0.884
	(−1.97)^{a}	(3.67)^{c}	(2.78)^{b}	(−2.65)^{b}	(−0.53)	(5.38)^{c}	(1.99)^{a}	(−0.57)	
29	−0.414	0.983	0.626	−2.927	0.373	0.040	0.088	7.786	0.902
	(−1.89)^{a}	(4.00)^{c}	(2.03)^{a}	(−5.21)^{c}	(2.77)^{b}	(2.66)^{b}	(0.206)	(1.75)	

30	0.958 (1.02)	1.707 (2.30)^b	1.524 (1.63)	-8.552 (-5.56)^c	0.776 (1.10)	0.052 (1.16)	-5.381 (-4.21)^c	-39.950 (-2.87)^b	0.861
32	2.359 (3.16)^b	2.342 (3.25)^c	-0.874 (-1.98)^a	-5.900 (-3.46)^c	-1.957 (-2.83)^b	0.112 (2.45)^b	-1.367 (-1.76)	-5.608 (-0.95)	0.779
33	-2.303 (-3.74)^c	0.693 (1.79)	-1.584 (-3.97)^c	10.598 (4.27)^c	0.265 (1.16)	0.178 (5.82)^c	5.619 (5.15)^c	-26.320 (-5.29)^c	0.557
35	1.744 (1.77)	3.473 (2.36)^b	-3.661 (-1.91)^a	-6.285 (-2.29)^b	-0.665 (-0.76)	0.137 (1.68)	-3.595 (-2.73)^b	-37.665 (-1.02)	0.654
36	-1.404 (-0.92)	0.419 (0.22)	3.131 (1.11)	0.382 (0.15)	1.942 (2.28)^b	0.008 (0.05)	1.737 (0.56)	-78.767 (-2.97)^b	0.699
slope coefficients restricted across industries:									
	ur	1.057 (6.70)^c	ur	ur	ur	ur	ur	ur	0.769
	ur	0.484 (4.67)^c	-0.347 (-2.33)^b	-0.882 (-5.06)^c	0.365 (5.82)^c	0.105 (14.34)^c	-0.568 (-3.45)^c	-10.986 (-7.34)^c	0.399

Notes:

Industries are identified by SIC code in Table 2.

T-statistics for zero equality are in parentheses.

Superscripts a, b, and c denote significance levels of 10, 5, and 1 percent, respectively.

"ur" indicates the estimated coefficient is unrestricted and varies across industries.

Table 5

Regression Results When Nondebt Tax Shields Are Proxied by DEP/PVCF

This table presents coefficients from the estimation of equation system (2), given that the nondebt tax shield variable is proxied by the ratio of the annual tax depreciation deductions (*DEP*) relative to discounted pretax cash flow (*PVCF*). The dependent variable is the industry leverage ratio (α) throughout the 1969–85 annual sample period (seventeen observations per industry). The ten industries are stacked, and the system is estimated with the Seemingly Unrelated Regression Technique. Results in the bottom two rows are obtained by imposing an equality constraint across industries on the stipulated coefficient.

$$\alpha = \beta_o + \beta_{dep}\ \text{DEP/PVCF} + \beta_2\ \text{GROWTH} + \beta_3\ \text{UNIQUENESS} + \beta_4\ \text{STRUCTURE} + \beta_5\ \text{SIZE} + \beta_6\ \text{PROFITABILITY} + \beta_7\ \text{VOLATILITY}$$

SIC	β_o	β_{dep}	β_2	β_3	β_4	β_5	β_6	β_7	R^2
20	0.713 (1.80)	−1.511 (−2.15)[c]	1.492 (1.86)[c]	−3.793 (−6.32)[a]	−0.761 (−2.29)[b]	0.163 (7.84)[c]	0.274 (0.23)	−24.409 (−2.00)[a]	0.929
22	−1.066 (−1.06)	3.738 (3.60)[c]	−0.846 (−1.20)[c]	−2.561 (−1.48)	1.337 (2.63)[b]	0.081 (0.99)	2.278 (1.71)	−55.202 (−3.76)[c]	0.786
26	−0.104 (−0.11)	−1.788 (−0.67)	0.469 (0.68)	−1.257 (−1.10)	0.029 (0.05)	0.134 (2.99)[b]	−1.120 (−1.34)	7.319 (0.73)	0.786
28	−1.825 (−3.04)[b]	0.530 (0.30)	0.376 (0.53)	−0.820 (−1.88)[a]	0.962 (2.33)[b]	0.220 (6.45)[c]	1.369 (1.20)	−1.884 (−0.32)	0.887
29	−0.022 (−0.09)	2.501 (2.79)[b]	−0.063 (0.19)	−1.334 (−1.71)	0.092 (0.44)	0.047 (3.36)[c]	−0.432 (−1.05)	8.325 (1.59)	0.921

30	1.216 (1.22)	8.310 (3.12)^{b}	3.210 (3.12)^{b}	−9.361 (−5.87)^{c}	0.073 (0.08)	0.094 (1.93)^{a}	−6.466 (−4.54)^{c}	−32.471 (2.19)^{a}	0.835
32	2.574 (2.97)^{b}	0.882 (0.69)	−0.253 (−0.50)	−2.420 (−1.36)	−1.735 (−2.22)^{a}	0.074 (1.43)	−2.878 (−4.01)^{c}	−3.609 (−0.67)	0.764
33	−2.454 (−3.71)^{c}	0.123 (0.09)	−1.921 (−3.13)^{b}	11.382 (4.44)^{c}	0.490 (2.07)^{a}	0.176 (4.75)^{c}	6.182 (5.28)^{c}	−29.488 (−6.28)^{c}	0.542
35	2.954 (2.90)^{b}	0.002 (0.00)	−1.200 (−0.68)	−2.745 (−1.21)	−2.111 (−2.71)^{b}	0.009 (0.13)	−2.099 (−1.13)	8.320 (0.32)	0.595
36	−1.112 (−1.17)	0.663 (0.55)	3.818 (1.64)	0.586 (0.27)	1.816 (2.44)^{b}	−0.043 (−0.32)	1.334 (0.63)	−79.781 (−3.41)^{c}	0.701
slope coefficients restricted across industries:									
	ur	−6.897 (−3.49)^{c}	ur	ur	ur	ur	ur	ur	0.769
	ur	−3.976 (−3.93)^{c}	−0.650 (−4.07)^{c}	−0.674 (−3.81)^{c}	0.661 (7.12)^{c}	0.136 (16.88)^{c}	−0.764 (−4.23)^{c}	−10.543 (−6.69)^{c}	0.422

Notes:

Industries are identified by SIC code in Table 2.

T-statistics for zero equality are in parentheses.

Superscripts a, b, and c denote significance levels of 10, 5, and 1 percent, respectively.

"ur" indicates the estimated coefficient is unrestricted and varies across industries.

TABLE 6

Regression Results When Both DEP/PVCF and PVDEP/PVCF Are Included

This table presents coefficients from the estimation of equation system (2), given inclusion of both variables *DEP/PVCF* and *PVDEP/PVCF*; the annual tax depreciation deduction is *DEP*, discounted tax depreciation deductions is *PVDEP*, and discounted pretax cash flow (*PVCF*). The dependent variable is the industry leverage ratio (α) throughout the 1969–85 annual sample period (seventeen observations per industry). The ten industries are stacked, and the system is estimated with the Seemingly Unrelated Regression Technique.

$$\alpha = \beta_o + \beta_{dep}\ \text{DEP/PVCF} + \beta_{pv}\ \text{PVDEP/PVCF} + \beta_2\ \text{GROWTH} + \beta_3\ \text{UNIQUENESS} + \beta_4\ \text{STRUCTURE} + \beta_5\ \text{SIZE} + \beta_6\ \text{PROFITABILITY} + \beta_7\ \text{VOLATILITY}$$

SIC	β_o	β_{dep}	β_{pv}	β_2	β_3	β_4	β_5	β_6	β_7	R^2
20	0.984	−4.223	0.802	2.342	−3.212	−0.996	0.137	−2.177	−4.831	0.942
	(2.58)^{b}	(−3.82)^{c}	(2.16)^{a}	(3.05)^{b}	(−5.66)^{c}	(−2.98)^{b}	(6.30)^{c}	(−1.57)	(−0.35)	
22	0.017	1.625	0.620	−1.948	−3.303	0.581	0.053	0.575	−53.998	0.794
	(0.09)	(0.57)	(0.82)	(−1.47)	(−1.24)	(0.62)	(0.58)	(0.17)	(−1.85)	
26	0.726	−6.810	0.548	0.217	−1.101	−0.433	0.096	−1.436	13.758	0.826
	(0.99)	(−2.63)^{b}	(2.82)^{b}	(0.34)	(−1.08)	(−1.01)	(2.51)^{b}	(−2.19)^{a}	(1.80)	
28	−2.095	−1.422	0.908	1.552	−0.040	0.553	0.209	2.085	0.546	0.925
	(−4.31)^{c}	(−0.93)	(4.20)^{c}	(2.53)^{b}	(−0.10)	(1.69)	(7.52)^{c}	(2.08)^{a}	(0.13)	

29	−0.556 (−1.73)	−1.230 (−0.65)	0.612 (2.70)^{b}	0.263 (0.90)	−2.737 (−3.10)^{b}	0.606 (2.12)^{a}	0.052 (3.48)^{c}	−0.298 (−0.78)	12.363 (3.00)^{b}	0.926
30	0.548 (0.81)	0.689 (0.33)	1.347 (5.29)^{c}	1.013 (1.40)	−4.957 (−3.73)^{c}	−0.155 (−0.26)	0.138 (4.01)^{c}	−4.439 (−4.77)^{c}	−28.453 (−2.95)^{b}	0.901
32	1.691 (2.73)^{b}	−1.789 (−1.36)	0.800 (2.73)^{b}	−0.309 (−0.79)	−3.637 (−2.47)^{b}	−1.195 (−2.13)^{a}	0.133 (3.05)^{b}	−2.692 (−3.78)^{c}	−11.546 (−2.21)^{a}	0.856
33	−1.878 (−3.18)^{b}	0.854 (0.71)	0.300 (2.03)^{a}	−0.944 (−1.67)	8.122 (3.42)^{c}	0.337 (1.63)	0.140 (4.15)^{c}	4.401 (3.97)^{c}	−24.826 (−4.82)	0.618
35	0.461 (0.49)	−1.828 (−1.62)	1.322 (4.14)^{c}	−1.334 (−1.00)	−2.223 (−1.28)	−0.430 (−0.62)	0.133 (2.17)^{a}	−1.412 (−0.98)	−27.242 (−1.19)	0.762
36	−5.672 (−4.12)^{c}	−3.216 (−2.29)^{a}	2.091 (3.77)^{c}	−3.960 (−1.57)	1.847 (0.90)	4.317 (5.00)^{c}	0.298 (2.43)^{b}	7.001 (3.05)^{b}	−37.153 (−1.79)	0.766

Notes:

Industries are identified by SIC code in Table 2.

T-statistics for zero equality are in parentheses.

Superscripts a, b, and c denote significance levels of 10, 5, and 1 percent, respectively.

coefficients (not shown) on *DEP/TA* are statistically significant in only one industry, whereas for *PVDEP/TA* the estimated coefficients are positive and statistically significant in 7 industries.

The relationship between leverage ratios and depreciation tax shields seems captured by the discounted tax shield (*PVDEP*) variable rather than by the annual deduction (*DEP*) variable. Inclusion of both *PVDEP* and *DEP* in the same equation, irrespective of scaling variable, generally shows that the discounted tax shield variable dominates the annual deduction variable. The findings suggest that the depreciation tax shield does not crowd out debt financing.

Summary

This study examines whether debt financing is crowded out by depreciation tax shields. The crowding-out hypothesis is predicated on the assumption that as nondebt tax deductions increase, the incentive to rely on tax-favored debt diminishes. Hence, there is a decline in the present value of interest tax deductions. The leverage ratio, of course, is directly related to the discounted value of interest tax deductions and, if crowding-out occurs, there exists a negative relationship between the leverage ratio and nondebt tax shields.

The analysis herein measures nondebt tax shields as the discounted value of expected tax depreciation deductions. When the discounted depreciation tax shield is scaled by either discounted pretax income or total assets, and subsequently the ratio is related to market based leverage measures, the estimates indicate that crowding-out does not occur; the estimated coefficients are almost always positive and statistically significant. These findings suggest that firms with relatively high depreciation tax shields also tend to have high leverage ratios. An explanation for this is that firms garnering a substantial proportion of cash flow from depreciation have substantial collateral assets, the collateral assets are financed at a lower interest rate and possess a greater debt capacity, and the greater debt capacity is exploited as firms maintain a capital structure with significantly more debt than otherwise.

DATA APPENDIX

Additional detail on the construction of *PVDEP* from equation (3), of *PVCF* from equation (4), and of the weighted average financing rate, *r*, is discussed below.

PVDEP: Discounted depreciation tax shield

Annual capital expenditures data are available for each industry from the BEA [26] for two assets types, structures and equipment, for the 1941–85 sample period. The depreciation deductions arising from each year's capital expenditures are computed separately for each asset type and are then added to arrive at the stream of total deductions promised to that particular industry. The capital expenditure from any one year is depreciated over the asset's tax life for that year. Equipment tax lives vary by industry and are based on results in Coen [6]. Those results show, for example, that the average tax life for equipment ranges in 1975 from nine years in Electrical Machinery (SIC 36) to fourteen years in Stone, Clay, & Glass (SIC 32). Following Coen, the equipment tax lives within one industry are arranged in steps; they equal one value for pre-1961; another value for 1962–70; another value for 1971–80; and in 1981–85 the tax lives are based on ACRS classes as described below. Structures tax lives are based on the SSRC-MIT-PENN Quarterly Econometric Model (SSRC [23]) and equal twenty-two years for all industries in the pre-1981 era. They are based on ACRS class lives thereafter.

The tax depreciation schedule used to depreciate capital expenditures is reflected in the series of weights denoted $z_{s,j}$ ($j = 1, \ldots, L$ where L is the asset tax life). Each weight represents the proportion of time s capital expenditures that is deductible for tax purposes at time $s + j$. This series sums to unity and is recomputed annually for each year $s = 1969\text{-}L, \ldots, 1985$. The weights represent a combination of accelerated and straight-line tax depreciation schedules. For all industries, the proportion of expenditures (structures and equipment) depreciated by accelerated methods is taken from the SSRC Model. Prior to 1981, half of all expenditures depreciated by accelerated methods are depreciated by sum-of-year's digits and half by 200 percent declining balance (150 percent for structures after 1969) with an optimal switch to straight-line at mid-life. Expenditures not depreciated by accelerated methods are depreciated by straight-line. In and after 1981, 20 percent of equipment expenditures are depreciated in the three-year ACRS class and qualify for a 6 percent investment tax credit. Eighty percent are depreciated in the five-year class and qualify for a 10 percent tax credit. Structures expenditures are depreciated in the fifteen-year ACRS class prior to the 1984 Deficit Reduction Act and in the eighteen-year class thereafter. In all cases the depreciable basis for ACRS schedules is reduced by one-half the allowable investment tax credit.

PVCF: Discounted value of expected pretax cash flow

As indicated in equation (4), which is based on the procedure used by Downs [10], the expected pretax cash flow is partitioned into two components. One component represents the productive potential of the real capital stock and is computed by extrapolating historical capital expenditures into the future according to the capacity depreciation schedules characteristic of the asset. Following the BEA, the capacity depreciation schedules are modeled along straight-line patterns. Productive service lives vary by industry and asset, and are based on data from the Bureau of Labor Statistics [27]. Half-life convention is followed. Let d_j denote the proportion of original productive capacity lost by an asset during the j'th year of use. The assets in place at time s promise real capital services at time $s + t$, denoted $K_{s,t}$, given by

$$K_{s,t} = \sum_{u=t}^{\infty} I_{s+t-u} \left[1 - \sum_{j=1}^{t} d_j \right].$$

I_s is the real capital expenditure at time s.

The second component of pretax cash flow in equation (4) is related to the user cost of capital. Given that all prices are expected to inflate at the same rate π, then the expectation formed at time s about the cash flow expected per unit of asset at time $s + t$, denoted $c_{s,t}$, is given by

$$c_{s,t} = c_s (1 + \pi_s)^t.$$

The user cost in the reference year is c_s, given by

$$c_s = \frac{q_s\,[r_s - \pi_s]\,[1 - v_s - \tau_s Z_s]}{[1\text{-}D_s]\,[1 - \tau_s]}.$$

Z_s is the present value of tax depreciation deductions per dollar of marginal investment,

$$Z_s = \sum_{j=1}^{\infty} (1 + r_s)^{-j}\, z_{s,j},$$

and D is a capacity depreciation term, $0 \leq D < 1$, computed as

$$D_s = \sum_{j=1}^{\infty} (1 + r_s - \pi_s)^{-j}\, d_j.$$

v denotes the investment tax credit (if any) and is obtained from the SSRC. π for 1969–78 is the annual average of the quarterly series presented by Hendershott and Hu [13]. Updated estimates for 1979–85 were considerately provided by Sheng Hu. q_s is the time s price of a new asset and is from the BEA [26].

r: Weighted average financing rate

The discount rate, r is a weighted average of (after-corporate-tax) debt and equity financing rates and it is recomputed annually for all industries, according to

$$r = \alpha(1 - \tau)k^d + (1 - \alpha)k^e.$$

The weight on debt is the industry leverage ratio (α) measured at market. The leverage ratio varies by year and by industry, as described in the text. The same debt financing rate (k^d) is used in all industries, but it varies by year, and it equals the high-grade corporate bond yield (*Citibase*). τ is the statutory federal corporate income tax rate. The equity financing rate (k^e) varies between industries and between years. It is based on a portfolio equilibrium between the Treasury bill yield (k^{rf}), the expected risk premium on the market portfolio (P), personal tax rates on equity and interest returns (τ^e and τ^d), and equity betas (β):

$$(1 - \tau^e)\,k^e = (1 - \tau^d)\,k^{rf} + \beta\,(1 - \tau^e)\,P.$$

The τ^e and k^{rf} vary by year but not by industry, and they are based on Hendershott [12] and *Citibase*, respectively.

P is a constant and is based on Ibbotson [14]. Data on τ^d are provided by Peek (with Wilcox [18]). The equity betas vary by year and by industry. They are computed with daily stock returns data from the *Center for Research in Security Prices* and equal the market-model slope coefficient from that year's industry portfolio return regressed on the market return.

Notes

1. There is a substantial literature on corporate capital structure. For a discussion of that literature see Masulis [16] or Pinegar and Wilbricht [20].

2. The number of firms for each industry with complete data varies each year. The minimum and maximum numbers of firms throughout the seventeen-year sample set are 48 and 59 for SIC 20, 16 and 26 for SIC 22, 25 and 30 for SIC 26, 81 and 104 for SIC 28, 27 and 33 for SIC 29, 21 and 27 for SIC 30, 13 and 18 for SIC 32, 35 and 40 for SIC 33, 60 and 82 for SIC 35, and 98 and 177 for SIC 36.

3. The market value of preferred equity (not available on *Compustat*) was computed for a sampling of firms by obtaining actual market transaction prices. The procedure was not applied to the final sample because preferred equity constituted less than 2 percent of total capital; sampling the transaction prices seemed to offer few benefits.

4. Ideally, measures of nondebt tax shields also might include research and development expense and investment tax credits. These additional variables, unfortunately, are available for a substantially smaller number of firms than are the other variables. In 1985, for example, the reported depreciation deduction (*Compustat* item #14) is available for 677 firms in the ten industry sample. The research and development variable (#46) is available for 463 firms, and the investment tax credit variable (#51) is available for 317 firms. The magnitude of these latter two variables is very small relative to the depreciation deduction; they are ignored in computing the nondebt tax shield.

5. The estimation of equation system (2) for the ten industries has sum of squared residuals (SSR) equal to 0.2130, there are 170 observations, there are 80 estimated coefficients, and there are 90 degrees of freedom. The restricted equation has SSR equal to 0.2302, and there are 71 estimated coefficients. The F-statistic is [(0.2302–0.2310)/9]/[0.2130/90], which is 0.8075. The critical value for the F-statistic with 9 and 90 degrees of freedom in numerator and denominator, respectively, is 1.98 at the 5 percent significance level.

6. The F-statistic reported in the previous paragraph indicates rejection of the hypothesis that across industries the seven estimated slope coefficients are equal. Nonetheless, the estimates reported in the bottom row of Table 3 are qualitatively similar to the estimated slope coefficients obtained when the equality restriction is enforced

one attribute at a time. Those independently estimated coefficients (t-stat) for the seven attributes, left-to-right in Table 3, equal .696 (9.31), .091 (.45), −1.888 (−5.84), .397 (4.49), .105 (11.10), −.939 (−3.14), and −10.530 (−5.52).

7. TW rely on a LISREL factor analytic estimation methodology rather than the SUR technique. They also employ three different market-based debt measures (one at a time) and they present, in their Table IV, the estimated coefficient between each attribute and each of the different leverage ratios. They report that two of the three coefficients on STRUCTURE are positive, one is negative, and all are statistically insignificant. They also report two of the three coefficients on SIZE are statistically insignificant, and that one of the coefficients is negative and significant.

8. The downward drift in the estimated coefficient is consistent with Pilotte's [19] finding that the change in leverage ratio surrounding ERTA is inversely related to capital intensity. Suppose that $\alpha = \beta X$, where X measures capital intensity as a proxy for nondebt tax shields. The total differential is $d\alpha = \beta dX + X d\beta$. The downward drift in β_{pv} is evidence that $d\beta < 0$, which in turn implies that a negative relationship exists between the change in leverage ratio and capital intensity.

9. The BEA capital expenditures data are stated on an establishment basis. The *Compustat* data are stated on an enterprise basis. *PVDEP* is made comfortable with *TA* through multiplication by the ratio of "Compustat industry total net fixed assets" over "BEA industry historic cost replacement cost."

10. The unrestricted estimate of equation system (2) that is listed in Table 4 has SSR equal to 0.2537 and 90 degrees of freedom. The restricted equation referred to in the text has SSR equal to 0.2993. The F-statistic is [(0.2993–0.2537)/9]/[0.2537/90], which is 1.80.

11. The estimated coefficients for the ten industries (and t-statistics) equal −8.468 (−1.57), −8.901 (−1.17), −5.791 (−1.18), −16.630 (−2.19), 4.015 (1.02), −21.237 (−2.87), −2.403 (−.49), −3.542 (−.67), −16.043 (−2.77), and −11.040 (−1.18).

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