Chapter I

Introduction

The cost of capital is perhaps the most fundamental and widely used concept in financial economics. Business managers and regulators routinely employ estimates of the firm's weighted average cost of capital ($WACC$) and the marginal tax rate (MTR) for investment decisions, rate regulation, restructuring activities, and bankruptcy valuation.[1] In economics, the cost of capital and the MTR are central to the research on tax policy, regulation, and welfare analysis.[2]

[1] The MTR is the expected effective tax rate on an incremental dollar of taxable income arising from debt financing, holding investment fixed, and is the sum of the products of the tax rates (tax payment divided by taxable income) in each state of nature multiplied by the relevant state probability. Fullerton (1984) provides a taxonomy of various definitions of the effective tax rate in economics. Also see Graham (1996b) and Graham and Lemmon (1998).

[2] Lau (2000, p. 3) notes that the cost of capital "is now a standard variable in the analysis of macroeconomics and of investment behavior at the firm, industry and economy-wide levels. It has also become a standard tool for the assessment of economic impacts of changes in tax policy. The concepts of the 'cost of capital' and its associated measure of a 'marginal tax rate' have generated a voluminous literature in the economics of taxation... The 'cost of capital' has been incorporated into both conventional macroeconomic models and intertemporal general equilibrium models of the impacts of tax policy."

A majority of firms use a single company-wide *WACC* for analyzing investments (Bierman, 1993; Graham and Harvey, 2001), and several private companies (e.g., Ibbotson Associates, Brattle Group) generate *WACC* and *MTR* estimates for external use. This book develops a theory of the firm's *WACC* and its *MTR* with risky debt and potentially redundant debt and non-debt tax shields.

The *WACC* and the *MTR* are endogenous to the firm's debt policy. The borrowing interest rate (coupon rate, r), the risks of the non-debt (depreciation) and debt (interest) tax shields, the *WACC,* and the *MTR* are intertwined, and they must be determined together. Increasing debt increases interest payments, not just because the firm is borrowing more, but also because creditors will require that each debt dollar pay a higher r, due to increased default risk. At the same time, increasing debt also increases the probability that some tax shields will be unusable (DeAngelo and Masulis, 1980; Mackie-Mason, 1990). The tax shields' risks and values depend on interactions between the debt and non-debt deductions (Zechner and Swoboda, 1986).[3] Thus a circularity arises—as debt increases and r changes, the tax shields and firm (debt plus equity) value change. This alters r, which, in turn, may change the tax shields' magnitudes and risks. Thus, even with a fixed statutory corporate tax rate, the *MTR* may be reduced. Since r reflects the tax shields' value, it influences and is, in turn, influenced by the *MTR.*

Prior research has noted, but not modeled, these interactions. This is because the related theory has developed along two broad research strands, each employing a different research strategy. First, capital structure research uses state-pricing to examine the combined value of the debt and equity. Second, cost of capital theory assumes riskless

[3] Bulow and Summers (1984) criticize the treatment of depreciation in the extant research, pointing out that it is important to recognize the stochastic nature of tax depreciation. They do not, however, explore the link between the risk of the deprecation tax shields and firm value, nor interdependencies between the depreciation and interest deductions.

debt (e.g., Hite, 1977) and uses capital asset pricing model ($CAPM$) pricing (default results in "kinked" equity payoffs, and this violates the $CAPM$'s assumptions).[4]

This research employs two innovations. First, we assume that priced risk is the standardized covariance of returns with an exogenous factor generating economy-wide shocks and that a single-factor version of the approximate arbitrage pricing theory (APT) holds (a later chapter elaborates). Second, to capture interdependencies between the tax shields' risks and the MTR, we determine r endogenously. Following the tradition in the cost of capital theory, we do not model bankruptcy costs. The model parameters can be estimated from historical data, and the theory thus implemented.

This research strategy provides better cost of capital estimates. We compare our results to standard textbook and industry cost of capital formulations that are derived from the riskless debt assumption. Our model also identifies the correct discount rate for valuing the tax shields and yields implications for estimation of firms' MTR. Collectively, our related $WACC$ and MTR findings have potentially important implications for low- and high-debt firms.

We also derive the firm's debt capacity—the maximum that the firm can borrow irrespective of the interest rate that it is willing to offer. Evidence indicates that acquiring external funds is not always easy (Graham and Harvey, 2001), and our model provides managers insights into the determinants of debt capacity. We find that debt capacity depends on characteristics of the firm's investment and on exogenous economic variables. An implication is that managers, to the extent that they can alter characteristics of their assets, can alter their debt capacity.

[4] The options approach (e.g., Galai and Masulis, 1976) admits kinked payoffs, but taxes pose technical problems. The difficulties associated with admitting interest tax shields in the options theory are discussed in, for example, Long (1974), Majd and Myers (1985), and Scholes and Wolfson (1992). These challenges are compounded with depreciation tax shields and, to simplify, continuous time models typically assume zero coupon debt and abstract from depreciation (e.g., Brennan and Schwartz, 1978; Ross, 1987; Leland, 1994).

The result that the firm maximizes borrowing with riskless debt and tax benefits (and no bankruptcy costs) is the classic result of Modigliani and Miller (MM, 1963). We examine how this result changes with risky debt and risky tax shields. As it turns out, and somewhat surprisingly, we find that the firm will still optimally maximize debt; the MM all-debt result is preserved.

Finally, our methodology allows us to value the government's (tax) claim across alternative debt levels. We specify numerically how policy variables (tax rate, tax rules, and the riskless rate) affect the market values of both the private (debt and equity) and public (tax) claims, thus providing a potentially useful conceptual framework for tax and interest policy debates.[5]

The book has eight chapters. Chapter II describes our accounting, tax, and pricing assumptions. Chapter III describes our distributional assumptions, initially a joint binomial assumption ($2 \times 2 = 4$ states) that yields analytical expressions for the risks and the costs of capital. The firm's realized cash flows are two firm-states, and the return on the factor generating economy-wide shocks takes on two macro-states. We consider all possible tax and default/solvency states in this single-period four-state economy and identify the risks of the tax shields and of the firm. Chapter IV presents a four-step solution procedure that yields the cost of capital. Chapter V discusses results of the binomial model and provides the intuition for our findings. It also derives the firm's debt capacity. Chapter VI generalizes the model to $s \times s$ states. Chapter VII contains numerical illustrations. The final chapter closes. Appendix A addresses technical issues. Given the exogenous policy variables, Appendix B illustrates the effect of each marginal debt dollar on the firm's economic balance sheet, its $WACC$, and the MTR.

[5] As is well known, current theory does not lend itself to such numerical specification. Copeland (2002) argues that for corporate finance theory to be useful to managers, it is important to be able to illustrate the theory with a complete numerical example.