

Valuation of the Debt Tax Shield

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ABSTRACT

In this study, we use cross-sectional regressions to estimate the value of the debt tax shield. Recognizing that debt is correlated with the value of operations along nontax dimensions, we estimate reverse regressions in which we regress future profitability on firm value and debt rather than regressing firm value on debt and profitability. Reversing the regressions mitigates bias and facilitates the use of market information to control for differences in risk and expected growth. Our estimated value for the debt tax shield is approximately 40 percent (10 percent) of debt balances (firm value), net of the personal tax disadvantage of debt.

THE DEBT TAX SHIELD HAS STIMULATED decades of debate regarding firm valuation and the cost of capital. In 1963, Modigliani and Miller (hereafter MM) first hypothesized that the tax benefits of debt increase firm value and decrease the cost of using debt capital. In 1977, Miller countered that firms pass out the tax benefits of debt to creditors through high interest rates to compensate them for the personal tax disadvantage of debt. Others have proposed that the financial distress costs of debt offset at least some of the tax benefits (see, e.g., DeAngelo and Masulis, 1980). A priori, therefore, the firm valuation and capital structure implications of the debt tax shield are unclear, so empirical investigation is required.

Empirical investigation of the debt tax shield has followed three primary lines of inquiry. First, many studies investigate the MM prediction that the debt tax shield promotes the use of debt versus equity financing. For example, Bradley, Jarrell, and Kim (1984), Long and Malitz (1985), Titman and Wessels (1988), and Fischer, Heinkel, and Zechner (1989) use various forms of debt/equity ratios to test whether nondebt tax shields, such as depreciation or investment tax credits, reduce the propensity to use debt tax shields. None of these studies find significant tax effects. In contrast, certain recent

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studies focus on incremental financing decisions and find cross-sectional evidence that high marginal tax rates promote the use of debt (e.g., MacKie-Mason (1990), Trezevant (1992), and Graham (1996, 1999)).¹

Second, Graham (2000) uses firm-level financial statement data to calculate the tax benefit of debt and estimates the mean corporate tax benefit of debt for a large sample of Compustat firms equals approximately 10 percent of total firm value. Although he does not provide direct market evidence of the debt tax shield, Graham demonstrates that firms derive substantial tax benefits from debt.

Third, a select few studies seek direct market evidence for the debt tax shield. For example, Masulis (1980) finds debt-for-equity swaps generally increase stock prices.² Similarly, Engel, Erickson, and Maydew (1999) find firms derive substantial net tax benefits when they swap tax-deductible trust preferred stock for nondeductible regular preferred stock. On the other hand, Fama and French (1998; hereafter FF) use cross sections to regress firm value on interest expense (which proxies for debt) and various controls for profitability. FF find a strong negative relation between debt and firm value, concluding that “imperfect controls for profitability probably drive the negative relations between debt and value and prevent the regressions from saying anything about the tax benefits of debt” (p. 839).

At its core, the primary factor confounding cross-sectional examinations of the value of the debt tax shield is that the value of a firm’s operations is unobservable and could be correlated with debt along nontax dimensions. For example, firms with high levels of debt could be mature, capital-intensive firms with lower earnings growth prospects than firms with low levels of debt. In addition, profitable firms could use less debt than unprofitable firms according to a financing pecking order, the financial distress costs of debt could decrease the value of operations, or debt could otherwise signal information about expected future operating profitability. When regressing firm value on debt, therefore, any imperfections in the controls for the value of operations will result in biased estimates of the value of the debt tax shield, even if the imperfections represent random error. In addition, using firm value as a dependent variable precludes the use of market-based measures (e.g., the market-to-book ratio) on the right-hand side of equations to control for risk and expected growth.

To address these concerns, we develop an alternative approach. Rather than specifying firm value as a function of debt and imperfect measures of future operating profitability, we reverse the relationship by specifying future operating profitability as a function of firm value, debt, and controls for firm-level capitalization rates. Reversing the regression offers two advan-

¹ In addition, Givoly et al. (1992) and Rajan and Zingales (1995) find that firms increase the use of debt following changes in statutory tax rates that increase the tax benefits of debt.

² Although this evidence might very well reflect the value of the debt tax shield, the agency, information, or corporate control attributes of debt-for-equity recapitalizations may contribute to the empirical results.

tages. First, moving future operating profitability to the dependent variable shifts any random measurement error in this variable to the regression residual where it no longer biases the debt coefficient, while moving the market value of the firm to the right-hand side controls for nontax information from debt regarding future operating profitability. Second, moving the market value of the firm out from the left-hand side of the equations enables us to use market-based variables on the right-hand side to control for risk and expected growth.

Using this reverse approach, we estimate both linear and nonlinear equations for a Compustat sample of 42,505 firm-year observations (2,964 firms) for the period from 1963 to 1993. We find a positive, significant value for the debt tax shield, net of the personal tax disadvantage of debt. As expected, we also find the estimated value of the net debt tax shield increases in statutory corporate tax rates over time, and it increases in estimated marginal tax rates across firms. Our estimates are generally equal to approximately 40 percent of debt balances, or 10 percent of total firm value. By way of comparison, the average statutory corporate tax rate for our sample period is 45 percent, plus state taxes.

This evidence supports the MM debt tax shield hypothesis, and it is consistent with the tax benefit calculations in Graham (2000) and the market evidence for a debt tax shield in Masulis (1980) and Engel et al. (1999). In addition, the evidence is consistent with the findings in MacKie-Mason (1990), Trezevant (1992), and Graham (1996, 1999) that debt policy is a function of corporate taxes. Nevertheless, we also provide evidence that the personal tax disadvantage of debt appears to offset a portion of the gross corporate tax benefits of debt, but the magnitude of this offsetting effect is limited.

These findings are subject to at least two important caveats. First, we rely on explicit MM assumptions to model the value of operations, and empirically, we measure certain variables with error. Therefore, the magnitude of our point estimates should be viewed with caution. Second, we specifically design our tests to distinguish between the MM and Miller (1977) hypotheses, which focus solely on corporate and personal tax factors. Therefore, our estimates cannot be used to illuminate the trade-off between tax and nontax factors.

The study proceeds as follows. We develop the research methodology in Section I. In Section II, we describe the sample and data. In Section III, we present the primary empirical results. In Section IV, we provide robustness tests. We conclude in Section V.

I. Research Methodology

A. MM Model

To develop our research methodology, we begin with the stylized MM setting in which there are no financial distress costs from debt, no personal tax

effects, and a single corporate tax rate. Given this setting, MM derives the following tax-adjusted valuation model:

$$V_L = V_U + \tau D. \quad (1)$$

V_L represents the market value of the firm, which equals the market value of equity plus the market value of debt. V_U represents the market value of the unlevered firm, τ represents the tax benefit from a dollar of debt, and D represents the market value of debt. To derive (1), MM assumes debt is perpetual.

To define V_U more precisely, MM specifies:

$$V_U = E(FOI)/\rho. \quad (2)$$

$E(FOI)$ represents the long-run average expected value of after-tax future operating income, or $EBIT \times (1 - \text{corporate tax rate})$, where $EBIT$ is earnings before interest and taxes. ρ represents the capitalization rate for $E(FOI)$, which increases in risk. In the MM model, $E(FOI)$ summarizes all expected future operating income, so it captures expected growth in income. In practice, finite-term empirical proxies for $E(FOI)$ inevitably fail to capture all expected future growth, so proxies for the capitalization rate can also be used to capture growth. In our study, therefore, we treat ρ as a function of both risk and growth (i.e., ρ increases in risk and decreases in expected growth).

Introducing nontax costs from debt, personal taxes, and nondebt tax shields (e.g., depreciation) alters interpretation of V_U and τ to some degree. In particular, the financial distress costs of debt generally reduce expected future operating profits, which reduce V_U according to (2).³ Because V_U captures nontax costs from debt, it can no longer be viewed as the value of the unlevered firm, but must be more strictly viewed as the value of operations. In addition, τ represents the *net* tax benefit from debt, meaning the gross corporate tax benefit of debt offset by the personal tax disadvantage of debt. For some firms, nondebt tax shields also decrease the value of τ .⁴

³ Specific examples of financial distress costs that reduce the value of operations include the agency costs resulting from conflicts of interest between shareholders and bondholders, the costs associated with bankruptcy court monitoring activities, and the costs incurred if firms pass out debt tax benefits to customers or suppliers via product or input prices. In contrast, direct costs of bankruptcy such as dissolution fees generally do not enter operating profits and could affect τ . However, Weiss (1990) and Andrade and Kaplan (1998) find that in expectation, the direct costs of bankruptcy are small relative to firm value.

⁴ As Graham (2000) shows, the marginal corporate tax benefit from an incremental dollar of debt is a concave decreasing function of the total amount of debt a firm employs. This is true because debt reduces taxable income, which decreases the probability that a firm will be fully taxable in all current and future states. For any particular firm, therefore, τ reflects the mean tax benefit of debt, averaged over the firm's entire function of marginal tax rates for different levels of debt.

Substituting (2) into (1) yields

$$V_L = E(FOI)/\rho + \tau D. \quad (3)$$

We refer to (3) as the forward equation. Reversing, we obtain

$$E(FOI) = \rho(V_L - \tau D). \quad (4)$$

Equations (3) and (4) form the basis for two complementary approaches for examining the value of the debt tax shield.

B. Forward Approach

Equation (3) suggests the use of some form of the following equation to estimate the value of the debt tax shield:

$$V_L = \alpha_1 + \alpha_2 E(FOI)/\rho + \alpha_3 D + \epsilon, \quad (5)$$

in which α_3 represents the estimated value for the net debt tax shield. $E(FOI)$ and ρ are not directly observable, so proxies must be used.

With many refinements, FF adopt the forward approach to examine the value of the debt tax shield. Specifically, FF use a measure of firm value as the dependent variable, they use interest expense to proxy for debt, and they use several proxies for expected future operating earnings and the capitalization rate as control variables. After exhaustive efforts, they conclude it is essentially impossible to find adequate proxies for expected future profitability and for the risk and growth factors that determine ρ . Given the inadequacy of the control variables, they estimate a negative value for the debt tax shield and express pessimism about the prospects of using this general approach to estimate debt tax effects.

At least two underlying factors complicate the use of (5). First, debt is likely to be correlated with the value of operations (i.e., $E(FOI)$ and ρ) along several nontax dimensions, including growth, financial distress, signaling, and size dimensions. If debt is correlated with $E(FOI)$ or ρ along nontax dimensions, and if we attempt to use imperfect measures to control for this correlation, then α_3 would be a biased estimate of the net debt tax shield. Indeed, *any* imperfection in the controls for $E(FOI)$ or ρ would induce bias in the debt coefficient, even if the error were white noise or otherwise uncorrelated with debt. Second, using the market value of the firm as the dependent variable precludes the use of the market-to-book ratio (and its variants) as a control for ρ . This limitation is critical because variants of the market-to-book ratio are common proxies for risk (see, e.g., Fama and French (1992)). In addition, the market-to-book ratio of operations reflects expectations about future operating earnings relative to current book value, so it proxies for expected growth in operating earnings (see, e.g., Penman (1996)).

C. Reverse Approach

In contrast to the forward approach, (4) suggests the use of some form of the following reverse equation to estimate the value of the debt tax shield:

$$E(FOI) = \alpha_1 + \alpha_2 \rho(V_L - \beta D) + \epsilon. \quad (6)$$

In this equation, β represents the estimated value of the net debt tax shield. Unlike (5), (6) is nonlinear in the parameters. As shown later, it is possible to estimate the equation by using nonlinear least squares or by using linear transformations of (6). The intuition supporting (6) is the greater the tax benefit from debt, the lower the expected operating earnings required to justify the current market value of the firm.

Although it is subject to its own set of limitations, (6) offers two advantages over (5). First, (5) results in biased and inconsistent estimates of the value of the net debt tax shield if there is *any* measurement error in the empirical (profitability) proxies for $E(FOI)$, even if this error represents white noise. In contrast, (6) only results in biased estimates to the extent the measurement error is correlated with debt. This is true because moving $E(FOI)$ to the left-hand side shifts the measurement error in the proxy for $E(FOI)$ to the dependent variable where the regression residual can capture the random component of the error. From another perspective, placing market value (V_L) on the right-hand side of (6) controls for all market information regarding $E(FOI)$, including information regarding growth prospects, financial distress costs, the strength of management, size, or the natural relation between profitability and debt that may arise from a capital structure pecking order. Second, moving V_L to the right-hand side of the equation makes it possible to use market information to help control for ρ , thus overcoming a key limitation of the forward approach.

Despite its advantages, the reverse approach requires market efficiency to ensure V_L controls for all available nontax information regarding expected future profitability. Any error in V_L could bias estimates. In contrast, random error in V_L would not bias estimates from the forward approach. The reverse approach also requires the use of a single proxy for expected future profitability. In contrast, the forward approach allows researchers to use a host of potential control variables for expected profitability.

D. Linear Empirical Specifications

Using (5) and (6), we now develop a set of linear empirical equations. From (5), the first empirical equation we estimate is the following basic forward regression:

$$V_L/TA = \alpha_1 + \alpha_2 FOI/TA + \alpha_3 D/TA + \epsilon, \quad (7)$$

where FOI is a proxy for $E(FOI)$ and TA is total assets. At this point, we treat ρ as a constant, so we do not include any specific controls for the capitalization rate.

In (7), we follow FF by deflating all of the regression variables by total assets (TA), but like FF, we do not deflate the intercept. The alternative is to deflate the entire equation by total assets as follows:

$$V_L/TA = \alpha_1/TA + \alpha_2FOI/TA + \alpha_3D/TA + \epsilon. \quad (8)$$

The decision to use an undeflated versus a deflated intercept is potentially important. Using an undeflated intercept essentially converts the variables from (5) into ratios. In contrast, deflating the entire equation simply uses total assets to weight the influence of sample observations. Each approach leads to a potentially distinct bias. In (7), the variables represent ratios, so bias occurs to the extent FOI/TA is an imperfect control for V_U/TA , and V_U/TA is correlated with D/TA . This bias would be negative, for example, if high-value profitable firms use less debt than low-value unprofitable firms according to a financing pecking order. In (8), bias occurs to the extent FOI is an imperfect proxy for V_U , and V_U is correlated with D . This bias is likely to be positive because D and V_U both increase in size. Hence, negative bias could result from (7), and positive bias could result from (8).

Given the potential biases for the forward approach, we also consider the reverse approach. By continuing to treat ρ as a constant, we can transform the nonlinear reverse equation (6) into the following linear specification:

$$FOI/TA = \alpha_1/TA + \alpha_2V_L/TA + \alpha_3D/TA + \epsilon, \quad (9)$$

where the estimate for the net debt tax shield (i.e., β) equals $-\alpha_3/\alpha_2$. In (9), we have chosen to deflate the intercept and all regression variables. Hence, (9) is equivalent to (8), except we reverse the roles for FOI and V_L . A key benefit from reversing the regression is that it shifts the effects of any random error in FOI to the regression residual, and it places V_L on the right-hand side of the equation to control for any available nontax information from debt regarding expected future operating earnings. For example, V_L controls for the size effect that could bias the estimate of β from (8).⁵

Just as V_L controls for the size effect that could bias estimates from the forward deflated-intercept equation (i.e., (8)), V_L would control for the pecking-order effects that could bias estimation of the forward undeflated-intercept equation (i.e., (7)). Nevertheless, using an undeflated intercept for the reverse equation introduces a new source of bias. In particular, FOI is a construct of imperfect accounting principles discussed in Section II, so it measures expected economic earnings with error. If the accounting measurement error in FOI is correlated with any of the explanatory variables, it would generally bias all regression coefficients. When using the deflated intercept as we do

⁵ Reversing the regression reverses the sign of the potential size bias, so without a perfect control for size, the estimate of β from (9) would be biased downward.

in (9), the accounting measurement error in *FOI* should be largely orthogonal to the market value of the firm and the book value of debt, which are the two explanatory variables.⁶ However, using an undeflated intercept (which is equal to TA/TA) is essentially equivalent to adding the deflator, total assets, to the original equation (for a discussion, see Miller and Modigliani (1966)). Unlike the other explanatory variables, total assets is likely to be correlated with the accounting measurement error in *FOI* because total assets equal the sum of all past operating income and net investments, and this correlation would bias estimated coefficients. Empirically, we find that using an undeflated intercept increases estimates of the debt tax shield above the estimates we report (to potentially unreasonable levels). Therefore, we focus on the deflated intercept specification (i.e., equation (9)).

Despite the advantages of (9), ρ is not really a cross-sectional constant, so estimates of the net debt tax shield from (9) should continue to be biased. After estimating (9) without a control for ρ , therefore, we use two different approaches to control for ρ . First, we estimate (9) for portfolios of observations with similar capitalization rates and report summary statistics. As discussed more fully later, we use years, industries, and market-to-book ratios of operations to form the portfolios. Second, we use a vector of four common controls for risk and growth to identify a subsample of observations with similar capitalization rates. We then estimate our model for the homogeneous subsample of firms, after replacing the intercept with a vector of dummy variables ($\sum_{i=1}^{44} \alpha_{1i} DIND_i$) to control for industry effects. The 44 dummy variables correspond to the industries identified in Fama and French (1997).⁷ Fixing industry effects provides an additional control for ρ by allowing us to focus on within-industry variation in our regression variables, as reflected in the following equation:

$$FOI/TA = \sum_{i=1}^{44} \alpha_{1i} DIND_i/TA + \alpha_2 V_L/TA + \alpha_3 D/TA + \epsilon. \quad (10)$$

E. Nonlinear Empirical Specification

Rather than simply partitioning the sample to control for ρ , another option is to estimate the reverse, nonlinear equation (i.e., (6)) directly. To do so, we specify ρ as a linear function of a vector (\mathbf{x}) of observable instruments associated with risk and growth, so that $\rho = \boldsymbol{\alpha}'\mathbf{x}$. We then substitute $\boldsymbol{\alpha}'\mathbf{x}$ for ρ in (6), which allows us to estimate the vector of $\boldsymbol{\alpha}$ parameters within the

⁶ Given market efficiency, the market value of the firm is not affected by accounting distortions. The book value of debt typically measures the market value of debt with only limited error, and conservative or aggressive accounting practices that affect measurement of *FOI* do not affect the measurement of debt because accounting for debt is standardized across firms.

⁷ Fama and French (1997) use four-digit SIC codes to identify 48 industries. However, four of their industries are from the financial sector (SIC 6000–6999), which we omit.

model.⁸ To control for any direct relation between *FOI* and the variables in \mathbf{x} , we also include these variables in additive form as $\boldsymbol{\gamma}'\mathbf{x}$. To control for industry effects, we replace the intercept with industry dummies, resulting in the following equation:

$$FOI = \boldsymbol{\alpha}'\mathbf{x}(V_L - \beta D) + \boldsymbol{\gamma}'\mathbf{x} + \sum_{i=1}^{44} \alpha_{1i} DIND_i + \nu. \quad (11)$$

We use a constant and four variables to specify \mathbf{x} . In particular, the first variable in \mathbf{x} is the industry median beta of operations (β_U), which helps control for risk. The second variable is the market-to-book ratio of operations. Assuming market efficiency, the market value of operations is $(V_L - \beta D)$, where β is the (unobserved) net tax benefits from a dollar of debt. Hence, our measure for the market-to-book ratio of operations is $(V_L - \beta D)$ divided by net operating assets (*NOA*), or $(V_L - \beta D)/NOA$. The third variable is the log of *NOA*, which measures size and is a proxy for risk and growth. The final variable is the log of operating liabilities (*OL*), where operating liabilities represent all nondebt liabilities. All else being equal, the risk of operations increases in *OL*, much like the risk of equity increases in debt (see, e.g., Copeland, Koller, and Murrin (2000)).

Substituting these variables for \mathbf{x} in (11) results in the following empirical specification (β_U drops out of the $\boldsymbol{\gamma}'\mathbf{x}$ term because it is spanned by the industry dummy variables):

$$FOI = \left[\alpha_1 + \alpha_2 \beta_U + \alpha_3 \frac{V_L - \beta D}{NOA} + \alpha_4 \log(NOA) + \alpha_5 \log(OL) \right] (V_L - \beta D) \\ + \sum_{i=1}^{44} \gamma_{2i} DIND_i + \gamma_3 \frac{V_L - \beta D}{NOA} + \gamma_4 \log(NOA) + \gamma_5 \log(OL) + \nu. \quad (12)$$

Equation (12) is nonlinear in the parameters, so we use nonlinear least-squares to estimate it. To mitigate the effects of heteroskedasticity, we weight the observations by the reciprocal of the square of total assets. This weighting variable is consistent with deflating the entire equation by total assets.

Although (12) may appear complex, it is simply an estimable version of (6). Unlike (9) and (10), (12) does not require us to partition the sample or to otherwise estimate the equation for a subset of observations. Despite this generality, the proxy for ρ is still likely to be measured with error, which could lead to bias. It is important, therefore, to consider estimates from (9), (10), and (12).

⁸ Alternatively, we could attempt to use risk and growth factors to estimate the capitalization rate (ρ) outside the model and then insert our estimate for ρ into a second-stage regression. However, the two-stage approach would require us to specify precisely how risk and growth affect ρ , and it would require us to estimate growth explicitly (for which extant literature provides little guidance). In contrast, the single-stage approach allows us to use instruments to control for risk and growth without imposing these restrictions and assumptions on the model.

Before proceeding, note that βD enters (12) three times, twice as a component of the $(V_L - \beta D)/NOA$ term in the \mathbf{x} vector, and once as a component of our primary explanatory variable. We believe it is optimal to use all three manifestations of βD to estimate the value of the net debt tax shield. Nevertheless, the βD term in \mathbf{x} is simply one relatively small feature of our control for risk and growth, and it does not materially affect our empirical results.

II. Data and Sample

A. Measurement of the Variables

We use Compustat data to measure the variables. Specifically, we measure the market value of the firm (V_L) as the market value of common equity plus the book value of debt (D) and preferred stock. We measure the market value of equity as the product of the number of shares outstanding (Compustat Data #25) and price per share at fiscal year end (#199). We measure the book value of preferred stock as preferred stock (#130) minus preferred treasury stock (#227) plus preferred dividends in arrears (#242). We measure the book value of debt as debt in current liabilities (#34) plus long-term debt (#9). This measure of debt excludes operating liabilities, which typically do not generate explicit tax-deductible interest expense. Removing operating liabilities from our definition of D (and therefore V_L) allows us to maintain the MM relationship that $V_L = V_U + \tau D$.⁹

Using the book value of debt to proxy for its market value introduces error into our V_L and D measures. However, discrepancies between the book and market values of debt are typically small when measured relative to total debt outstanding, and Miller and Modigliani (1966) argue that this type of error is unlikely to be of a sufficiently systematic nature to bias estimates. Nevertheless, the potential for bias exists, so empirical results should be interpreted accordingly. We also conduct a robustness test using interest expense in lieu of D .

We measure FOI as the average realized operating income for the five years that follow the current year. Requiring five years of future information allows us to capture growth trends in operating earnings that we could not capture by simply using single-period-ahead operating income, and it allows us to capture a larger share of expected future financial distress costs than a single year of future information would capture.¹⁰ It also restricts our

⁹ V_U also excludes the value of operating liabilities because it is a function of expected operating income, and operating income is measured after deducting the implicit cost of operating liabilities (see, e.g., Copeland et al. (2000)). Empirically, we find that adding operating liabilities to our measure of V_L increases our estimates of the net debt tax shield.

¹⁰ Liu, Nissim, and Thomas (2002) examine the valuation performance of a comprehensive list of commonly used price multiples. They find the simple sum of consensus (mean) analyst earnings forecasts for the next five years is the best performer in terms of explaining current market value. In this study, we use the average of ex post realizations of operating income for the next five years as our dependent variable for the primary tests, and we use the average of consensus analyst forecasts for the next five years for a robustness test. Empirically, we find all of our results are largely unaffected if we use weighted averages of realized operating income for the next five years, with the greatest weights on the most distant years to further capture growth trends.

sample to firms that do not face imminent bankruptcy, which further limits the confounding effects of financial distress costs. This is important because any expected financial distress costs that extend beyond our measurement period create error in *FOI* and potential bias in our estimates for τ , except to the extent our proxies for ρ capture these expected costs. Despite these benefits, requiring five years of future information could induce survivorship bias, which we address with a robustness test in Section IV.B.

We define operating income (*OI*) as income before extraordinary items (#18) plus after-tax interest expense ($\#15 \times (1 - \tau_c)$), where τ_c equals the top corporate statutory federal tax rate.¹¹ This definition of operating income is essentially equal to *EBIT*($1 - \tau_c$), which is consistent with the definition in MM. We use cross-sectional regressions to estimate the value of the debt tax shield, and we treat τ_c as a cross-sectional constant, so all of the empirical estimates for the value of the net debt tax shield we report are similar when we use *EBIT* (#170 + #15) to construct our *FOI* measures as they are when we use *EBIT*($1 - \tau_c$) to construct the measures.¹²

We estimate market beta (β_L) using monthly stock returns during the five years that end at the end of the current year (at least 30 observations are required). As a market index, we use the CRSP value-weighted returns including all distributions. We adjust market beta for leverage using the following formula: $\beta_U = \beta_L[(V_L - D)/(V_L - D \times \tau_c)]$ (see, e.g., Copeland and Weston (1988, p. 457)).¹³ To reduce measurement error and to obtain estimates of β_U for firms with less than 30 monthly stock returns, we estimate the median unlevered beta for the firms in each of the 44 nonfinancial industries (based on four-digit SIC codes) identified by Fama and French (1997). We then use the industry median betas, rather than using firm-specific betas.

B. Sample and Descriptive Statistics

Our sample consists of all firm-year observations on the combined Compustat (Industry and Research) files for any of the 31 years from 1963 to

¹¹ The top statutory corporate tax rate was 52 percent in 1963, 50 percent in 1964, 48 percent from 1965 to 1967, 52.8 percent from 1968 to 1969, 49.2 percent in 1970, 48 percent from 1971 to 1978, 46 percent from 1979 to 1986, 40 percent in 1987, 34 percent from 1988 to 1992, and 35 percent from 1993 to 1998. State taxes also are relevant, and for some firms, nondebt tax shields decrease the marginal tax rate below the statutory tax rate. Therefore we measure τ_c with error. Also note that throughout the paper, we treat interest income as a component of operations, which is consistent with the fact that we do not net financial assets against gross debt to measure *D*.

¹² Another option would be to use free cash flows to measure *FOI*. However, Liu et al. (2002) demonstrate that valuation using earnings multiples produces much more precise estimates of firm value than valuation using free cash flow multiples, largely because investment by growth firms depresses free cash flow. Therefore, we follow FF and Miller and Modigliani (1966) by using earnings measures.

¹³ This formula assumes the value of the firm reflects the tax benefits of debt, which could be problematic because we are examining the hypothesis that investors price the tax benefits of debt. However, β_U only represents one of our four proxies for risk and growth. Empirically, results are essentially the same if we adjust market beta for leverage by assuming τ_c equals zero.

Table I
Descriptive Statistics

V_L represents the market value of the firm, measured as the market value of common equity plus the book values of debt and preferred stock. FOI represents average operating income over the subsequent five years. Operating income is defined as net income plus interest expense times $(1 - \tau_c)$, where τ_c equals the top corporate statutory federal tax rate. NOA represents net operating assets, measured as total assets minus operating liabilities, where operating liabilities (OL) are all nondebt liabilities. β_U represents unlevered market beta. D represents debt. All variables except β_U are deflated by total assets. The number of observations is 42,505.

	Mean	Std. Dev.	5%	25%	50%	75%	95%
V_L	1.176	0.888	0.486	0.708	0.918	1.308	2.719
FOI	0.098	0.082	-0.005	0.055	0.085	0.130	0.240
NOA	0.759	0.107	0.565	0.703	0.774	0.832	0.908
OL	0.241	0.107	0.092	0.168	0.226	0.297	0.435
β_U	0.870	0.255	0.328	0.759	0.893	1.018	1.276
D	0.273	0.173	0.006	0.144	0.261	0.387	0.566

1993 that satisfy the following criteria. First, the company was listed on the NYSE or AMEX.¹⁴ Second, the company was not a financial institution (SIC codes 6000–6999). Third, common shares outstanding (#25), price per share at fiscal year end (#199), total assets (#6), and income before extraordinary items (#18) are available for the current year and for each of the five subsequent years. Fourth, current year net operating assets are at least \$10 million. Fifth, the observation is not an outlier.¹⁵ These sample selection criteria result in a sample of 42,505 firm-year observations (2,964 firms).

Table I presents the distribution of the variables. To obtain insights into the distribution of the variables holding size constant, we deflate all of the variables in Table I by total assets (except β_U). The average firm finances 27 percent of its assets with debt and 24 percent with operating liabilities. The market value of the firm (after removing operating liabilities) is 118 percent of the book value of total assets.

Table II provides two sets of Pearson correlations. The upper triangle presents correlations among undeflated variables that we weight according to the reciprocal of the square of total assets, which is consistent with the weights we use for estimation of (8), (9), (10), and (12). The lower triangle presents correlations among variables deflated by total assets, which is consistent with the estimation of (7) that includes an undeflated intercept. Whether it is deflated or not, FOI has a strong, positive relation to V_L ,

¹⁴ The capitalization rates for many Nasdaq firms are likely to be substantially different from the capitalization rates for NYSE and AMEX firms. Therefore, we exclude Nasdaq firms to increase the homogeneity of capitalization rates among sample firms. Empirically, however, this exclusion does not materially affect results for our sample period.

¹⁵ To mitigate the effects of influential observations, we delete observations for which any of the variables, deflated by total assets, is outside the 0.1–99.9 percent range of its pooled empirical distribution.

Table II
Weighted Pearson Correlations among Undeclared Variables
(Upper Triangle) and Pearson Correlations among
Deflated Variables (Lower Triangle)

V_L represents the market value of the firm, measured as the market value of common equity plus the book values of debt and preferred stock. FOI represents average operating income over the subsequent five years. Operating income is defined as net income plus interest expense times $(1 - \tau_c)$, where τ_c equals the top corporate statutory federal tax rate. NOA represents net operating assets, measured as total assets minus operating liabilities, where operating liabilities (OL) are all nondebt liabilities. β_U represents unlevered market beta. D represents debt. The weighting variable is the reciprocal of the square of total assets. The deflator is total assets (β_U is not deflated). The number of observations is 42,505. Correlation coefficients with an absolute value above 0.02 are statistically significant at the 0.001 level.

	V_L	FOI	NOA	OL	β_U	D
V_L		0.70	0.72	0.60	0.01	0.48
FOI	0.42		0.67	0.59	-0.06	0.44
NOA	0.12	0.04		0.80	-0.09	0.82
OL	-0.12	-0.04	-1.00		-0.07	0.63
β_U	0.18	0.10	-0.04	0.04		-0.11
D	-0.23	-0.25	0.27	-0.27	-0.27	

indicating that it contains substantial information about the value of operations. In the undeclared case, there is a positive correlation between D on the one hand, and V_L and FOI on the other, which is predictable because all of these variables increase in size. In the deflated case, there is a negative correlation between D on the one hand, and V_L and FOI on the other, which is not surprising because expected growth for mature high-debt firms may well be lower than expected growth for low-debt firms, or high-value profitable firms may use less debt than low-value unprofitable firms according to a financing pecking order.

III. Primary Empirical Results

Many of the parameters we estimate are likely to vary over time, so to account for this nonstationarity, we follow FF by estimating equations for each year and reporting summary statistics from the annual regressions.

A. Linear Specifications

We begin by estimating (7), the forward regression with an undeclared intercept, which is consistent with the approach used by FF. However, FF add a variety of potentially important control variables, and our data requirements reduce the size of our sample below the size of the sample used by FF. Despite these differences, we obtain essentially the same empirical result FF obtain. In particular, the mean estimated value for the net debt tax shield is negative and statistically significant (-0.541 , $t = -8.851$), as reported in Table III.

Table III
**Summary Statistics from Cross-sectional Regressions Explaining
the Value of the Firm with Undeclared Intercept**

V_L represents the market value of the firm, measured as the market value of common equity plus the book values of debt and preferred stock. TA represents total assets. FOI represents average operating income over the subsequent five years. Operating income is defined as net income plus interest expense times $(1 - \tau_c)$, where τ_c equals the top corporate statutory federal tax rate. D represents debt. The t -statistic is the ratio of the mean cross-sectional coefficient to its standard error. "Positive" is the proportion of cross sections in which the coefficient is positive.

$$V_L/TA = \alpha_1 + \alpha_2 FOI/TA + \alpha_3 D/TA + \epsilon$$

	α_1	α_2	α_3	R^2	N
Mean	0.848	5.022	-0.541	0.259	1,371
t -statistic	20.44	13.06	-8.851		
Positive	1.000	1.000	0.097		

This negative estimate reflects a negative nontax relation between debt and firm value. For example, high-debt firms may have lower growth opportunities than low-debt firms, or profitable high-value firms with access to internal cash flow may use less debt than unprofitable low-value firms according to a financing pecking order. If FOI measured future expected profitability and growth without error, it would control for these nontax factors. Given measurement error in FOI , however, nontax factors bias the estimated debt coefficient.

Next we estimate (8), which is the forward regression with a deflated intercept. When using this equation, we are concerned that debt and firm value are both positively related to size, which could bias the debt coefficient upward. Consistent with this concern, the estimated debt coefficient is too large for tax factors to explain (0.946, $t = 16.18$), as reported in Table IV.

Given this bias, we reverse (8) and estimate (9). Shifting V_L to the right side of the equation controls for nontax information from debt, including the size effect that biases estimation of (8). Without controlling for capitalization rates (which are a key component of V_U), however, we continue to expect bias. Consistent with this expectation, the estimated value for the net debt tax shield is negative and significant (-0.483, $t = -5.183$), as reported in Table V.

In Table VI, we report the results from our first attempt to control for capitalization rates. To conduct this test, we partition the overall sample into portfolios based on industries and market-to-book ratios, which are two crucial controls for risk and growth. Specifically, we form two equal portfolios of observations within each industry-year, according to the market-to-book ratio of operations. We then estimate (9) for each portfolio and report summary statistics. Ideally, we would like to measure the market-to-book ratio of operations as $(V_L - \beta D)/NOA$. However, this measure is unobservable because it is a function of the parameter β . Therefore, we use V_L/NOA

Table IV
**Summary Statistics from Cross-sectional Regressions Explaining
the Value of the Firm with Deflated Intercept**

V_L represents the market value of the firm, measured as the market value of common equity plus the book values of debt and preferred stock. TA represents total assets. FOI represents average operating income over the subsequent five years. Operating income is defined as net income plus interest expense times $(1 - \tau_c)$, where τ_c equals the top corporate statutory federal tax rate. D represents debt. The t -statistic is the ratio of the mean cross-sectional coefficient to its standard error. "Positive" is the proportion of cross-sections in which the coefficient is positive.

$$V_L/TA = \alpha_1/TA + \alpha_2FOI/TA + \alpha_3D/TA + \epsilon$$

	α_1	α_2	α_3	R^2	N
Mean	8.018	7.568	0.946	0.714	1,371
t -statistic	5.887	17.07	16.18		
Positive	0.742	1.000	1.000		

to proxy for it. All of the results we report for our portfolio tests are essentially the same when measuring the market-to-book of operations as $(V_L - (0.4 \times D))/NOA$, that is, by assuming β equals 0.4.

Despite the benefits we gain from this approach, there are few observations per regression, so the distribution of estimated regression coefficients has high variance and kurtosis. As discussed earlier, the estimated value for the net debt tax shield (β) equals the estimated D coefficient divided by the estimated V_L coefficient (times -1). The estimated V_L coefficient is close to zero for many portfolios, which creates large outliers and renders interpretation of the mean meaningless.¹⁶ Therefore, we focus on the median.

As reported in Table VI, the median estimate for the net debt tax shield is 0.466 (p -value = 0.001). By way of comparison, the average corporate tax rate during our sample period is 0.45, plus state taxes. Hence, using industries and the market-to-book of operations to control for risk and growth converts the large negative estimate for the net debt tax shield from Table V into a potentially plausible positive coefficient.¹⁷ However, the use of small portfolios and only two proxies for risk and growth to form the estimate suggests the need for caution in interpreting the magnitude of the estimate.

In Table VII, we report results from our second attempt to control for capitalization rates. In this case, we use four proxies for the capitalization rate, and we fix industry effects according to (10). The four proxies are the

¹⁶ Outliers with estimated V_L coefficients close to zero have an overwhelming effect on the mean (27.83) and standard deviation (1,389) of the β estimates, which is why we focus on the median. However, the mean β estimate for the interquartile range of the distribution (0.38) is potentially reasonable.

¹⁷ The industry and market-to-book controls both affect the estimate. If we partition on industries alone, the median estimate for β is essentially zero (-0.004 , $p = 0.776$), which is much higher than the estimate for β from Table V (-0.483) in which we do not impose any control for ρ . Further controlling for ρ by partitioning the sample on market-to-book ratios then increases the median estimate for β the remainder of the way from -0.004 to 0.466.

Table V
Summary Statistics from Cross-sectional Reverse Regressions,
No Control for Capitalization Rates

FOI represents average operating profitability over the subsequent five years. Operating profitability is defined as net income plus interest expense times $(1 - \tau_c)$, where τ_c equals the top corporate statutory federal tax rate. *TA* represents total assets. V_L represents the market value of the firm, measured as the market value of common equity plus the book values of debt and preferred stock. *D* represents debt. β equals $-\alpha_3/\alpha_2$. The *t*-statistic is the ratio of the mean cross-sectional coefficient to its standard error. "Positive" is the proportion of cross sections in which the coefficient is positive.

$$FOI/TA = \alpha_1/TA + \alpha_2 V_L/TA + \alpha_3 D/TA + \epsilon$$

	α_1	α_2	α_3	β	R^2	N
Mean	0.572	0.067	0.026	-0.483	0.676	1,371
<i>t</i> -statistic	5.872	15.51	5.809	-5.183		
Positive	0.871	1.000	0.839	0.161		

unlevered beta of operations, the market-to-book of operations, the log of net operating assets, and the log of operating liabilities. To isolate a subsample of observations with similar capitalization rates, we measure the squared standardized distance of the values for the four proxies for the capitalization rate from their sample means for each observation. Specifically, we calculate $v_i^2 = (m_i - \bar{m})' S^{-1} (m_i - \bar{m})$, where i denotes the i th observation, bar denotes average over all sample firms in that year, m is the 4×1 vector of our proxies for the capitalization rate, and S is the 4×4 sample covariance matrix for the year.¹⁸ v^2 measures the contribution of each observation to the multivariate variation in the four proxies.

While v^2 increases in the deviation of each of the four proxies from its mean, it does not account for the direction and size of the effect of each proxy on the capitalization rate. For example, the deviation of one proxy from its mean could actually offset the deviation of another proxy from its mean, leaving the capitalization rate unchanged. Nevertheless, a low value for v^2 suggests that all four risk and growth proxies for an observation are relatively close to their means. Therefore, the group of observations with the lowest v^2 values should have similar capitalization rates. To exploit this similarity in capitalization rates, we estimate (10) for the quartile of observations with the lowest values for v^2 for each year.

Relative to the portfolio approach, this approach not only allows us to use more proxies for capitalization rates, but it also allows us to focus on relatively large subsamples of observations for each year. Hence, the distribution of annual estimates exhibits much less variance and kurtosis than the

¹⁸ As in the previous test, we use V_L/NOA in place of $(V_L - \beta D)/NOA$ to proxy for the market-to-book of operations. We obtain similar results when measuring the market-to-book of operations as $(V_L - (0.4 \times D))/NOA$, that is, by assuming β equals 0.4.

Table VI
Summary Statistics from OLS Regressions for Portfolios Sorted by Year, Industry, and the Market-to-Book Ratio of Operations

FOI represents average operating profitability over the subsequent five years. Operating profitability is defined as net income plus interest expense times $(1 - \tau_c)$, where τ_c equals the top corporate statutory federal tax rate. *TA* represents total assets. V_L represents the market value of the firm, measured as the market value of common equity plus the book values of debt and preferred stock. *D* represents debt. β equals $-\alpha_3/\alpha_2$. The *p*-value is for the test that the median is zero. "Positive" is the proportion of regressions in which the coefficient is positive. There are 31 years, 44 industries (as identified by Fama and French (1997)), and two portfolios for each industry, sorted according to V_L/NOA . Therefore, the maximum possible number of regressions is 2,728. The actual number of regressions is 2,425.

$$FOI/TA = \alpha_1/TA + \alpha_2 V_L/TA + \alpha_3 D/TA + \epsilon$$

	α_1	α_2	α_3	β	R^2	<i>N</i>
Median	0.327	0.084	-0.031	0.466	0.846	13
<i>p</i> -value	0.001	0.001	0.001	0.001		
Positive	0.586	0.946	0.404	0.635		

distribution of portfolio estimates, which enables us to focus on mean estimates. A drawback of this approach is that we can only use one quartile of observations to generate our estimates of the net debt tax shield. However, the approach does allow us to isolate the effect of gradually dropping our control for capitalization rates. In particular, we also estimate (10) after combining the first two quartiles of observations with the lowest values for v^2 . We then repeat this exercise for the first three quartiles and finally for the full sample. As the sample size increases, our control for capitalization rates decreases. When using the full sample, for example, we drop all of our control for capitalization rates except the fixed industry effects. In this case, the estimated net debt tax shield should be biased downward severely, much like the results reported in Table V.

As reported in Table VII, Panel A, the estimated value of the net debt tax shield for the quartile of observations with the most homogenous capitalization rates is 0.391 ($t = 7.653$). Like the result from the portfolio approach, therefore, the estimated net debt tax shield is positive and highly significant. However, the estimated tax shield using the quartile approach is somewhat lower than the estimate using the portfolio approach and suggests there may be a material offset from the personal tax disadvantage of debt.

Table VII, Panels B, C, and D demonstrate that gradually decreasing the control for capitalization rates decreases estimates of the net debt tax shield, from 0.391 to 0.295 for the two quartiles with the lowest v^2 scores, to 0.196 for the three quartiles with the lowest scores, and to -0.442 for the full sample. Overall, the results from Table VII suggest that inadequate or otherwise noisy controls for the capitalization rate appear to bias estimates of the

Table VII
Summary Statistics from Cross-sectional OLS Regressions
According to Capitalization Rates

FOI represents average operating profitability over the subsequent five years. Operating profitability is defined as net income plus interest expense times $(1 - \tau_c)$, where τ_c equals the top corporate statutory federal tax rate. *TA* represents total assets. *DIND* represents separate dummy variables for each industry. The 44 industries are those identified by Fama and French (1997). V_L represents the market value of the firm, measured as the market value of common equity plus the book values of debt and preferred stock. *D* represents debt. β equals $-\alpha_3/\alpha_2$. The *t*-statistic is the ratio of the mean cross-sectional coefficient to its standard error. "Positive" is the proportion of cross sections in which the coefficient is positive.

$$FOI/TA = \sum_{i=1}^{44} \alpha_{1i} DIND_i/TA + \alpha_2 V_L/TA + \alpha_3 D/TA + \epsilon$$

	α_2	α_3	β	R^2	<i>N</i>
Panel A: 25 Percent of Observations with Smallest Variation in the Capitalization Rate					
Mean	0.099	-0.041	0.391	0.789	342
<i>t</i> -statistic	14.91	-6.859	7.653		
Positive	1.000	0.097	0.903		
Panel B: 50 Percent of Observations with Smallest Variation in the Capitalization Rate					
Mean	0.096	-0.031	0.295	0.753	685
<i>t</i> -statistic	15.90	-5.847	5.955		
Positive	1.000	0.161	0.839		
Panel C: 75 Percent of Observations with Smallest Variation in the Capitalization Rate					
Mean	0.090	-0.020	0.196	0.728	1,028
<i>t</i> -statistic	16.31	-4.748	4.358		
Positive	1.000	0.194	0.806		
Panel D: All Observations					
Mean	0.069	0.023	-0.442	0.709	1,371
<i>t</i> -statistic	15.68	4.961	-4.599		
Positive	1.000	0.774	0.226		

net debt tax shield downward. A key advantage from reversing the regressions is that we can use the market-to-book of operations to help impose this control on our tests.

B. Nonlinear Specification

Rather than estimating (9) or (10) for subsamples of observations to control for capitalization rates, we can estimate (12) for the entire sample. As reported in Table VIII, the estimated value for β when using this approach is 0.414, which is similar to the estimate from the simple linear specification reported in Table VII, Panel A (i.e., both estimates are approximately equal to 40 percent). In terms of total firm value (including operating liabilities),

Table VIII

Summary Statistics from Cross-sectional Nonlinear Regressions

FOI represents average operating income over the subsequent five years. Operating income is defined as net income plus interest expense times $(1 - \tau_c)$, where τ_c equals the top corporate statutory federal tax rate. β_U represents unlevered market beta. V_L represents the market value of the firm, measured as the market value of common equity plus the book values of debt and preferred stock. D represents debt. NOA represents net operating assets, measured as total assets minus operating liabilities, where operating liabilities (OL) are all nondebt liabilities. $DIND$ represents separate dummy variables for each industry. The 44 industries are those identified by Fama and French (1997). The observations are weighted by the reciprocal of the square of total assets (which is consistent with deflation by total assets in a linear specification). The t -statistic is the ratio of the mean cross-sectional coefficient to its standard error. "Positive" is the proportion of cross-sections in which the coefficient is positive.

$$FOI = \left[\alpha_1 + \alpha_2 \beta_U + \alpha_3 \frac{V_L - \beta D}{NOA} + \alpha_4 \log(NOA) + \alpha_5 \log(OL) \right] (V_L - \beta D) \\ + \sum_{i=1}^{44} \gamma_{2i} DIND_i + \gamma_3 \frac{V_L - \beta D}{NOA} + \gamma_4 \log(NOA) + \gamma_5 \log(OL) + v$$

	α_1	α_2	α_3	α_4	α_5	β	γ_3	γ_4	γ_5	N
Mean	0.103	-0.015	-0.006	-0.008	0.011	0.414	0.125	0.836	0.117	1,371
t -statistic	13.10	-3.433	-5.863	-7.413	11.18	10.80	1.754	5.812	1.799	
Positive	1.000	0.290	0.000	0.000	0.968	0.968	0.613	0.774	0.677	

our 40 percent estimate of the net debt tax shield suggests that, on average, the debt tax shield increases total firm value by approximately 10 percent.¹⁹ Similarly, Graham (2000) calculates that the average corporate tax benefits from debt equal approximately 10 percent of total firm value.

The distribution of the estimated debt coefficient is relatively tight and the t -statistic associated with the time series distribution of the coefficient is high ($t = 10.80$).^{20,21} Although the Fama and MacBeth (1973) t -statistics we report are robust to cross-sectional correlation in the residuals, they do not adjust for any potential time-series correlation. Because the cross sections include many common firms, time-series correlation likely exists, which

¹⁹ The mean ratio of the book value of debt to the total market value of the firm (i.e., including operating liabilities) is 0.24. Hence, the mean estimated value of the net debt tax shield relative to total firm value is $0.24 \times 0.4 = 0.096$.

²⁰ To check the sensitivity of the results, we repeat the analysis excluding each of the four proxies for risk and expected growth, one variable at a time. In all cases, the mean estimated value for β remains substantially positive and significant. The lowest estimate for β (0.214, $t = 3.286$) is obtained when dropping the market-to-book of operations, which illustrates the importance of this proxy for risk and growth.

²¹ The fitted values for our capitalization rates range from -0.053 to 0.197 . The mean rate is 0.070 , one-half of the fitted rates are between 0.039 and 0.091 , and less than two percent of the fitted rates are negative.

could inflate our reported t -statistics. Therefore, we calculate alternative t -statistics that account for autocorrelation in the annual slopes.²² As noted by FF, sample autocorrelations are likely to be imprecise when the number of cross sections is relatively small, so it is not clear that the autocorrelation-adjusted t -statistics are any more accurate than the Fama–MacBeth t -statistics. Nevertheless, the autocorrelation-adjusted t -statistic for β also is highly significant ($t = 7.00$).

As outlined by FF, another way to distinguish between the MM and Miller (1977) hypotheses is to incorporate the corporate tax benefits of debt into our measure for operating earnings. Specifically, we replace the dependent variable, FOI , with FOI^* . We use OI to construct FOI^* in the same manner in which we use OI to construct FOI , except we now define OI as $EBIT$ minus reported income taxes. All else equal, reported income taxes decrease in the use of debt, so unlike FOI , FOI^* captures the corporate tax benefits of debt. Hence, FOI^* is analogous to the “ E ” variable in FF, which also is designed to capture the corporate tax benefits of debt. Following the logic in FF, we should no longer expect to capture the value of the debt tax shield in the estimated debt coefficient (β) when using FOI^* . Instead, the debt coefficient should now capture the personal tax disadvantage of debt (if any), with a negative coefficient. It also could capture any future expected nontax costs from debt that our empirical proxies for $E(FOI)$ and ρ fail to capture.

As reported in Table IX, shifting the corporate tax benefits of debt to the dependent variable results in a negative estimated value for β , equal to -0.080 ($t = -1.613$). This negative coefficient provides direct market evidence that investors price at least some personal tax disadvantage for debt,

²² Specifically, the Fama–MacBeth t -statistics are calculated as follows:

$$t\text{-statistic}(coef) = \frac{\text{mean}(coef)}{\sqrt{\frac{1}{31} \text{var}(coef)}},$$

where

$$\text{mean}(coef) = \frac{1}{31} \sum_{i=63}^{93} coef_i$$

and

$$\text{var}(coef) = \frac{1}{30} \sum_{j=63}^{93} [coef_j - \text{mean}(coef)]^2.$$

The adjusted t -statistics are calculated as:

$$\text{adjusted } t\text{-statistic}(coef) = \frac{\text{mean}(coef)}{\sqrt{\frac{1}{31^2} \sum_{i=63}^{93} \sum_{j=63}^{93} \rho^{|i-j|} \text{var}(coef)}},$$

where ρ is the correlation between $coef_t$ and $coef_{t-1}$ calculated using the $t = 64, 65, \dots, 93$ coefficients.

Table IX
Summary Statistics from Cross-sectional Nonlinear Regressions
Where FOI^* Incorporates the Corporate Tax Benefit of Debt

FOI^* represents average operating income over the subsequent five years. Operating income is defined as net income plus interest expense, as opposed to net income plus interest times $(1 - \tau_c)$ as in Table VIII. β_U represents unlevered market beta. V_L represents the market value of the firm, measured as the market value of common equity plus the book values of debt and preferred stock. D represents debt. NOA represents net operating assets, calculated as total assets minus operating liabilities, where operating liabilities (OL) are all nondebt liabilities. $DIND$ represents separate dummy variables for each industry. The 44 industries are those identified by Fama and French (1997). The observations are weighted by the reciprocal of the square of total assets (which is consistent with deflation by total assets in a linear specification). The t -statistic is the ratio of the mean cross-sectional coefficient to its standard error. "Positive" is the proportion of cross-sections in which the coefficient is positive.

$$FOI^* = \left[\alpha_1 + \alpha_2 \beta_U + \alpha_3 \frac{V_L - \beta D}{NOA} + \alpha_4 \log(NOA) + \alpha_5 \log(OL) \right] (V_L - \beta D) \\ + \sum_{i=1}^{44} \gamma_{2i} DIND_i + \gamma_3 \frac{V_L - \beta D}{NOA} + \gamma_4 \log(NOA) + \gamma_5 \log(OL) + v$$

	α_1	α_2	α_3	α_4	α_5	β	γ_3	γ_4	γ_5	N
Mean	0.107	-0.012	-0.006	-0.009	0.012	-0.080	0.125	0.955	0.101	1,371
t -statistic	14.34	-2.679	-6.088	-8.303	11.44	-1.613	1.830	6.594	1.354	
Positive	1.000	0.323	0.000	0.065	0.968	0.387	0.613	0.806	0.677	

although the effect is small and only marginally significant. In addition, nondebt tax shields could contribute to the estimate, as could any expected financial distress costs from debt that we do not capture effectively with our proxies for $E(FOI)$ and ρ .

IV. Robustness Tests

Although the estimates in Tables VI–IX generally support the MM tax hypothesis, we remain concerned that measurement error in some of our empirical proxies could be correlated with debt. Therefore, we conduct the following three sets of robustness tests. To do so, we generally focus on (12), which allows us to use the full sample of observations without partitioning.

A. Variation in Tax Rates

One way to examine our tax interpretation for the primary results, and to examine the personal tax disadvantage of debt directly, is to exploit cross-period variation in statutory tax rates. Specifically, we examine the hypothesis that the value of the net debt tax shield increases in the corporate tax rate, but decreases in the personal tax rate. We use the top statutory cor-

Table X
Analysis of the Debt Valuation Coefficient

β represents the year-specific coefficient on debt from the cross-sectional analysis estimated with *FOI* as the dependent variable. τ_c equals the top federal statutory corporate tax rate. τ_p equals the top federal statutory personal tax rate. *Trend* equals year minus 1962.

$$\beta = \alpha_1 + \alpha_2\tau_c + \alpha_3\tau_p + \alpha_4Trend + \epsilon$$

	α_1	α_2	α_3	α_4	R^2	N
Estimated coefficient	-0.320	2.863	-0.942		0.106	31
<i>t</i> -statistic	-0.720	1.806	-1.746			
Estimated coefficient	-0.172	2.761	-1.039	-0.003	0.109	31
<i>t</i> -statistic	-0.257	1.675	-1.629	-0.297		

porate tax rate (τ_c) as a proxy for the corporate tax rate, and we use the top statutory personal tax rate (τ_p) as a proxy for the personal tax rate on interest income.²³

To examine the relation between the estimated net debt tax shield and tax rates, we regress the estimated debt coefficients (β) from the annual cross sections on τ_c and τ_p . Statutory corporate tax rates generally trend down during our sample period, so we repeat the regressions using *Trend* as a control variable (where *Trend* equals year minus 1962). Specifically, we estimate:

$$\beta = \alpha_1 + \alpha_2\tau_c + \alpha_3\tau_p + \alpha_4Trend + \epsilon. \quad (13)$$

As reported in Table X, the estimated coefficient for the corporate tax rate (personal tax rate) is positive (negative) and marginally significant in both specifications. On the other hand, the estimated coefficient for *Trend* is insignificant, and including *Trend* does not influence inferences regarding α_2 or α_3 . In untabulated results, we also find that estimated values for α_2 and α_3 remain essentially unchanged when we include controls for interest rates and for the rate of change in the industrial production index.

The positive coefficient for the corporate tax rate helps confirm our tax interpretation for the debt coefficient in Table VIII. The negative coefficient for the personal tax rate is especially instructive, because it provides further market evidence that the value of the net debt tax shield is a function of personal taxes. Like the results in Table IX, the evidence in Table X is consistent with a “weak” form of the hypothesis in Miller (1977) that personal taxes offset at least some portion of the corporate tax benefits of debt.

²³ The top statutory corporate tax rate has been detailed previously. The top statutory personal tax rate we use is 91 percent in 1963, 77 percent in 1964, 70 percent from 1965 to 1981, 50 percent from 1982 to 1986, 38.5 percent in 1987, 28 percent from 1988 to 1990, 31 percent from 1991 to 1992, and 39.6 percent in 1993.

To further examine variation in the estimated value of the net debt tax shield over time, we calculate the average estimated tax shield for six different five- (or six-) year periods within our overall sample period. Except for the period from 1969 to 1973, which included the effects of the unexpected oil crisis and resulting recession, we find that the average estimated value for the net debt tax shield is reasonably close to the mean statutory corporate tax rate ($\bar{\tau}$) for each period. Specifically, the average estimate for β is 0.50 for the years 1963 to 1968 ($\bar{\tau} = 49.8$), 0.20 for the years 1969 to 1973 ($\bar{\tau} = 49.2$), 0.46 for the years 1974 to 1978 ($\bar{\tau} = 48.0$), 0.43 for the years 1979 to 1983 ($\bar{\tau} = 46.0$), 0.52 for the years 1984 to 1988 ($\bar{\tau} = 42.4$), and 0.34 for the years 1989 to 1993 ($\bar{\tau} = 34.2$).

The low estimate (0.20) for the value of the net debt tax shield during the 1969 to 1973 period suggests that at least some forms of measurement error still affect our estimates. It may not be surprising that this error is especially relevant during the 1969 to 1973 period. The macroeconomic shock in 1974 that affected our measure of *FOI* for the 1969 to 1973 period (*FOI* is measured as average after-tax operating income in the subsequent five years) was largely unexpected, so *FOI* likely measures *ex ante* expectations for these years with substantial error. Furthermore, this error might very well be correlated with debt, because the shock likely affected low-debt growth firms systematically differently from the way it affected more stable, high-debt firms. Therefore, it is quite likely that we estimate β with material bias during this period.

All else being equal, the value of the net debt tax shield should increase in firm-specific corporate tax rates. To exploit cross-sectional variation in corporate tax rates, we use estimated predebt firm-level marginal tax rates from Graham (as first used by Graham, Lemmon, and Schallheim (1998)) to divide each cross-sectional sample into low-tax and high-tax groups of observations according to the sample median tax rate. We then create a dummy variable for each group, $DMTR_1$ for low-tax observations and $DMTR_2$ for high-tax observations, and we interact these dummy variables with the intercept, the capitalization rate, and debt.²⁴ The firm-level tax rates are available for 14 of our sample years (1980 through 1993), and the time-series average of the cross-sectional mean tax rates over the 14 years is 0.328 for the low-tax observations and 0.404 for the high-tax observations. As reported in Table XI, the estimated mean value for the net debt tax shield is 0.236 ($t = 2.055$) for the low-tax observations and 0.399 ($t = 7.911$) for the high-tax observations, which is consistent with our tax interpretation for the primary findings.

The portfolio approach from Section III provides a second way to exploit variation in firm-specific tax rates. Specifically, we assign the estimate of the debt tax shield from each portfolio to each firm-year observation within

²⁴ The estimated marginal tax rate is equal to the top statutory tax rate for approximately three-fourths of our sample observations ($DMTR_2 = 1$) and is equal to a lower rate for one-fourth of the observations ($DMTR_1 = 1$). The use of dummy variables helps mitigate the effect of any measurement error in the firm level tax rates.

Table XI
Summary Statistics from Cross-sectional Nonlinear Regressions
Allowing for Different Debt Coefficients Depending
on Firm-Level Tax Rates

FOI represents average operating income over the subsequent five years. Operating income is defined as net income plus interest expense times $(1 - \tau_c)$, where τ_c equals the top corporate statutory federal tax rate. $DMTR_1$ is a dummy variable that equals one for low-tax observations and zero otherwise. $DMTR_2$ is a dummy variable that equals one for high-tax observations and zero otherwise. An observation is defined as high tax (low tax) if the estimated marginal pre-debt tax rate for the firm is greater than or equal to (less than) the sample median tax rate. β_U represents unlevered market beta. V_L represents the market value of the firm, measured as the market value of common equity plus the book values of debt and preferred stock. D represents debt. NOA represents net operating assets, measured as total assets minus operating liabilities, where operating liabilities (OL) are all nondebt liabilities. $DIND$ represents separate dummy variables for each industry. The 44 industries are those identified by Fama and French (1997). The observations are weighted by the reciprocal of the square of total assets (which is consistent with deflation by total assets in a linear specification). The t -statistic is the ratio of the mean cross-sectional coefficient to its standard error. "Positive" is the proportion of cross sections in which the coefficient is positive.

$$FOI = \left[\sum_{i=1}^2 \alpha_{1i} DMTR_i + \alpha_2 \beta_U + \alpha_3 \frac{V_L - \sum_{i=1}^2 \beta_i DMTR_i D}{NOA} + \alpha_4 \log(NOA) + \alpha_5 \log(OL) \right] \\ \times \left(V_L - \sum_{i=1}^2 \beta_i DMTR_i D \right) + \sum_{i=1}^2 \gamma_{1i} DMTR_i + \sum_{i=1}^{44} \gamma_{2i} DIND_i \\ + \gamma_3 \frac{V_L - \sum_{i=1}^2 \beta_i DMTR_i D}{NOA} + \gamma_4 \log(NOA) + \gamma_5 \log(OL) + v$$

	α_{11}	α_{12}	α_2	α_3	α_4	α_5	β_1	β_2	γ_3	γ_4	γ_5	N
Mean	0.063	0.094	-0.020	-0.004	-0.006	0.010	0.236	0.399	0.231	0.656	0.207	1,200
t -statistic	7.561	12.44	-2.285	-10.04	-4.373	10.88	2.055	7.911	1.547	2.558	2.011	
Positive	1.000	1.000	0.357	0.000	0.214	1.000	0.786	1.000	0.571	0.714	0.643	

the portfolio. Using the predebt firm-level marginal tax rates, we then partition the sample of firm-year observations into low-tax and high-tax subsamples based on the median tax rate. If our estimates of the net debt tax shield do, indeed, reflect taxes, then we expect the estimates to be greater for the high-tax observations than for the low-tax observations. Consistent with this expectation, the median estimate of the net debt tax shield for the low-tax group is 0.28 (the median tax rate is 0.34), and the median estimate of the net debt tax shield for the high-tax group is 0.46 (the median tax rate is 0.46). The difference between the two median estimates of the net debt tax shield is highly significant, as is the difference between the two median tax rates.

The analysis in Green and Hollifield (2001) provides a final way to exploit variation in both personal and corporate tax rates. In particular, Green and Hollifield estimate that the present value of the tax rate on share repurchases is equal to roughly 60 percent of the statutory tax rate on long-term capital gains. Within their model, firms distribute all positive cash flows to shareholders each period through either dividends or share repurchases, so the tax rate on equity flows (τ_e) is equal to $[(1 - s) \times \tau_p] + [s \times 0.6 \times \tau_g]$, where s ($(1 - s)$) is the proportion of distributions to shareholders in the form of share repurchases (dividends) and τ_g is the tax rate on capital gains. We measure s as the moving average ratio of share repurchases (Compustat data item #115) to total distributions (share repurchases plus common dividends (item #21)) for the current year and the prior two years.²⁵ We measure τ_g as the federal statutory tax rate on long-term capital gains. We then use these measures to estimate the tax rate on equity flows (τ_e) for each firm-year observation and plug the estimate for τ_e and our measures for τ_c and τ_p into Miller's (1977) formula for the gain from leverage, which is $1 - [((1 - \tau_c) \times (1 - \tau_e))/(1 - \tau_p)]$. This yields a rather rough estimate of the gain from leverage for each firm-year observation.

Of the 42,505 observations in our sample, the required dividend and share repurchase data is available for 20,377 observations, all in the period from 1973 to 1993. We calculate that the mean estimated gain from leverage for the observations in this subsample is 0.36. To compare this mean with our market estimates of the debt tax shield, we estimate (12) for the subsample of 20,377 observations. We then assign the estimated debt coefficient from each annual cross section to all the observations in each section and find that our mean estimated debt coefficient for the entire subsample is 0.31, which is reasonably close to the mean estimated gain from leverage of 0.36. Moreover, the Pearson correlation between the two estimates is positive (0.077) and highly significant.

B. Analyst Earnings Forecasts

In (12), we use five years of ex post realizations of after-tax *EBIT* to proxy for ex ante expectations. As previously discussed, unexpected economic shocks could cause realized earnings to deviate from expectations, which introduces measurement error into *FOI*. In addition, requiring five years of future information to measure *FOI* could result in survivorship bias. In this section, we purge these potential sources of error and bias from our tests by constructing a direct measure of expected after-tax *EBIT* from I/B/E/S analyst forecast data.

²⁵ In Green and Hollifield (2001), firms do not retain cash flows, but distribute cash flows as share repurchases or dividends. To be consistent, therefore, we focus on the ratio of share repurchases to total distributions, which excludes retentions from the denominator. This measure for s can be viewed as a very rough proxy for the expected amount of total cash flows a firm eventually will pay out as share repurchases versus dividends.

Although using forecast data eliminates the measurement error and survivorship bias that arises from using ex post realizations, it introduces other potential errors into our estimates—for example, analysts forecast net earnings, not *EBIT*. As a result, we must add back some assumed amount of interest expense to convert the forecasts from net earnings to *EBIT*. Furthermore, prior research documents that analyst forecasts measure expectations with bias (for a review, see Kothari (2001)). In addition to these two sources of error, forecast data are not generally available for more than two-thirds of our sample period. Despite these errors and limitations, however, we use the analyst forecasts to cross check the results from Table VIII.

We measure consensus (mean) analyst forecasts of future earnings in the fifth month of the subsequent fiscal year, to ensure that all of the information used to construct our independent variables is fully available to the analysts. For most companies, explicit earnings forecasts are only available for the current year and for the subsequent fiscal year. For years with no explicit forecast (up to five years ahead), we generate forecasts by applying the mean long-term growth forecast (g) to the mean forecast for the prior year in the horizon. That is, we let $EPS_{t+s} = EPS_{t+s-1}(1 + g)$. We multiply the per share forecasts by the number of shares outstanding to convert them into totals. Next, we convert the earnings forecasts into forecasts of after-tax *EBIT* by assuming the current level of interest expense remains constant during the forecast period. Finally, we calculate FOI^E as average expected operating income for the subsequent five years.

Using FOI^E as the dependent variable, we then estimate (12) for all sample years in which forecasts (and I/B/E/S number of shares outstanding) are generally available, which is the period from 1984 to 1993. As we report in Table XII, the estimated value of the net debt tax shield is positive and highly significant. Specifically, the mean estimate is 0.322. By way of comparison, the mean statutory federal corporate tax rate during this period of 0.383. This finding provides comfort that our primary results are not driven by the use of realized earnings as a proxy for expected earnings.

C. Interest Expense

As a final test, we follow FF by using interest expense to estimate the value of the net debt tax shield, which helps us assess the effects of any potential measurement error in *D*. Specifically, we estimate:

$$FOI = \left[\alpha_1 + \alpha_2 \beta_U + \alpha_3 \frac{V_L - \beta I}{NOA} + \alpha_4 \log(NOA) + \alpha_5 \log(OL) \right] (V_L - \beta I) + \sum_{i=1}^{44} \gamma_{2i} DIND_i + \gamma_3 \frac{V_L - \beta I}{NOA} + \gamma_4 \log(NOA) + \gamma_5 \log(OL) + v, \quad (14)$$

Table XII
Summary Statistics from Cross-sectional Nonlinear Regressions
Using Analysts' Earnings Forecasts in Measuring *FOI*

FOI^E represents average expected operating income for the subsequent five years. Expected operating income is defined as expected earnings plus the current level of interest expense times $(1 - \tau_c)$, where τ_c equals the top corporate statutory federal tax rate. β_U represents unlevered market beta. V_L represents the market value of the firm, measured as the market value of common equity plus the book values of debt and preferred stock. D represents debt. NOA represents net operating assets, calculated as total assets minus operating liabilities, where operating liabilities (OL) are all nondebt liabilities. $DIND$ represents separate dummy variables for each industry. The 44 industries are those identified by Fama and French (1997). The observations are weighted by the reciprocal of the square of total assets (which is consistent with deflation by total assets in a linear specification). The t -statistic is the ratio of the mean cross-sectional coefficient to its standard error. "Positive" is the proportion of cross sections in which the coefficient is positive.

$$FOI^E = \left[\alpha_1 + \alpha_2 \beta_U + \alpha_3 \frac{V_L - \beta D}{NOA} + \alpha_4 \log(NOA) + \alpha_5 \log(OL) \right] (V_L - \beta D) \\ + \sum_{i=1}^{44} \gamma_{2i} DIND_i + \gamma_3 \frac{V_L - \beta D}{NOA} + \gamma_4 \log(NOA) + \gamma_5 \log(OL) + v$$

	α_1	α_2	α_3	α_4	α_5	β	γ_3	γ_4	γ_5	N
Mean	0.079	0.009	-0.004	-0.006	0.008	0.322	0.759	1.794	0.095	1,116
t -statistic	14.30	2.160	-11.19	-4.184	7.216	5.400	3.222	5.074	0.498	
Positive	1.000	0.800	0.000	0.100	1.000	1.000	0.900	0.900	0.500	

where I is interest expense (Compustat data item #15). In this specification, the estimated value for β should equal the value of the net debt tax shield divided by the interest rate. As reported in Table XIII, the estimated value for β is 3.567 ($t = 8.095$), which provides comfort that measurement error in D does not drive our primary results.

V. Conclusion

In this study, we use cross-sectional regressions to estimate the value of the debt tax shield, net of the personal tax disadvantage of debt. Recognizing that debt is likely correlated with the value of operations along nontax dimensions, we use reverse regressions to mitigate the effects of this correlation. After doing so, we find firm value is a positive, strong function of debt. In addition, we find the estimated value of the net debt tax shield is positively related to time-series variation in statutory corporate tax rates, and it is positively related to cross-sectional variation in estimated firm-level marginal tax rates. Furthermore, results are robust to the use of analyst forecasts to construct our proxy for future operating earnings, and the results are robust to the use of interest expense to measure debt.

Table XIII
Summary Statistics from Cross-sectional Nonlinear Regressions
with Interest Expense

FOI represents average operating income over the subsequent five years. Operating income is defined as net income plus interest expense times $(1 - \tau_c)$, where τ_c equals the top corporate statutory federal tax rate. β_U represents unlevered market beta. V_L represents the market value of the firm, measured as the market value of common equity plus the book values of debt and preferred stock. I represents interest expense. *NOA* represents net operating assets, measured as total assets minus operating liabilities, where operating liabilities (*OL*) are all non-debt liabilities. *DIND* represents separate dummy variables for each industry. The 44 industries are those identified by Fama and French (1997). The observations are weighted by the reciprocal of the square of total assets (which is consistent with deflation by total assets in a linear specification). The *t*-statistic is the ratio of the mean cross-sectional coefficient to its standard error. "Positive" is the proportion of cross sections in which the coefficient is positive.

$$FOI = \left[\alpha_1 + \alpha_2 \beta_U + \alpha_3 \frac{V_L - \beta I}{NOA} + \alpha_4 \log(NOA) + \alpha_5 \log(OL) \right] (V_L - \beta I) \\ + \sum_{i=1}^{44} \gamma_{2i} DIND_i + \gamma_3 \frac{V_L - \beta I}{NOA} + \gamma_4 \log(NOA) + \gamma_5 \log(OL) + v$$

	α_1	α_2	α_3	α_4	α_5	β	γ_3	γ_4	γ_5	<i>N</i>
Mean	0.101	-0.010	-0.005	-0.010	0.012	3.567	0.085	0.756	0.101	1,371
<i>t</i> -statistic	13.77	-2.354	-6.050	-8.249	12.257	8.095	1.161	5.074	1.517	
Positive	1.000	0.290	0.000	0.032	1.000	0.968	0.645	0.774	0.677	

Our estimated values for the net debt tax shield are substantial, equal to approximately 40 percent of debt balances. In comparison, the average corporate tax rate for our sample period is 45 percent, plus state taxes. Hence, the evidence suggests corporations capture the bulk of the corporate tax benefits of debt, and consistent with the analysis in Green and Hollifield (2001), the personal tax disadvantage of debt is much smaller than envisioned by Miller (1977). The relatively small personal tax differential between debt and equity could suggest the tax rate on equity is higher than commonly assumed, or it could simply suggest that the marginal investors in both the debt and equity markets are largely tax exempt. Finding new ways to estimate personal tax effects directly is, we believe, a high research priority.

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