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TAXATION, CORPORATE FINANCIAL POLICY AND THE COST OF CAPITAL

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Abstract

The cost of capital plays an important role in the allocation of resources among competing uses in a decentralized market system. The purpose of this paper is to organize and present what is known and what is hypothesized about the effects of taxation on the incentive to invest, via the cost of capital, taking full account of important issues that arise independently from the question of taxation. Included in the analysis is a discussion of empirical findings about the interaction of inflation and taxation in influencing the incentive to invest, and a treatment of taxation and uncertainty.

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I. Introduction

The cost of capital plays an important role in the allocation of resources among competing uses in the context of a decentralized market system. Most simply, it is the price paid for the use of capital resources over a defined period of time. However, even in the presence of a functioning capital market with a well-defined rate of interest, determination of the cost of capital is complicated by a number of factors.

Because investment projects are normally long-lived and irreversible, an instantaneous opportunity cost does not suffice for evaluating such undertakings. Likewise, risk is a major factor in the investment decision, inducing a dependence of the cost of capital on the risk characteristics of the associated investment. The nature of this relation depends, in part, on the extent to which markets exist for the trading of risks. The common institutional structure in which investment decisions are made by individuals distinct from those to whom investment earnings accrue also complicates matters, as does the use of several different types of securities to obtain funds for investment.

Each of these questions has provoked much thought and research. Though this paper's main subject is the effect of taxation on the cost of capital, our analysis cannot logically be separated from these other issues. Indeed, it is the richness of the problem of determining the cost of capital in the <u>absence</u> of any taxation that contributes to the complexity of the present problem. For example, the existence of corporations as intermediaries in the investment decision is important not only because of the question of management incentives vis a vis stockholders, but also because tax systems commonly tax such corporations as independent entities. Much of the complexity in the analysis of the impact of taxes on the cost of capital may be traced to this fact.

The purpose of this paper, then, is to organize and present what is known and what is hypothesized about the effects of taxation on the incentive to invest, via the cost of capital, taking full account of the issues that arise independently from the question of taxation. This approach makes for less certain conclusions, but perhaps appropriately so. There are many problems in this area awaiting satisfactory resolution.

Our analysis begins in Section II with a presentation of the basic model of multiperiod consumer optimization that gives rise to the notion of a cost of capital. Even in the simplest two-period framework, issues arise that may lead to ambiguity in the definition of capital cost, and are instructive about the results of more complex models. Section III introduces taxation in its simplest form, an income tax. The discussion of an income tax presupposes a definition of income. Central to any such definition for capital income is the notion of depreciation, which we develop in this section. With this concept, it is then possible to define a shadow price or <u>user</u> cost of capital (Jorgenson, 1963) which accounts not only for the cost of capital as defined above, but also for the costs of asset depreciation and taxation. Having defined the user cost in Section IV, we then are prepared for a preliminary examination of the effects of the taxation on firm behavior.

In Section V, we present a more realistic treatment of taxation, considering the interaction of corporate and individual taxes, and the special role of inflation in distorting the measurement of income. This area is a particularly controversial one, and we review some of the empirical work to date.

In Section VI, we introduce uncertainty, beginning with the Modigliani-Miller theorem (1958). There follows a development of the Arrow-Debreu concept of state contingent commodities and prices and the simpler Capital Asset Pricing Model (Sharpe, 1964; Lintner, 1965) as vehicles for deriving discount rates for risky projects in the absence of taxation. We also discuss related issues that will become important in analyzing the effects of taxation, notably the effects of incomplete markets and the problem of managerial incentives.

In Section VII, we integrate the results of Section V and VI to consider the impact of taxes on the cost of capital in the presence of uncertainty, including a discussion of the effects of bankruptcy and tax law asymmetries with respect to gains and losses. This is the most general of approaches, and it provides some (though perhaps not yet enough) help in explaining some of the confounding aspects of corporate financial policy, particularly the observed patterns of dividends and borrowing. Our analysis also includes a normative discussion of the welfare effects of tax-induced changes in the cost of capital in the presence of uncertainty.

II. The Cost of Capital

In a one-good, two-period certainty model without taxes, competitive price-taking firms maximize the welfare of their owners by accepting all investment projects (which defer output by a period) that earn a rate of return of at least the one-period interest rate. Since the interest rate is the rate at which individuals can convert purchases back and forth between the periods, any project that earns more than the interest rate, r, expands the owner's budget set.

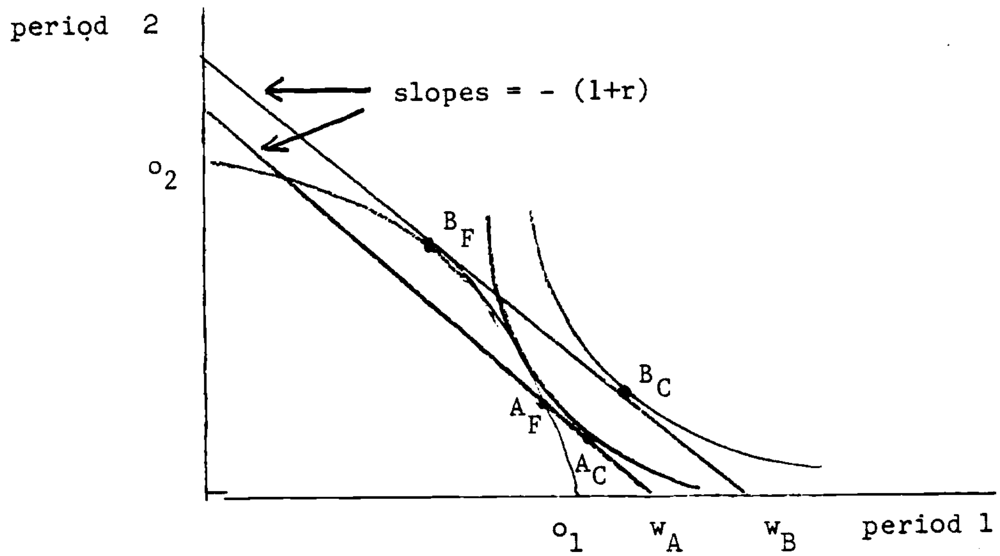
With a continuum of available projects, a firm's marginal rate of return will equal the cost of capital. This is depicted in Figure 2.1. The firm maximizes the wealth of its representative shareholder by moving up its two-period production possibilities frontier from point o_1 (no investment) until the marginal rate of transformation of period 2 output for period 1 output is exactly $(1 + r)$, at point B. Stopping at point A would yield a lower wealth, w_A, versus w_B. The corresponding consumption choices shown, A_C and B_C, indicate a trading back of some of the period 2 output to consume more in period 1. This is accomplished by borrowing at the market interest rate, r, and using part of the second period income to repay the loan.

This result, that production and consumption decisions should be made independently, is commonly called the Fisher (1930) Separation Theorem, although it is simply a variant of the general role of the market price vector as the signal to both firm and household that produces a Pareto-Optimum in competitive equilibrium (Arrow, 1951; Debreu, 1952). In fact, we may think of the relative price of period 2 consumption as $P_2 = \frac{1}{1 + r}$ and neglect the fact that the goods are consumed at different times.

Here, the cost of capital equals the marginal rate of return. If projects were discrete, the last acceptable project might yield a return greater than r.

Figure 2.1

Welfare Maximization and the Cost of Capital



In a model extended to several periods, multi-period projects would have to be evaluated using the interest rates from all relevant periods. The correct procedure (Hirshleifer, 1970) is to calculate the present value of each project:

$$(2.1) \qquad PV = \frac{Y_1}{1 + r_1} + \frac{Y_2}{(1 + r_1)(1 + r_2)} + \cdot \cdot \cdot + \frac{Y_T}{\prod_{j=1}^{T} (1 + r_j)}$$

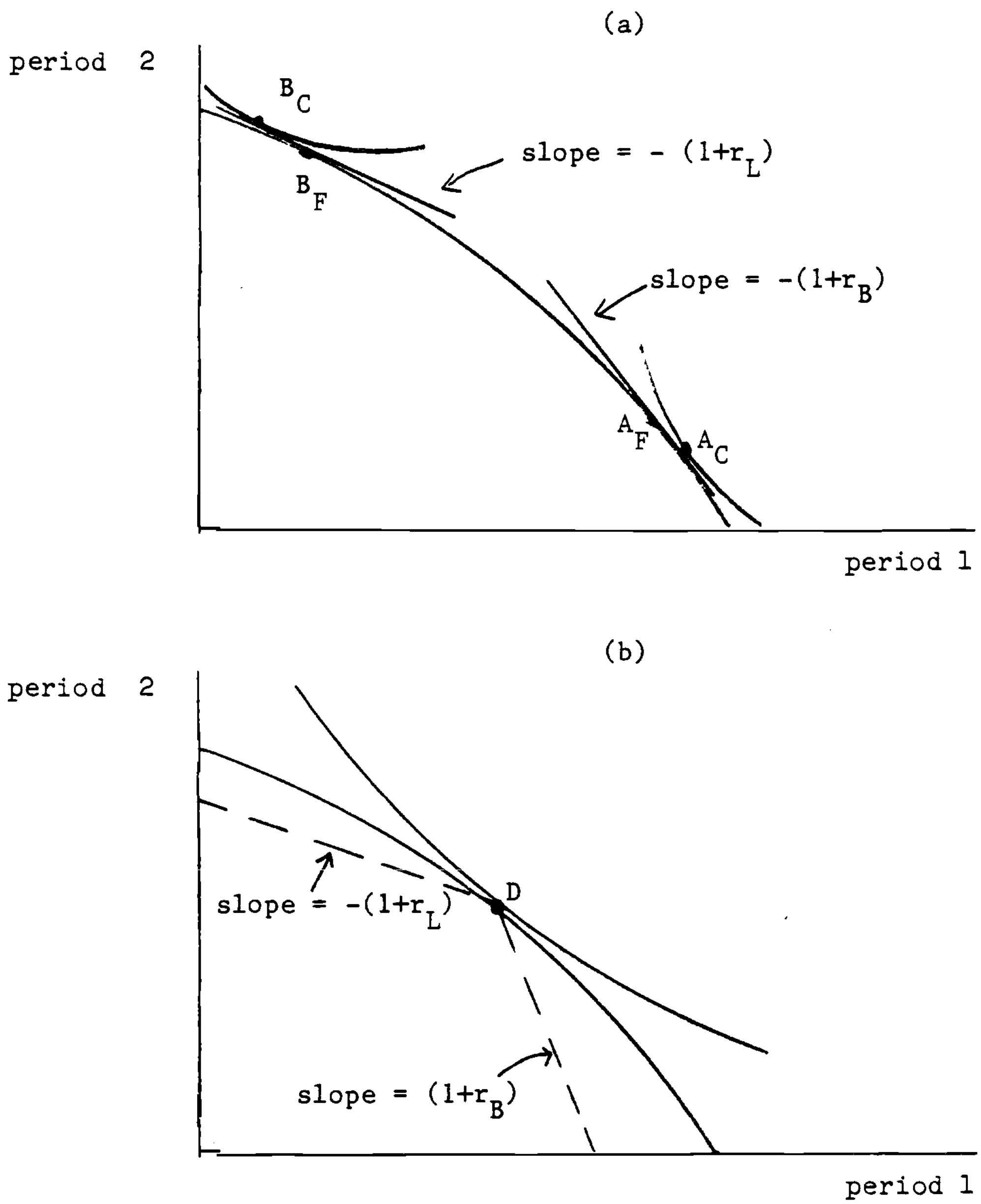
where Y_j is the project flow in period j, and r_j the interest rate in period j, and accept those projects for which the present value is positive. This is clearly the appropriate way for a competitive firm to behave.

Such results break down in the face of various alternatives in assumptions. For example, it is frequently assumed that consumers cannot borrow, or can borrow only at a higher rate than that at which they can lend. If this borrowing constraint applies to firm and owner taken together, the outcome is as depicted in Figure 2.2.

In panel A, the two possible outcomes shown are those with net borrowing and those with net lending. If the consumer is a net borrower, the firm should produce at point A_F in response to the borrowing interest rate r_B. If the consumer is a net lender, the firm should produce at B_F in response to the interest rate r_L. From the equilibrium requirement that the consumption in the respective cases lie as shown in the vicinity of points A_C and B_C (indicating net borrowing and lending, respectively), the divergence of the rates r_B and r_F appear to increase the likelihood of an intermediate outcome, as shown in panel (b) of Figure 2.2. Here, the consumer neither lends nor borrows. His discount rate r^* lies between r_B and r_F, and this is the rate the firm should use in its decisions. Aside from the added complexity, the problem now has the feature that the cost of capital need correspond to no observed market interest rate. Further, the firm cannot base its decisions on any observed rate, or any fixed

Figure 2.2

Welfare Maximization with a Borrowing Constraint



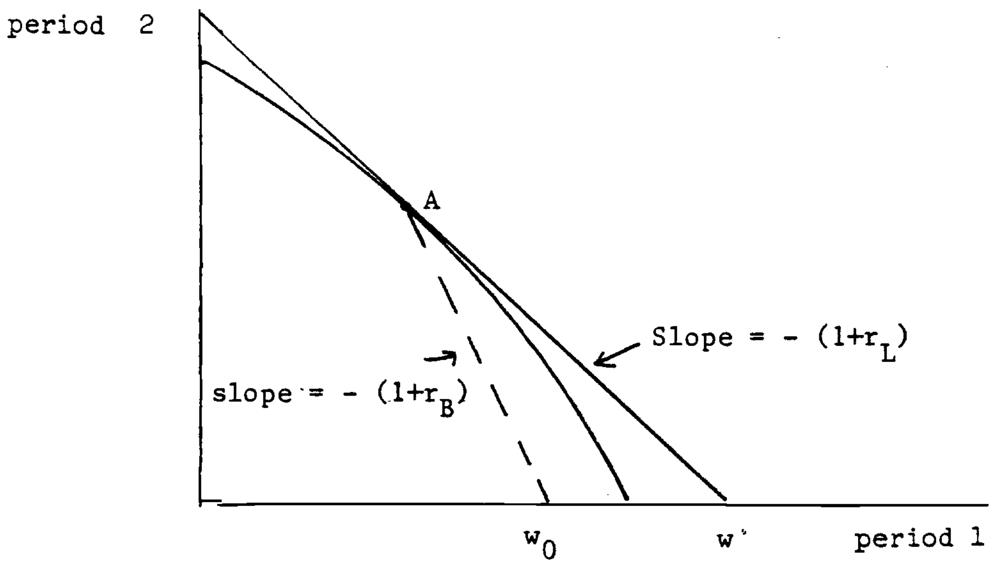
combination of such rates. The discount rate at point D may lie anywhere between r_F and r_B. The weights to use depends on the preferences of the firm's owner. A corollary of this breakdown of separation is that if the firm has more than one owner, and through differences in preferences or endowments these owners find themselves in different situations with respect to borrowing and lending, they will disagree about what the firm should do. If, for example, the firm initially planned to produce at point D, borrowers would wish to invest less, and lenders would want more investment. Thus, each firm's cost of capital would depend on the composition of its owners, and some decision mechanism, such as voting, would be required to determine its policy.

An additional distinction that may be introduced is between firm borrowing and individual borrowing. If the higher borrowing rate only applies to individual borrowing, for example, then it can be avoided simply by arranging for all borrowing to be done by the firm, rather than the individual. Such different treatment of an individual and a firm he owns makes little sense in a very simple model. However, legal distinctions induced by provisions such as limited liability could give rise to different borrowing opportunities. Also, as discussed below, the tax system may cause differences in effective borrowing rates.

This possibility of an advantage to borrowing by firms (or individuals) makes firm financial policy a decision with real effects. If the firm can borrow at a lower rate than its owner, it can increase his welfare by increasing its borrowing, thereby allowing a reduction in his own personal borrowing. This makes the firm more valuable to the individual, as depicted in Figure 2.3. If the individual does not borrow, he will value the firm at w_0 in terms of current consumption. However, if the firm borrows, allowing the individual access to

Figure 2.3

Firm Financial Policy with Differing Borrowing Rates



the lower interest rate r_L, he will value the firm at w_1. From another perspective, the firm's cost of capital differs according to the source of its funds. If it borrows, its cost of capital is r_L. If it does not borrow, but obtains funds from its owners who do, it must earn the higher rate r_B. Therefore, if there is a restriction on the extent to which a firm can borrow, its cost of capital depends on whether it has reached this limit and now faces the higher, personal borrowing cost of the margin. The observation of firms engaging in borrowing does not necessarily imply that they face a cost of capital equal to r_L.

Thus, the existence of more than one interest rate destroys the separation of firm policy and individual preferences and the unanimity of owners with respect to the investment decision, and introduces scope for a firm to influence its value and cost of capital through financial policy. These results are particularly relevant when taxes are considered.

III. Capital Income Taxation

Most of the taxes that influence the cost of capital are called income taxes. But what is an income tax? The common definition of income is the Haig (1921) - Simons (1938) measure of cash flow plus accretions to wealth. This may also be put as the amount which can be consumed without a decline in the value of wealth.

In a two-period one-good model with output in each period taken as numeraire (and hence no price level changes between periods), the period 1 income from a one dollar investment in period 0 equals the full return less the initial dollar invested. For a marginal investment with zero present value, this net return would be r, the interest rate. In a multi-period model, period 1 income would equal the investment's cash flow, less the original dollar, plus the remaining value of the investment. In each succeeding period, income would equal cash flow plus the change in the asset's value. In equilibrium, this value in each period must equal the present value of the asset's future returns. This, in turn, depends on the interest rate.

For example, consider a project that costs one dollar and has annual returns x_t over T years. If the interest rate is constant at r, then the value at the beginning of period $t < T$ is (from 2.1)

$$V_t = \frac{x_{t+1}}{1 + r} + \dots + \frac{x_T}{(1 + r)^{T-t}} \qquad 0 \leq t < T \tag{3.1}$$

with $V_T = 0$. From successive applications of (3.1), we may also write this as:

$$x_t + \Delta V_t = r V_{t-1} \qquad 0 < t \leq T \tag{3.2}$$

where $\Delta V_t = V_t - V_{t-1}$. Equation (3.2) may be interpreted as the equilibrium condition that requires a total rate of return on an asset equal to the interest rate. For a fixed vector of returns, $\underset{\sim}{x}$, and a fixed interest rate, r, equation (3.1) or (3.2) allows us to calculate the initial value V_0 and each successive value. Alternatively, to determine the returns the firm must earn to achieve a net present value of zero, we set $V_0 = 1$ (the asset's initial cost) and solve for $\underset{\sim}{x}$. Since $\underset{\sim}{x}$ has T elements, we must make a further assumption to obtain a unique solution.

For example, we may take x_t to be constant. In this case, the zero-present-value solution for x is:

$$(3.3) \qquad x = \frac{r}{1 - (1 + r)^{-T}}$$

From (3.1) and (3.3), we obtain the solutions for V_t and ΔV_t:

$$(3.4) \qquad V_t = 1 - (1 + r)^{-(T-t)} \qquad\qquad t \leq T$$

$$(3.5) \qquad \Delta V_t = - r \frac{(1 + r)^{-(T+1-t)}}{1 - (1 + r)^{-T}} \qquad\qquad t \leq T$$

which are functions of the interest rate except in the limiting case of $T = \infty$, where the asset is a consol with $V_t \equiv 1$ and $\Delta V_t \equiv 0$ regardless of t.

The opposite of the capital gain, ΔV_t, is commonly referred to as the "economic depreciation" in period t of the asset in question (Hotelling, 1925). Though this derivation of ΔV is general, the reference to economic depreciation is normally confined to assets that wear out and must be replaced. Because of this association, it is important to distinguish between economic depreciation and notions of depreciation based on productivity, age, and other factors. For example, a constant output asset that produces for T years is as productive, until its demise, as its new counterpart, while its <u>value</u> declines steadily after its purchase (see (3.5)).

Because economic depreciation is part of an asset's income, its measurement is important for purposes of income taxation. However, because an asset's change in value depends on future flows, it normally depends on future interest rates. One important special case which is an exception to this rule is the asset with services that decline at a constant geometric rate. Such an asset has a pattern of return summarized by the decay rate δ:

(3.6) $$x_t = x_1(1-\delta)^{t-1}$$

Solving (3.1) for the value of x_1 needed for V_0 to equal 1, we obtain

(3.7) $$x_1 = r + \delta$$

Substitution of this value of x_1 into (3.1) and (3.2) yields:

(3.8) $$V_t = (1 - \delta)^t$$

(3.9) $$- \Delta V_t = \delta(1 - \delta)^{t-1}$$

Thus, the asset's value is proportional to its current productivity, as is its economic depreciation. Neither depends on prospective interest rates.

Let us now consider the effects of income taxation on the incentive to invest and the equilibrium valuation of assets. A tax levied at rate τ on all income, both cash flow and capital gains, would yield an after-tax cash flow of $x_t - \tau(x_t + \Delta V_t)$. This could be accomplished by a tax on cash flow net of a depreciation deduction equal to $- \Delta V_t$. However, the value of depreciation depends on the tax rate, even if the gross cash flows $\underset{\sim}{x}$ are fixed. Equation (3.2) is replaced by:

(3.2') $$(x_t + \Delta V_t)(1 - \tau) = rV_{t-1} \qquad 0 < t \leq T$$

which, combined with the terminal condition that $V_T = 0$ yields:

(3.1') $$V_t = \frac{x_{t+1}}{1 + \frac{r}{1-\tau}} + \ldots + \frac{x_T}{(1 + \frac{r}{1-\tau})^{T-1}} \qquad 0 \leq t < T$$

Thus, an income tax has the effect of presenting the firm with a discount rate $\frac{r}{1-\tau}$ to use in evaluating the before-tax flows $\underset{\sim}{x}$. Hence, $\frac{r}{1-\tau}$ is the firm's cost of capital.

Although nothing in general can be said about the response of r to change in τ, one can observe that <u>should</u> $(\frac{r}{1-\tau})$ be independent of τ, the values $V_0, \ldots, V_{T-1}$ obtained from (3.1) and (3.1') are the same for a given vector $\underset{\sim}{x}$ (Samuelson, 1964). This might occur, for example, if the alternative investments open to the firm's owners carried a fixed rate of return, $\bar{i}$ (perhaps determined by world markets), also taxed at rate τ. The opportunity cost net of tax would then be $r = \bar{i}(1-\tau)$, so that $(\frac{r}{1-\tau}) = \bar{i}$ would not depend on τ.[1]

With $d(\frac{r}{1-\tau})/d\tau \neq 0$, the pattern over time of V_t and hence ΔV_t for the marginal asset (for which $V_0 = 1$) depends on τ. For the asset with fixed returns over T years, for example, ΔV_t would be (compare (3.5)):

$$(3.5') \qquad \Delta V_t = -\left(\frac{r}{1-\tau}\right) \frac{\left(1 + \frac{r}{1-\tau}\right)^{-(T+1-t)}}{1-\left(1 + \frac{r}{1-\tau}\right)^{-T}} \qquad t \leq T$$

Only for the geometrically depreciating asset will τ not influence the pattern of capital gains, since the latter depend only on the asset's age and depreciation rate, and not the cost of capital.

A major alternative to income as a tax base is personal cash-flow or consumption.[2] In contrast to an income tax, a cash-flow tax would tax all asset returns, but permit a deduction for asset purchases. This replaces (3.1) with

$$(3.1'') \qquad V_t = (1-\tau)\left(\frac{x_{t+1}}{1 + r} + \ldots + \frac{x_T}{(1 + r)^{T-t}}\right) \qquad 0 \leq t < T$$

but also makes the initial cost of the asset, net of tax, only $(1-\tau)$ rather than 1. Thus, the net present value of each new asset per dollar invested, holding $\underset{\sim}{x}$ and r fixed, is simply $(1-\tau)(V_0 - 1)$. The value of inframarginal gains is reduced, but the cost of capital and the marginal incentive to invest are not. Net present value is still maximized by accepting all projects that have non-negative present value at the discount rate r. This tax system amounts to the assumption of a partnership role by government in each investment project, and so is equivalent to a tax on an enterprise's economic rents (Brown, 1948).[3]

Both consumption tax and income tax approaches lead to outcomes in which pure rents are taxed and firms evaluate all projects with a single discount rate. This result may also be generalized by combining the two approaches. Consider a tax system with gross flows taxed at rate τ that allows immediate expensing of a fraction α of investment with a fraction ϕ of economic depreciation permitted as a deduction each year. This leads to the transition equation:

$$(3.2''') \quad x_t(1-\tau) + \Delta V_t(1-\phi) = rV_{t-1} \qquad 0 < t \leq T$$

and hence the valuation formula:

$$(3.1''') \quad V_t = \left(\frac{1-\tau}{1-\phi\tau}\right) \frac{x_{t+1}}{(1 + \frac{r}{1-\phi\tau})} + \ldots + \frac{x_T}{(1 + \frac{r}{1-\phi\tau})^{T-t}} \qquad 0 \leq t < T$$

If we take account of taxes, the asset's initial out-of-pocket cost is[4]

$$(3.10) \qquad P_0 = 1 - \alpha\tau + \phi\tau\,(V_0 - 1)$$

Now, suppose $\alpha + \phi = 1$, so that firms may expense a fraction $(1-\phi)$ of their investment and receive deductions for a fraction ϕ of their economic depreciation. In this case, we may express (using (3.1''') and (3.10)) the net present value of a one dollar gross investment as:

$$(3.11) \qquad V_0 - P_0 = (1-\tau) \frac{x_1}{(1 + \frac{r}{1-\phi\tau})} + \ldots + \frac{x_T}{(1 + \frac{r}{1-\phi\tau})^T} - 1$$

Hence, the firm should accept all projects for which the net present value of before-tax flows is positive, discounted at the rate $\frac{r}{1-\phi\tau}$, which defines this rate as its cost of capital. As with both income and consumption taxes, initial rents are taxed at rate τ. Thus, all tax systems for which $\alpha + \phi = 1$, including the extreme limits where $\alpha = 1$ or $\phi = 1$, combine a rent tax at rate τ with a cost of capital equal to $\frac{r}{1-\phi\tau}$. If $\frac{r}{1-\phi\tau}$ is invariant to changes in ϕ or τ, all systems are "neutral" in the strong sense of not influencing the incentive to invest. Generally, they are neutral in the weaker sense that they cause firms to use the same discount rate for evaluating gross-of-tax flows from each investment project, regardless of the project's characteristics.

IV. Taxation and the User Cost of Capital

Probably the most familiar model used in the analysis of taxation's effect on investment is the neoclassical model introduced by Jorgenson (1963), the main component of which is the "user cost of capital," which is a summery statistic for the overall incentive to use capital in production.[5] The user cost differs from the notion of the cost of capital defined above in that it includes a component for asset depreciation, and allows for a broad range of tax schemes.

The basic model that gives rise to the user cost is of a firm producing output using a single capital input. Without loss of generality, we may think of capital as the only input in a production function:

$$Y = F(K) \qquad F' > 0,\ F'' < 0 \tag{4.1}$$

where units of capital services are in terms of those offered by new capital costs.

The presence of two distinct goods, capital and output, in each period requires the introduction of at least one relative price. However, because there is another commodity, money, implicitly present, we introduce two money prices, that of capital goods, q_t, and output p_t, for each period t. This allows for general price inflation, which, as discussed below in Section ...., has important real effects on the cost of capital via focus of the tax system on nominal magnitudes.

At least two key assumptions lie behind the simplicity of the user cost formulation. First is the restriction to exponentially depreciating capital goods. As shown in Section III, these goods have the desirable property of an economic depreciation rate that is invariant with respect to the interest rate. This allows the representation of depreciation as a technological parameter in the user cost formula. Similarly, the assumption of a constant (from the firm's viewpoint) marginal cost of new capital goods makes the price q_t exogenous. Neither of these simplifications is necessary for the derivation of the user cost as the shadow price of capital, but they are required for other applications.

Though the user cost can be derived from a discrete time model such as those examined above, it has come more commonly from a continuous time formulation, which we follow here.

Since capital services decay exponentially at rate δ, we may think of a unit of age t capital simply as $\varepsilon^{-\delta t}$ units of new capital.[6] Thus the capital stock at time t is

$$(4.2) \qquad K_t = \int_{-\infty}^{t} e^{-\delta(t-s)} I_s \, d_s$$

where I_s is investment at date $s \leq t$. Differentiating (4.2) with respect to t yields the transition equation:

$$(4.3) \qquad \dot{K}_t = I_t - \delta K_t$$

The firm's optimization problem involves the choice of investment at each time to maximize the wealth of its owners. Without taxes, this is:

$$(4.4) \qquad \text{maximize } w = \int_0^{\infty} e^{-rt} \, [p_t F_t - q_t I_t]$$

Subject to (4.2) or (4.3), this amounts, as one would expect, to the choice of investment at each date so that the net present value of future capital services is zero at the margin. Indeed, if we substitute the K_t in (4.4) using (4.2), and differentiate with respect to I_t, we obtain just this result:

$$(4.5) \qquad q_t = \int_t^{\infty} e^{-r(s-t)} \, p_s F_s' \, e^{-\delta(s-t)} ds$$

where F'_s is the marginal product of capital at date s. However, a more useful way of expressing this result comes from substituting instead for I_t in (4.4) using (4.3), and solving with respect to K_t. The Euler condition, which must hold at the optimum yields:

$$(4.6) \qquad F'_t = C_t = \frac{q_t}{p_t}(r - (\frac{\dot{q}}{q})_t + \delta)$$

The term C_t is the familiar expression for the user cost of capital, expressing the shadow price of capital at time t. The fact that investment decisions made at date t should depend only on conditions precisely at that date, and not on the future, results from the lack of constraints on capital stock adjustment or investment reversibility (Arrow, 1964). We discuss this further below. To interpret (4.6), note that it can be rewritten:

$$(4.7) \qquad F'_t - [\delta - (\frac{\dot{\overline{q/p}}}{q/p})](\frac{q}{p})_t = [r - (\frac{\dot{p}}{p})_t](\frac{q}{p})_t$$

This expression is analogous to (3.2). It states that, in output units, the total earnings at date t from an investment, the marginal product plus the real change in asset value, must yield a rate of return equal to the real interest rate $r - (\frac{\dot{p}}{p})_t$. The rate of economic depreciation $\delta - (\frac{\dot{\overline{q/p}}}{q/p})$ takes account of changing relative prices. This choice of units affects the measure of income, but not the user cost itself.

One of the frequent early criticisms of the user cost approach was that while it was based on a model with zero adjustment costs, it normally appeared in an investment equation specifying the partial adjustment of capital to the desired stock dictated by (4.6). While some authors (including Eisner and Stratz, 1963; Lucas, 1967; Gould, 1968; and Treadway, 1969) derived conditions under which such partial adjustment was consistent with optimizing behavior, there is no general result in this vein. However, another way of looking at this problem is that the user cost itself is misspecified. In particular, if the true cost to the firm of new investment goods is included in the optimization, the result will be a correct measure of the user cost, to which firms set their contemporaneous marginal product of capital.

For example, suppose it is costly for the firm to add new capital goods to its stock quickly, so that it faces a convex adjustment cost in addition to the underlying, constant capital goods price. Then the total cost of new investment goods is:

$$(4.8) \qquad \bar{q}(I) \cdot I = (q + \phi(I))I$$

where $\phi(\cdot)$ is the convex adjustment cost function (ϕ', $\phi'' > 0$)[7] and $\bar{q}(I)$ is the total average cost of new capital goods to the firm.

Replacing q_t with $\bar{q}_t$ in expression (4.4), and again maximizing with respect to K, we obtain the analog of (4.6):

$$(4.6') \qquad F'_t = \hat{C}_t = \frac{\hat{q}_t}{p_t}\left(r - \left(\frac{\dot{\hat{q}}}{\hat{q}}\right)_t + \delta\right)$$

where

$$(4.9) \qquad \hat{q} = \bar{q} + I\,\frac{d\bar{q}}{dI}$$

is the marginal cost to the firm of new capital goods.

Unfortunately, while q_t may be observable, $\hat{q}_t$ is not, at least on the supply or cost side. On the demand side, we know that $\hat{q}$ equals the discounted flow of marginal products (as in (4.5)) but these, too, are unobservable at present and will change with a change in tax policy. However, following Tobin's (1969) initial insight, authors more recently (Abel, 1979; Hayashi, 1981) have pointed out that although the marginal cost $\hat{q}$ is unobservable, it is related to the firm's market value. Thus, one can, for example, parameterize the adjustment cost function $\phi(\cdot)$, solve equation (4.9) for I in terms of q, and regress.

This is an important issue for predicting the short run impact of tax policies on investment. In the long run, this problem is less important. As our focus here is on the long run effects of taxation on capital allocation rather than on the short run impact on investment, we return to the simplified model in which the supply probe of capital is constant.

A number of major tax code provisions may be introduced into the user cost formula. We assume there to be a single income tax, assessed at rate τ on cash flow $p_tF(K_t)$ less depreciation allowances on existing capita. In addition, we assume there is an investment tax credit at rate K on new capital goods purchases.[8] At this point, we ignore the additional complications of personal taxation and the special treatment of debt. One may think of this user cost as the one that holds for a self-financed entrepreneur.

Letting D^t be the depreciation allowance given a unit of capital originally purchased for a dollar, we obtain the following optimization problem:

$$(4.10) \qquad w = \int_0^\infty e^{-rt} \{(1-\tau)\, p_tF(K_t) - q_t(1-k)I_t + \tau \int_{-\infty}^{t} q_sI_sD^{t-s}\, ds\}\, dt$$

$$= \int_0^\infty e^{-rt} \{(1-\tau)\, p_tF(K_t) - q_t(1-k-\tau Z)I_t\}\, d + \tau \int_{-\infty}^{t} q_sI_sD^{-s}ds$$

where

$$(4.11) \qquad Z = \int_0^\infty e^{-rt}\, D^t\, dt$$

is the present value of depreciation allowance accruing to a dollar of new capital, all tax parameters are constant, and investors never sell or buy used capital goods.[9] Solving (4.10) with respect to K_t, as before, yields:

$$(4.12) \qquad F' = C_t = \frac{q_t}{p_t}\left(r - \left(\frac{\dot{q}}{q}\right)_t + \delta\right)(1 - k - \tau Z)/(1-\tau)$$

Comparing (4.12) to (4.6), we see that they differ by the ratio $(1 - k - \tau Z)/(1-\tau)$, which may be interpreted as the effective reduction in subsequent cash flows. As already shown, when these two factors are set equal through expensing ($k = 0$, $Z = 1$), the marginal incentive to invest is unaffected by taxation. Likewise, this property holds whenever $\frac{k}{\tau} + Z = 1$.

A special result also holds when depreciation allowances correspond to economic depreciation. This is most easily shown when prices are stable, in which case:

$$(4.13) \qquad D^t = \delta e^{-\delta t}$$

so that $Z = \frac{\delta}{r + \delta}$ and (dropping subscripts) $c = \frac{q}{p}\left(\frac{r}{1-\tau} + \delta\right)$.

This corresponds to the earlier result that economic depreciation results in the use of a discount rate equal to $\frac{r}{1-\tau}$ in evaluating gross of tax flows. Likewise, expensing and economic depreciation can be combined to give a result corresponding that in (3.11).[10]

Typical tax systems treat assets differently, of course. Aside from the problems caused by inflation, there is a gap between the patterns of economic depreciation and those of depreciation allowances.[11] This means that there is no general cost of capital, but a different one for each potential project. This project-specific discount rate may be derived from the user cost formula (4.12)

We begin by noting that a marginal investment is one for which the marginal product of capital equals the user cost. Hence, the gross return from such a project t years after purchase would be $C_t e^{-\delta t}$ units of output or $p_t C_t e^{-\delta t}$

dollars unit of capital. Hence, the discount rate ρ that results in the project's gross flows having a zero net present value is defined implicitly by the equation

$$(4.14)\qquad q_0 = \int_0^\infty e^{-\rho t} p_t C_t e^{-\delta t} dt$$

Substituting in (4.14) for C_t using (4.12) yields (dropping subscripts):

$$(4.15)\qquad \rho = \frac{(r - \frac{\dot{q}}{q} + \delta)(1 - k - \tau Z)}{(1-\tau)} - (\delta - \frac{\dot{q}}{q})$$

Since ρ is determined by nominal cash flows, it is the nominal cost of capital. The real cost of capital would express the resturns in constant dollars, multiplying them by the initial price level p_0 rather than the actual price level p_t. This would yield a discount rate of $\rho - (\frac{\dot{p}}{p})$.

For the simple case where inflation is zero and depreciation allowances do follow economic depreciation ($Z = \frac{\delta}{r+\delta}$), the cost of capital ρ is constant only if the investment tax credit satisfies (Auerbach 1982a):

$$(4.16)\qquad k = k\ (1 - \frac{\delta}{r+\delta})$$

where k_0 is the credit that applies to assets for which $\delta = 0$. This requires a tax credit that increases with the productive life of assets (decreases with δ) (Sunley, 1976; Auerbach, 1978; Bradford, 1980). In fact, the tax law in the U.S. seems to reflect this requirement, at least roughly. Currently, for example, assets qualifying for a three-year tax write-off receive only a 6 percent investment credit while those in the five-year category reeive a ten percent credit. (This does not explain the lack of any credit on buildings, which fall into the fifteen-year class.)

A cost of capital that differs across prospective investments leads to a distortion in the choice or production technique, since a requirement for the efficient allocation of resources in production is that firms apply the same cost of capital to all projects.[12] However, even with production efficiency, a uniform tax on capital income distorts the intertemporal consumption decision by introducing a wedge between the consumer's marginal rate of substitution and the firm's marginal rate of transformation between goods in different periods.[13]

One can assess the impact of capital taxation through its effect on the amount and type of capital used in production. An income tax τ imposes a cost of capital equal to $\frac{r}{1-\tau}$ on the firm. This leads to a higher user cost and hence less capital used in production.[14] Aside from the induced decline in capital use, the higher cost of capital also leads to the choice of less durable capital. This can be demonstrated using a generalization of the neoclassical model in which the rate of capital decay, δ, is chosen by the firm to minimize its user cost of capital.[15]

Suppose that, in exchange for a greater rate of depreciation, the firm can obtain greater capital service per unit of new capital (ten Cordobas versus one Rolls Royce). If this ratio of capital services per unit of new capital is $A(\delta)$ $(A' > 0)$, then the cost of capital expression without taxes, (4.6), becomes (dropping subscripts and inflation):

$$(4.17) \qquad F' = C = \frac{1}{A(\delta)}\frac{q}{p}(r+\delta)$$

which is minimized with respect to δ when:

$$(4.18) \qquad \frac{A'}{A''} = \frac{1}{r+\delta}$$

The second-order condition requires that $A'' < 0$. Since an income tax simply replaces r by $\frac{r}{1-\tau}$ in (4.17) and (4.18), we may think of an increase in τ as having the same impact on the choice of δ as an increase in r. Totally differentiating (4.18) with respect to r yields:

$$(4.19) \qquad \frac{d\delta}{dr} = -\frac{(A')^2}{A''A}$$

which is positive.

Perhaps a more familiar way of presenting this result is in "Austrian" capital models in which capital goods yield a single cash flow. The firm chooses how long to delay the realization of this output, which grows in potential over time. One may think of the asset as a tree awaiting harvest.[16] If B(T) is the function representing the cash flow coming from termination at date T, the firm seeks to maximize e^{-rt} B(T) in the absence of taxes. This yields the first-order condition:

$$(4.19) \qquad \frac{B'}{B} = r$$

and the second order condition:

$$(4.20) \qquad \frac{B''}{B} - \left(\frac{B'}{B}\right)^2 < 0$$

The project should be terminated when potential output grows at the rate of interest. Again, since an income tax raises the cost of capital to $\frac{r}{1-\tau}$ and is equivalent to an increase in r,[17] we totally differentiate (4.19) with respect to r to discover the effect of income taxation on T:

$$(4.21) \qquad \frac{dT}{dr} = \left(\frac{B''}{B} - \left(\frac{B'}{B}\right)^2\right)^{-1}$$

which, by (4.20), is negative.

It should be emphasized that this shift to less durable capital does not represent a production distortion. Indeed, an increase in the rate of time preference r not caused by taxation would cause the same shift. When the tax system is more complicated than an income tax, however, production distortions may result from differences in the cost of capital applied to projects (see (4.15)). This may exaggerate or mitigate the effect on asset durability of a uniform income tax, according to whether the cost of capital rises more for short-lived or long-lived assets. A particular example of this concerns the effect of inflation on the choice of asset life, considered below.[18]

V. Personal Taxation and Inflation

The user cost formulation (4.12) continues to be helpful in the examination of more realistic tax systems and environments.

A. Inflation

Since nominal depreciation allowances typically do not change with the price level, they decline in real value during inflationary periods. This causes an increase in the effective taxation of capital income, and therefore in the cost of capital.[19] This effect is most easily seen for the case of economic depreciation allowances not indexed for inflation. Here, if all prices rise at the same rate $\pi = \frac{\dot{q}}{q} = \frac{\dot{p}}{p}$ (so that the price of capital goods at time t is $q_t = e^{\pi t}q_0$) economic depreciation at time t of an asset purchased at time zero for q_0 is $q_t\ \delta e^{-\delta t} = q_0\ e^{\pi t}\delta e^{-\delta t}$. The present value of economic depreciation per dollar of assets purchased at time zero is:

$$(5.1) \qquad Z_e = \frac{1}{q_0} \int_0^\infty e^{-rt} q_0 e^{\pi t} \delta e^{-\delta t} dt = \frac{\delta}{r-\pi+\delta}$$

With depreciation allowances expressed in nominal terms, and based on prices in the year of purchase, the present value of depreciation allowances is:

$$(5.2) \qquad Z_h = \frac{1}{q_0} \int_0^\infty e^{-rt} q_0 \delta e^{-\delta t} dt = \frac{\delta}{r+\delta}$$

Thus, for a given real discount rate $r - \pi$ (see 4.7)), Z_e is fixed, but Z_h declines with the rate of inflation. What actually happens when π increases depends on the value taken by $\frac{d(r-\pi)}{d\pi}$, discussion of which is best deferred until personal taxes have been considered.[20] With a zero investment tax credit, combination of (5.2) and (4.15) yields the following expression for the cost of capital (Auerbach 1979a):

$$(5.3) \qquad \rho = \frac{r-\pi}{1-\tau} + \left(\frac{\tau}{1-\tau}\right)\pi Z_h$$

For $\pi > 0$, this exceeds the cost of capital imposed by an income tax, given the real interest rate $r - \pi$. Moreover, $\frac{d\rho}{d\delta} > 0$, so that the cost of capital increases with δ. Inflation discriminates against short-lived assets. As a result, an increase in inflation that both increases ρ in general, but increases it most for low values of δ will have an ambiguous effect on the choice of asset life, since a uniform increase in ρ would cause δ to decline (see Section IV) but a discrimination against short-lived assets alone would cause δ to increase.[21]

B. Personal Taxation

Most early work on taxation and the cost of capital ignored personal taxation. This is justifiable only if all forms of corporate source personal income are taxed at the same rate, for then we can reinterpret r (or $r-\pi$ if there is inflation) as the rate of time preference, gross of the personal tax rate. However, in addition to inflation corrections, this outcome would normally require a full integration of corporate and personal income taxes, as under an imputation system where income taxes paid by corporations are treated essentially as withholding of personal income taxes (King 1977). Even where an imputation system is used in practice (as currently in Great Britain) there remain imperfections, such as the failure to adjust interest income for price-level changes. Thus, any existing tax system would require us to take explicit account of personal taxation in our analysis.

In the U.S., and in other countries that do not have integrated income taxes, there are several features that are important to consider. First, personal income taxes have progressive marginal rate structures, whereas corporate income taxes typically do not. Second, capital gains are taxed (if at all) at a lower rate than dividends and interest payments, and on realization rather than accrual. Third, corporations can deduct interest payments, but not dividends.

Fourth, no price level adjustments are made to account for the increase of an inflation premium on capital gains and interest payments. These characteristics provide for a very complicated analysis. Indeed, questions arise concerning the existence of an equlibrium with finite asset demands, for without constraints such a tax system provides opportunities for unlimited arbitrage at government expense among households and/or corporations in different tax brackets. Many of the results that one obtains, therefore, depend on the way in which constraints are modelled.

Probably the most commonly discussed of the four characteristics just cited is the deductibility of interest payments. As suggested by Modigliani and Miller (1963), the deductibility of interest imparts a bias to the financing decision. If one ignores the personal taxation of dividends, capital gains and interest, firms have an incentive to finance their investments by borrowing. One way of understanding this is to recognize that the firm and the household face different after-tax rates of interest. The individual faces no taxes, and hence faces an interest rate r. The firm pays taxes on interest income and can deduct interest payments, and thus faces an interest rate equal to $r(1-\tau)$. Therefore, as in Section II, the firm's owner, wishing to borrow to undertake a certain investment program, will maximize his personal wealth by doing all borrowing at the firm level, rather than the personal level. In theory, this gain need not stop at the point where no borrowing is done at the personal level. The firm can continue to borrow, using the proceeds to repurchase ownership in the firm from the individual, who uses the funds for loans made to the firm. This operation constitutes pure arbitrage, for the increase in firm indebtedness leads to an increase in tax deductions. One must impose a constraint to rule out such behaivor, either in the form of a restriction on share repurchases, or on the amount of borrowing that the firm does.

The presence of personal taxes complicates matters because of the favorable tax treatment of capital gains. Since only part of the stockholder's equity return comes in the form of fully taxed dividends, there exists at least a partial offset to the favorable tax treatment of debt at corporate level. The traditional way of comparing the cost of capital for equity financed versus debt-financed investments is to imagine a potential project being financed either by the sale of new shares or new debt, with subsequent cash flows being distributed as dividends, in the former case, or interest payments and principal repayments, in the latter. Further simplifications are that the assets being purchased are consols, not depreciating and receiving no depreciation allowances, and that capital gains are taxed upon accrual rather than the correct (but more difficult to model) taxation only upon realization.[22]

For equity-financed investment, the after-tax cash flow in period t is $\bar{x}(1-\tau)(1-\theta) - c\,\Delta V_t$, where $\bar{x}$ is the annual gross return, τ is the corporate tax, θ is the personal income tax and c is the capital gains tax. This yields the capital market equilibrium equation corresponding to (3.2):

$$(5.4)\qquad x(1-\tau)(1-\theta) + (1-c)\,\Delta V_t = rV_{t-1}$$

since the total after-tax reward (which includes the capital gain ΔV_t) must deliver a rate of return equal to the rate of time preference, r.

Application of (5.4) successively yields:[23]

$$(5.5)\qquad V = \sum_{t=1}^{\infty}\left(1 + \frac{r}{1-c}\right)^{-t}\left(\frac{1-\theta}{1-c}\right)(1-\tau)\bar{x} = \frac{(1-\theta)(1-\tau)\bar{x}}{r}$$

So that the asset's net present value equals zero ($V_0 = 1$) when

$$(5.6)\qquad \bar{x} = \frac{r}{(1-\theta)(1-\tau)}$$

Since this is the same result one would obtain by discounting the stream of returns $\bar{x}$ at the rate $\frac{r}{(1-\theta)(1-\tau)}$, this is the relevant cost of capital. Note that the capital gains tax term disappears from (5.5), precisely because a consol generates no capital gains or losses.

Capital gains taxes would matter if the firm reinvested part of the cash flow in each year, rather than distributing it fully. For example, suppose it paid out a fraction p of the return $\bar{x}$, reinvesting the residual in capital of the same type. This would yield a dividend of $\bar{x}(1-\tau)p$ in year 1, $\bar{x}(1-\tau)p + (\bar{x}(1-\tau))^2(1-p)p$ in year 2, and $x_t = \bar{x}(1-\tau)p(1 + \bar{x}(1-\tau)(1-p))^{t-1}$ in year t: a return growing at rate (1-p) over time. The term $\bar{x}$ in equation (5.4) is replaced now by x_t and (5.5) because:

$$(5.5') \qquad V_0 = \sum_{t=1}^{\infty}(1 + \frac{r}{1-c})^{-t}(\frac{1-\theta}{1-c})(1-\tau)\bar{x}p(1 + \bar{x}(1-\tau)(1-p))^{t-1}$$

$$= \frac{(1-\theta)(1-\tau)\bar{x}p}{r - x(1-\tau)(1-p)(1-c)}$$

Setting $V_0 = 1$ yields the new cost of capital:

$$(5.6') \qquad \bar{x} = \frac{r}{(1-\tau)[1 - (p\theta + (1-p)c)]}$$

which indicates that the full "double-taxation" of equity income in (5.6) is mitigated to the extent that earnings are retained and reinvested, allowing the stockholder to suffer only capital gains taxes instead of taxes on dividends.

For a debt-financed project, we assume that the entire cash flow of the firm is absorbed by interest payments and principal repayments (negative if new debt is issued). If i is the interest rate, then this yields the identity:

$$(5.7)\qquad x_t(1-\tau) - iB_{t-1} + i\tau B_{t-1} + \Delta B_t = 0$$

since interest payments are tax deductible. If we note that this can be rewritten:

$$(5.8)\qquad \bar{x}_t(1-\tau) + \Delta B_t = i(1-\tau)B_{t-1}$$

then it is clear that we can follow the same procedure as before, solving this time for the amount of debt B_0 that the project will support. Regardless of whether x_t grows or is constant, the resulting value of $\bar{x}$, and hence the cost of capital, is (not surprisingly) the interest rate:

$$(5.9)\qquad \bar{x} = i$$

By combining the results in (5.6') and (5.9), one can also derive a weighted average cost of capital for the case in which debt and equity finance are used at the margin:[24]

$$(5.10)\qquad \bar{x} = bi + (1-b)\,\frac{r}{(1-\tau)[1 - (p\theta + (1-p)c)]}$$

where b is the fraction of debt used at the margin.

The firm seeking to minimize its cost of capital should choose to finance with debt or equity according to whether i is greater than or less than the expression on the right hand side of (5.6'). If all individuals faced the same personal tax rates, then the after-tax return to debt, $i(1-\theta)$, would have to be equal to discount rate r. Thus, equity would be at least as preferred as debt if and only if:

$$(5.11)\qquad (1-\theta) \le (1-\tau)[1 - (p\theta + (1-p)c)]$$

a condition unlikely to be satisfied unless p is extremely low. This result, along with the fact that c (and hence the cost of equity capital) declines with the holding period of capital gains, lies behind the conclusions drawn by Stiglitz (1973) from a T period model of an investor-entrepreneur:

(1) Firms should use debt finance at the margin;[25]

(2) Firms should pay no dividends; and

(3) Investors should realize no capital gains before year T.

None of these predictions is consistent with the evidence in the U.S. Corporations have steadfastly distributed a large fraction of their earnings as dividends,[26] and have maintained debt-value ratios far below unity.[27]

These facts make it difficult to determine the cost of capital, because the model we have thus far does not correctly predict the way that firms behave. At best, it is an incomplete description of corporate financial behavior, and there have been many approaches to completing it.

Probably the simplest though least satisfying approach has been to assume the existence of some *ad hoc* constraints requiring that the dividend payout rate be no less than its observed value p and the debt-value ratio be no greater than its observed value, b. This gives meaning to the weighted average discount rate based on observed magnitudes, but it does little else. It is a *deus ex machina* for explaining the coexistence of sources of finance with apparently different costs. A more realistic approach to such constraints requires the presence of uncertainty. As we discuss below in Section VI, both dividend policy and borrowing behavior can be viewed as examples of the "principal-agent" problem in which holders of the securities in a firm respond to the behavior of managers possessing greater information than they about the firm's prospects and facing a certain personal incentive structure. A simple (although not entirely satisfactory) approach used in the literature (see Baumol and Malkiel, 1967; Auerbach, 1979c; and Feldstein, Green and Shchinski, 1978 for example) to represent the effect of uncertainty on the financial decision is to assume that tne required that the required rates of return on debt and equity increase with leverage, presumably because of increased bankruptcy risk as well as other factors. In this case, the cost of capital may be minimized at an interior value of b even if debt is taxed less heavily than equity. For example, if we let the required rate of return on debt after tax, $r_b = i(1-\theta)$, be an increasing function of b, the cost of capital in (5.10) is at a minimum when:

$$(5.12) \qquad bi' + i - \frac{r}{(1-\theta)[1-(p\theta+(1-p)c)]} = 0$$

where $i' = \frac{1}{1-\theta}\frac{dr_b}{db}$. In this case, the cost of capital is still described by expression (5.10), and the marginal costs of both debt and equity finance equal this minimized value, rather than their respective average costs i and $\frac{r}{(1-\theta)[1-(p\theta+(1-p)c)]}$. Thus, the weighted average concept allows us to estimate a firm's cost of capital from observed interest rates and equity returns. A problem with this approach to modelling uncertainty is that it is unclear whether the implicit separation of real and financial decisions is appropriate.

A third method of explaining at least the existence of equity, if not observed dividend policy, has been the progressivity of the personal tax structure. While condition (5.11) may not hold for the average marginal tax rate in the U.S., it could hold for the upper tail of the marginal tax rate distribution. This was certainly true before the tax cut of 1964, when the value of θ could exceed .9 (while τ was .52), and was still true to a lesser extent before the reduction of the top bracket rate from .7 to .5 in 1981. With some investors able to supply funds more cheaply to the firm through equity, and others through debt, the resulting equilibrium would be segmented, with investors possessing marginal tax rates above some critical value, θ^*, holding only equity, and others holding only debt. This configuration has come to be known as a "Miller equilibrium", after the arguments by Miller (1977). Though the Miller equilibrium does not require that firms be constrained in their choice of financial policy, it does require the existence of constraint on individual investors. Otherwise, they could take an arbitrarily large negative position in the security that offers the lower after-tax return to them, covering it with a positive position in the other security.[28] For example, high bracket investors could borrow to buy stock, while low bracket investors could sell equity short and purchase bonds. Restrictions on borrowing as well as short-selling have some basis in fact; at least they are tenable simplifications to make in a model.

One implication of the Miller model is that the cost of capital for each firm equals the weighted average of its costs of equity and debt in the trivial sense that each source has the same cost, the interest rate. Another implication is that changes in the personal tax schedule influence the relative returns to debt and equity in such a way that the after-tax returns must stay equal for the marginal asset holder, whose tax rate is defined solely by equation (5.11). Put another way, for the investor for whom the effective tax rates on equity and debt are the same, the net returns to holding debt and equity must be equal. Hence, the <u>gross</u> returns must be equal, too. Thus, changes in the interest rate in response to taxation summarize changes in the firm's cost of capital. This also follows directly from the fact that, in equilibrium, firms must be indifferent between debt and equity.

The segmentation of portfolios predicted by the Miller hypothesis is at variance with reality, but this may be ascribed to the ignorance of uncertainty thus far. An important question considered below is how uncertainty and the desire among investors for diversification changes this result.

Explaining dividend behavior has proved more challenging, since there are essentially no asset holders for whom capital gains are taxed as heavily as dividends.[29] One ingenious argument (Miller and Scholes, 1978) even attempted to show that the effective personal tax rate on dividends is zero because the tax law permits certain tax deductions to be taken only against capital income. Hence, more dividends provide the opportunity for more deductions. This hypothesis is one of the few in this area lending itself to precise empirical testing based on individual tax returns, and, unfortunately, such a test resoundingly rejects it (Feenberg, 1981).

A second explanation for the payment of dividends rests on the potential inability of firms to turn retained earnings into capital gains.[30] In the Stiglitz model, for example, it is assumed that the accumulated value of the firm's retentions can be realized at the final date T by the investor, presumably through the sale of the firm or by the sale of the firm's assets. But these two options differ in an important way. The sale of an asset will be at a price determined by its productive value relative to that of comparable, newly produced assets: its replacement cost. The sale of a firm's <u>shares</u> to another investor need not realize the same price. As long as the firm's owner cannot realize capital gains without selling shares in the firm to another taxable investor, there is no arbitrage mechanism to equate these values. In terms of Tobin's "q", the long run value of marginal q need not equal unity. The normal mechanism for equating q to one is through new share issues. If q were greater than one, firms could increase infinitely the value of their stockholders' wealth by issuing new shares. If q were less than one, they could perform the same operation in reverse, repurchasing shares from their stockholders. However, the law in most countries treats new share issues and share repurchases asymmetrically. Until very recently, share repurchases were illegal in the

U.K., while there are Internal Revenue Code provisions in the U.S. that allow preferential capital gains tax treatment of repurchases only if they are sufficiently out of proportion to existing stock ownership and are not done on a regular basis in lieu of dividends.

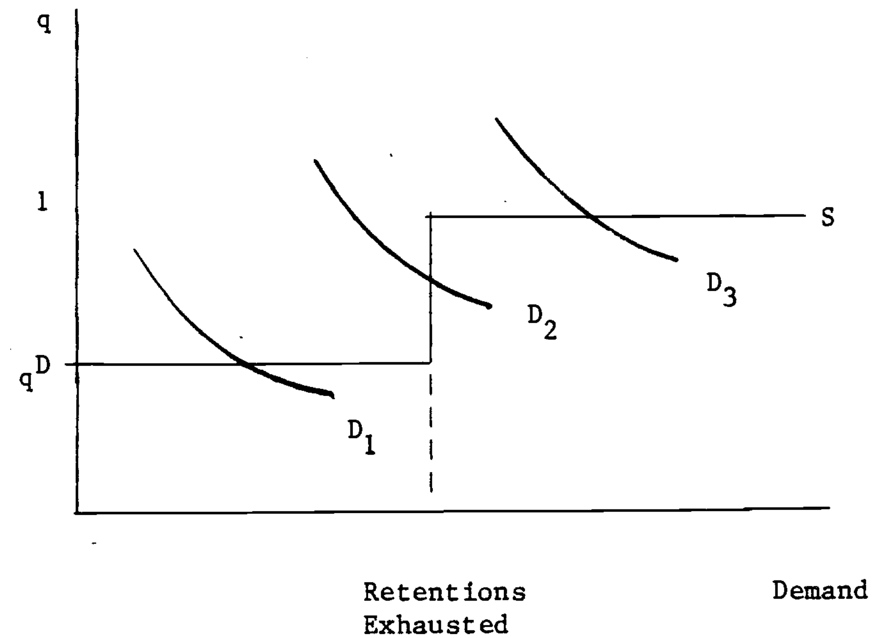
Without share repurchases, the value of marginal q can fall as low (for a uniform personal tax code) as $q^D = (\frac{1-\theta}{1-c})$, the ratio of the after-personal-tax to after-capital-gains-tax value of a dollar paid to the investor. At this value of q, firms are just indifferent between paying dividends and retaining, since the dividend tax on a dollar of dividends, θ, equals the after-tax loss in value of a dollar retained, $(1-q)(1-c)$. Hence, there is a range of possible values for q, between q^D and 1. Only at the borders of this interval will the firm find it desirable to pay dividends (when $q = q^D$) or issue new shares ($q = 1$). The equilibrium value of q in any period will depend on the demand for corporate equity, according to Figure 5.1. As long as the demand for a firm's shares falls short of that which could be provided by a full retention of earnings, q cannot rise (D_1). Only when the demand cannot be met through retentions will the price rise, and only when the price reaches one will firms supply more equity.

This "new view" of equity finance implies that the cost of capital differs according to which of these three regimes a firm is currently in and those in which it will find itself in the future.[31] Suppose q_0 is the value of q now, and q_1 the value of q in the next period. Capital market equilibrium requires that the after-tax rate of return on the firm's investment equal r. If the firm invests for one period in assets yielding a return $\bar{x}$ per dollar, this requirement implies that

$$(5.13) \qquad rq_0 = (1-\tau)\bar{x}[p(1-\theta) + (1-p)q_1(1-c)] + (1-c)(q_1 - q_0)$$

FIGURE 5.1

"q" and the Demand for Equity



where p is the payout rate next period. Assuming that firms pay no dividends unless $q = q_D$, the term in brackets in (5.13) simply equals $q_1(1-c)$. Thus, (5.13) may be simplified in solving for an expression for the cost of capital:

$$(5.14) \qquad \bar{x} = \frac{q_0}{q}\left[\frac{r}{(1-\tau)(1-c)} - \left(\frac{1}{1-\tau}\right)\left(\frac{q_1-q_0}{q_0}\right)\right]$$

For q constant, this simplifies to

$$(5.15) \qquad \bar{x} = \frac{r}{(1-\tau)(1-c)}$$

regardless of what regime the firm is in. Even if $q = q^D$, so that the firm pays dividends in both periods, the cost of capital does not depend on the personal rate of tax on ordinary income, θ.[32] This is because the difference between the dividend tax, θ, and the capital gains tax, c, is offset by the reduced cost to the investor of obtaining a given earnings stream.

The case studied above, in which firms issue new share today and pay dividends in the future, corresponds to a situation in which $(q_0,q_1) = (1,q_0)$, and in which the cost of capital is:

$$(5.16) \qquad \bar{x} = \frac{r + (\theta - c)}{(1-\tau)(1-\theta)}$$

which differs from the expression derived above in (5.6'). There is no contradiction here, however. Equation (5.16) gives the <u>one period</u> cost of capital for a firm issuing new shares now and distributing some of its earnings next period, while the more familiar (5.6') gives the cost of capital required over several periods for a firm issuing new shares now and then paying dividends in all succeeding periods. One could derive (5.6') by combining a succession of one period costs of capital, defined by (5.16) in the first period and (since $q = q_D$ for later periods) (5.15) thereafter. The distinction is analogous to that between short-term and long-term interest rates. This comparison helps to explain why the payout rate enters into (5.6'). If the short term cost of capital is higher now than in the future, the average long-term cost of capital will be lower the longer the term of investment being undertaken. This analogy also helps explain why the appearance of p in expression (5.6') does not imply that the firm can influence its current cost of capital through the choice of dividend policy. It simply indicates that, under the assumptions made, the cost of capital is temporarily high at present.[33]

What really distinguishes the "classical" view of the cost of equity finance from the "new" view is the choice between (5.6') and (5.16) as the appropriate cost of capital to use. This choice cannot be made alone on the basis of whether firms issue new shares or pay dividends, but rather on the extent to which they can change these policies. Under the new view, a firm for which $q = 1$ now but $q = q^D$ in the future will issue new shares now and pay dividends in the future. If this firm decides to invest more in the future, it will do so by retaining earnings, and will face a cost of capital as described by (5.15). Hence, its observed payout policy is a result of its optimal investment policy. However, if the observed payout policy of a firm is predetermined, additional investment in future periods will incur the initial cost of new share issues before subsequent reinvestment out of retentions. Hence, the cost of capital in (5.6') is a more accurate description of the firm's incentive to invest. Intermediate to these situations is one in which the firm may have a range over which it may vary dividends. In this case, q may rise above q^D while dividends are still at some positive level, making it impossible to identify the firm's cost of capital simply from its dividend policy.

These different views of equity policy have strikingly different implications for the cost of capital. Under the new view, for example, the cost of capital does not depend directly on the personal income tax rate if firms pay dividends. Thus, an unannounced change in this tax rate will have no effect on the incentive to invest: it is a wealth tax.[34]

Empirical evidence on the subject of which "view" of equity taxation is more accurate is inconclusive. On the one hand, firms rarely issue new shares and when they do, appear to require a higher rate of return on the their investment.[35] On the other hand, changes in the tax rate θ do not appear to influence q in a manner consistent with the new view.[36]

An interesting parallel can be drawn between the q that may result from the taxation of dividends and that resulting from a corporate tax policy of partial expensing and partial economic depreciation, discussed above in Section III. As can be seen from an examination of (3.1'''), the two policies are formally equivalent, for $\theta = \tau$ and $c = \phi\tau$. That is, a system with no personal taxes, a corporate tax equal to θ, expensing at rate $(1-\theta)$ and the taxation of economic depreciation at rate c is identical to a system with no corporate income tax, a personal tax rate θ and capital gains tax rate c. The value of the firm's capital equals $(\frac{1-\theta}{1-c}) = q^D$, and its cost of capital equals $\frac{r}{1-c}$. It is relatively straightforward to show that the combination of the two systems yields a value of q equal $(\frac{1-\tau}{1-\phi\tau})(\frac{1-\theta}{1-c})$ and a discount rate of $\frac{r}{(1-\phi\tau)(1-c)}$. Thus, changes in the corporate tax rate, holding $\phi\tau$ constant, have precisely the same windfall effects as changes in the value of θ. Indeed, parallels between the effects of corporate and personal taxation have been recognized in discussions about the structure of the corporate income tax under a system of personal consumption taxation (Institute for Fiscal Studies, 1978).

The lower rate of equity taxation under the new view also makes more plausible the Miller equilibrium, since it requires a lower value of θ for an individual to face equal effective tax rates on debt and equity. In general, for a firm that finances with both debt and equity, the cost of capital (Auerbach, 1979c) is the weighted average of the costs of equity and debt,

$$c = bi + (1-b)\frac{r}{(1-\tau)(1-c)} \tag{5.17}$$

where

$$b = \frac{B}{B + \frac{E}{\frac{D}{q}}} \tag{5.18}$$

the fraction of debt in the firm's financial structure, taking account of the undervaluation of equity. As before, the weighted average cost of capital concept is interesting only when firms are constrained in their use of debt or equity or uncertainty is present. Otherwise, the appropriate cost of capital is simply the minimum of the costs of equity and debt. An interior solution, such as is predicted by the Miller model, is one in which these costs are the same.

C. Inflation and Personal Taxation

The impact of inflation on the choice of financial policy is not well understood, and depends on the assumptions one makes about the constraints on firm behavior with respect to borrowing and dividends. The key factors affecting the cost of capital in the presence of inflation are the basing of depreciation allowances on historic cost (discussed above in Subsection A), the taxation of nominal, rather than real, capital gains, and the full taxation of nominal interest payments received and full deductibility of those made.

To study the effects of the last three factors, we continue to assume for the moment that firms invest in nondepreciating consols with no depreciation allowances and hence no impact of inflation on the real side. If prices rise at some constant rate π, then a consol earning a return $\bar{x}$ in year 1 earns (in nominal terms) $\bar{x}(1+\pi)^{t-1}$ in year t. Making this adjustment to the analysis in the previous section, we obain the analogues to (5.6') and (5.9) for the real cost of equity capital (under the traditional view of fixed payout policy) and debt capital:

$$(5.19a) \qquad \bar{x} = \frac{r - \pi}{(1-\tau)[1-(p\theta + (1-p)c)]} + \frac{\pi c}{(1-\tau)[1-(p\theta + (1-p)c)]}$$

$$(5.19b) \qquad \bar{x} = i - \frac{\pi}{1-\tau} = \frac{r-\pi}{1-\theta} + \pi(\frac{1}{1-\theta} - \frac{1}{1-\tau})$$

As noted by Darby (1975) and Feldstein (1976), the nominal interest rate must rise by more than the inflation rate for the expression in (5.9') to be invariant with respect to the inflation rate. This has been dubbed "Super Fisher's Law" to distinguish it from the notion put forward by Fisher (1930) that the real rate of interest should remain roughly constant through equal changes in the nominal interest rate and the inflation rate.

The effect of taxing nominal interest payments and capital gains is that the cost of equity capital rises with π for a given real after-tax discount rate, $r-\pi$, while the cost of debt may increase or decrease, according to whether the loss from paying taxes on the inflation premium at the personal level exceeds the gain from its deductibility at the corporate level. Without assumptions about these tax rates, the effects of inflation on the cost of capital as well as the choice between debt and equity are uncertain.

One may (as in Feldstein <u>et al.</u>, 1978) posit representative values of c, θ and τ that indicate a cheaper average cost for debt, and assume that some compensating factor, such as an interest rate that rises with leverage, leads to an interior solution for the cost of capital. Typically, one assumes that $\theta < \tau$, so that an increase in inflation given $r-\pi$ raises the average cost of debt, and upsets the equality of the two marginal costs, leading firms to issue more debt.

Under this approach, there are real costs and tax benefits to issuing debt. Inflation increases the benefits but not the costs.

An alternative approach is to assume the existence of a Miller equilibrium, and ask what happens to the marginal tax rate θ^* at which individuals are indifferent between holding debt and equity. If θ^* rises, the number of individuals wishing to hold debt will increase and the new equilibrium will be one in which the economy has more debt than before. If the costs of debt and equity are initially equal for the marginal individual with tax rate θ^*, then (5.19) implies that debt will be cheaper (more expensive) than equity at θ^* if and only if:

$$(5.20) \qquad (1-\tau)(1-c^*) \underset{(<)}{>} (1-\theta^*)$$

where c^* is the capital gains tax rate corresponding to θ^*. However, by assumption, $(1-\tau)[1 - (p\theta^* + (1-p)c^*)] = (1-\theta^*)$; hence, $(1-\tau)(1-c^*) \geq (1-\theta^*)$. In a Miller equilibrium, inflation induces a shift <u>away</u> from debt finance. Only if $p = 0$, or if one adopts the "new" view of equity finance in which the cost of equity capital is always independent of the personal tax rate, will inflation be neutral with respect to the choice between debt and equity. Thus, the notion that inflation favors debt finance derives from a view that the marginal investor is taxed more heavily on equity income than debt income. This requires either explicit constraints or some form of uncertainty.

Evaluation of the cost of capital in the more complicated situation in which assets do depreciate and receive allowances based on historic cost is facilitated by the fact that we may express the user cost of capital by replacing the term $r - \frac{\dot{q}}{q}$ in (4.12) with a term that reflects the more complicated tax system we have analyzed:

$$(5.21) \qquad F' = C = \frac{q}{p}(d(1-\tau) + \delta)(1 - k - \tau Z)/(1-\tau)$$

where d is the firm's real cost of funds before tax, equal to a weighted average of the costs of debt and equity in (5.19), and Z is the present value of depreciation allowance discounted at the nominal rate $d(1-\tau) + \pi$ (Auerbach 1981_). For the equity financed firm, and no personal taxes, $d(1-\tau)$ reduces to $r - \pi = r - \frac{\dot{q}}{q}$. Similarly, the real cost of capital may be derived by replacing $r - \frac{\dot{q}}{q}$ in (4.15) with $d(1-\tau)$, and subtracting the inflation rate, to obtain:

$$(5.22) \qquad \rho - \pi = \frac{(d(1-\tau) + \delta)(1 - k - \tau Z)}{(1-\tau)} - \delta$$

When assets don't depreciate and receive no investment credit or depreciation allowances, this expression reduces to d, the weighted average of the terms in (5.19). For given values of δ and b (the optimal values of which might change as a result of a change in π), one can use (5.22) to measure the total effect of a change in the inflation rate on the firm's cost of capital, and can isolate the individual effects of the tax provisions dealing with capital gains, interest payments and depreciation, as well as the response of the real, after-tax return, $r - \pi$. One can also calculate the effective total tax rate on an investment by comparing the cost of capital derived in (5.22) to the net, after-tax return $r - \pi$ that is received by holders of securities. Finally, one can measure the effective corporate tax rate by assuming all investment to be equity financed and ignoring personal taxes. This amounts to replacing $d(1-\tau)$ with $r - \pi$ in equation (5.22) and comparing the resulting value of $\rho - \pi$ with $r - \pi$ or, alternatively, comparing the value of $\rho - \pi$ obtained from (5.22) with the real, after corporate tax discount rate $d(1-\tau)$. The effective corporate tax rate is simpler to calculate than the total effective tax rate, and is a useful device for comparing existing depreciation provisions with economic depreciation (which would yield an effective rate of τ) and expensing (which would yield an effective rate of zero). It is also helpful in comparing the impact of the tax law on different assets. Under the assumption that real and financial decisions are separate, differences among investments in the total effective tax rate come solely from differences in corporate tax treatment.

The most comprehensive measurement of the total effective tax rate on corporate source capital income is provided in a comparative study by King et al. (1983) of capital income taxation in the U.S., the U.K., Germany and Sweden. The approach used is to obtain estimates of real, after-tax rates of return, financial policy, representative personal tax rates for different classes of investors, and the rate of inflation, and then calculate the effective tax rate, following a procedure like the one outlined above. Among other results, the study found that increases in the rate of inflation, on balance, increase the effective tax rate in the U.S. (though not in all countries). For example, under 1970 tax law, a rise in the inflation rate from zero to 6-2/3 percent would have raised the estimated effective tax rate by 3.5 percentage points, from 43.7 to 47.2 percent. A striking result, for all countries, is the extent to which effective tax rates differ across investments because of the pattern of depreciation allowances and investment tax credits. This is consistent with several studies that have looked exclusively at the effective corporate tax rate, starting with some assumed after-corporate-tax discount rate and comparing it to the cost of capital. Estimates in Auerbach and Jorgenson (1980) and Jorgenson and Sullivan (1981) suggest great differences in effective corporate tax rates across investments, with a trend since 1954 favoring investment in equipment relative to structures. This has resulted from several rounds of acceleration of depreciation schedules, which were more beneficial for equipment, as well as the introduction, in 1962, and increase, in 1975, of the investment tax credit, which applies only to equipment.[37] Under the Economic

Recovery Tax Act of 1981 (since amended by the Tax Equity and Fiscal Responsibility Act of 1982), the effective corporate tax rate, for a 4 percent after-tax corporate return and an 8 percent inflation, is negative for representative types of equipment but near the statutory rate of 46 percent for structures (Auerbach, 1982c; also see Gravelle, 1982). If real and financial decisions are independent, this suggests a substantial bias in the tax law against investment in structures.

To calculate the cost of capital, we must know not only the effective tax rate but also the after-tax return. For example, increases in the effective tax rate may be partially offset by declines in the after-tax return. In such a case, the increase in the effective tax rate would overstate the increase in the cost of capital and the decline in the incentive to invest. For debt finance, it is easy to calculate the real cost of funds; one simply substitutes the nominal interest rate into expression (5.19b). If desired, the return after personal taxes may be calculated using an estimate of the tax rate θ. However, this last step is not required if one is interested in the cost of capital itself rather than the effective tax rate. For equity, the calculation is more difficult. Under a Miller equilibrium, it is also unnecessary, since the interest rate is the cost of capital for all sources of finance. More generally, though, the weighted average approach gives a more accurate estimate of the cost of capital if average costs of debt and equity differ. A common approach, used by Feldstein (1982) for the U.S. and Boadway, Bruce and Mintz (1982) for Canada, is to represent the real return on equity as the ratio of corrected after-tax corporate profits to equity value.

Unfortunately, the earnings-price ratio differs from the desired, but unobservable measure of the retired return on equity for a number of reasons. First of all, it is a realized return rather than the <u>ex ante</u> expected return.

Second, current earnings need not reflect future expected earnings; high price-earnings multiples may reflect the prospect of future rents, rather than a low discount rate. Third, the use of the earnings price ratio as a real return assumes an anticipated rise in share prices at the general inflation rate. Finally, the expected return to equity includes a premium for risk.[38] Indeed, one explanation of the decline in the U.S. stock market during the 1970s was an increase in the risk premium demanded by investors in common stocks (Malkiel, 1979). If this were correct, and attributable to an increase in the riskiness of the stock market (as opposed to increased risk aversion) the rise in earnings relative to price would not signify any increase in the cost of capital for a project with given risk characteristics, and would lead to an overstatement of its cost of capital during the 1970s.[39] In calculating the cost of capital in the U.S., Feldstein (1982) finds a general postwar pattern with no obvious trend. While the tax law with respect to depreciation became steadily more generous, inflation rose and thereby increased the effective corporate tax rate relative to the zero inflation tax rate. Finally, his estimate of the real cost of funds rose, despite a decline in the real after-tax interest rate, because of a sharp decline in the price-earnings ratio in the 1970s.

An approach to measuring the effective taxation of corporate source income to that based on the cost of capital involves the use of observed flows of profits and interest payments and taxes for corporations in a given year to estimate the effective rate of tax at the corporate level. This approach, used by Feldstein and his collaborators,[40] differs from the previous one by focusing on actual current profits and taxes rather than hypothetical future ones. This may offer an advantage in presenting a more accurate description of reality, but gives an average tax rate that may be an inaccurate measure of the effective corporate tax rate faced by new investment undertaken in a given year. This error is inevitable whenever accelerated depreciation and investment tax credits lead to a deferral of tax payments, relative to those under an income tax, into the later years of an asset's life. A firm with an old capital stock will pay more taxes as a percentage of income than will one with a young capital stock, though both may face the same effective tax rate at the margin. The extreme example of this would occur under a system of expensing, shown above to produce a zero effective corporate tax rate. A second distinction lies in the fact that measured income may include economic rents in excess of the required return on investment. The taxation of these rents does not affect the incentive to invest, but does show up in measures of the average tax rate. Finally, changes in the tax law affecting new investment, which typically have offered a lower effective tax rate to new investment than existing investment, would show up only gradually over time in an average tax rate measure.

A comparison of the cost of capital and average tax rate approaches in King et al. (1983) suggests that for the year 1979, the total effective tax rate is substantially higher when calculated using this average tax rate approach rather than the cost of capital approach.

The results of Feldstein and Summers (1979) and Feldstein et al. (1983) also suggest that the total effective tax rate is more sensitive to the rate of inflation than results of King et al. For example, Feldstein and Summers estimate that of the total effective tax rate of 67.8 percent in 1970, at an inflation rate of 5.5 percent, 26.6 percent of the taxes collected were due to inflation. This translates into a 3.3 percentage point increase in the total effective tax rate per percentage point increase in the inflation rate, compared to the value of about half a percentage point implied by the results of King et al. This difference may stem from many sources, but one important one is the different assumptions made by the two studies about the personal tax rate on interest income, θ. Feldstein and Summers use an aggregate value of 42.0 percent, which leads to the conclusion that the gains from the full interest deductibility of debt by corporations are roughly offset by the losses of bondholders. It is difficult to know whether this tax rate is appropriate, though evidence on the yield differential on comparable tax exempt and taxable bonds (Gordon and Malkiel, 1981) suggests an implicit tax rate that is substantially lower. This is an important issue because of the substantial increases in inflation experienced during the 1970s.

VI. Uncertainty and the Cost of Capital

Formally, one may analyze problems of uncertainty without departing from the model used to study deterministic models. We may think of uncertainty as adding an additional dimension to the firm's investment decision; projects have a pattern of returns across different states of nature as well as across time. Just as the rate of time preference defines the price in current dollars of output in successive periods, consumers have preferences with respect to output in different states of nature, described by marginal rates of substitution across these states, that define the prices of such state-contingent commodities. In the competitive equilibrium of such an Arrow (1953) - Debreu (1959) economy, there exist unique prices for each state-contingent commodity at each date, and assets are priced according to the bundle of returns they offer across these dates and states. Markets for the individual state-contingent commodities need not exist for such prices to be defined. Since each investment may yield a different pattern of returns across states of nature, a consumer may be able to obtain output in a single state through the purchase of a particular combination of assets. By the requirement that no unexploited arbitrage opportunities can exist in equilibrium, different asset combinations that yield a unit return in a given state must have the same total cost. This defines the "implicit price" of the commodity.

However, the ability to obtain each state-contingent commodity separately rests on the unlikely existence of enough assets relative to the number of commodities. Specifically, there must exist as many assets with linearly independent returns as there are states of nature for the assets to "span" the space of returns. Otherwise, only a subspace of lower dimension is spanned, with prices defined. For example, with three states of nature and two assets, one can obtain only combinations of the state-contingent returns that lie on a particular plane in the three-dimensional state space. The price of a unit of output in one of the states is not defined unless this unit bundle lies in the plane of feasible purchases.

Even without spanning, however, there need be no breakdown in the application of the general results of certainty analysis with respect to firm behavior. As long as firms produce within the subspace spanned by existing assets, and behave competitively in that they take prices for feasible combinations of state contingent returns as given, the Fisher separation theorem still applies, and each firm's owners will unanimously support a policy of market value maximization.[41]

In this context, the Modigliani-Miller (1958) Theorem may be interpreted as saying that the way in which a given bundle of state-contingent commodities is divided between claims of debt holders and equity holders can have no effect on the bundle's total price. With complete spanning, this is a trivial result. Investors can engage in "homemade leverage," maintaining their preferred vector of consumption across states of nature in the presence of a change in any firm's financial policy. However, in the absence of complete spanning, a change in firm financial policy may result in a change in the dimension of the subspace of commodities available to consumers. For example, with limited corporate liability, an increase in firm leverage may cause bankruptcy, and a zero equity return, in some states of nature. The consumer, by hypothesis not possessing limited liability, cannot replicate this pattern by borrowing on his own. Thus, firm leverage may widen the choice of return bundles available to the consumer, and thereby have real effects (Stiglitz, 1969). This result is similar to the one already discussed in Section II in which firms and households face different borrowing rates.

There are many other reasons why the introduction of uncertainty may influence the leverage decision. Aside from changing the available menu of state-contingent return bundles, bankruptcy may involve real social costs, rather than just a change in the distribution of returns between owners of debt and equity. Further, there is an information problem not dealt with in the simple Arrow-Debreu model. Firms subject to limited liability may misrepresent their return bundle as very safe, and hence with a low probability of bankruptcy, and sell large amounts of debt at a higher price than the actual pattern of returns could dictate. In this sense, truth telling is not "incentive compatible." However, if managers face a particular compensation structure, such as a stiff financial penalty if the firm goes bankrupt, investors may in equilibrium be able to infer the firm's real prospects from the manager's leverage decision. This application of "market signalling" (Spence, 1974) is discussed in Ross (1977). The actual design of incentive-compatible compensation structures for managers ("agents") by asset holders ("principals") is referred to as the "principal-agent" problem (Ross, 1973) or, simply, the "agency" problem. For a given compensation structure, a manager typically will find there to be a unique optimum for the debt equity ratio. Thus, the leverage decision and the resulting cost of capital is very dependent on the information structure of the economy and the incentives faced by decision-makers.[42]

As with the choice of financial policy, firms will choose to maximize market value with respect to real investment decisions if they are competitive and the investments produce returns that lie in the subspace already spanned by existing securities. If a new investment produces returns that are "large" relative to the existing markets for such returns, perhaps because it offers a previously unobtainable state-contingent commodity bundle, the firm can influence the opportunity set of its investors at the same time it alters their wealth (Ekern and Wilson, 1974; Radner, 1974). In general, once it is allowed that a firm can influence the implicit prices of state-contingent commodities faced by its stockholders, the Fisher separation theorem breaks down because an increase in wealth no longer leads to a parallel outward shift in a consumer's budget line. Thus the sign of the change in welfare caused by a change in wealth depends on the preferences of the individual consumer, and stockholders with different preferences or shares in the firm will normally oppose wealth maximization and disagree about what the firm should do (King, 1977). Indeed, the entire concept of wealth is ambiguous when relative prices change, since it depends on the choice of units.

If one defines the cost of capital to be the expected return a firm requires for a project with given risk characteristics, this cost is uniquely defined only if the competitive assumptions are satisfied. Otherwise, the different objectives supported by different stockholders translate into different rates of return they would require the firm to earn on a project. Furthermore, if firm policy is determined by some collective decision rule such as majority voting, an announced policy may lead to a change in shareholder composition, which in turn may lead to a new vote and policy. Hence, it is not sufficient to say that a firm's behavior is determined by its stockholders.

One important case in which the conditions for competitive behavior are met (Ekern and Wilson, 1974) is the mean variance model, in which individual preferences are assumed to depend only on the mean and variance of the distribution of state-contingent returns.[43] This case forms the basis of the Capital Asset Pricing Model (CAPM) (Sharpe, 1964; Lintner, 1965) in which each asset i has an equilibrium expected rate of return:

(6.1) $\bar{r}_i = r_f + P_\sigma C_{i,\mu}$

where r_f is the risk-free return, $C_{i,m}$ is the covariance of the firm's return with the economy's aggregate return (and hence the part of its risk that is undiversifiable) and P_σ is the "price of risk" that depends on the distirbution of wealth and risk preferences across individuals.[44] Using the fact that (VI.1) also holds for the aggregate, or "market" return r_m, we may rewrite it as

(6.2) $\bar{r}_i = r_f + \beta(r_m - r_f)$

where β is the regression coefficient of the firm's return on the market return, $C_{i,m}/C_{m,m}$: its "beta."

Since the standard CAPM is a model in which stockholders will unanimously favor market value maximization, expression (VI.1) also defines the cost of capital for a prospective project with the same risk characteristics. Any project yielding greater than $\bar{r}_i$ per dollar will sell for more than one dollar and increase wealth.

An important characteristic of equilibrium in the CAPM is that all investors hold the same portfolio of risky assets, regardless of their attitudes toward risk: the market portfolio. Differences in willingness to bear risk are reflected solely in the fraction of wealth placed in the risk-free asset, debt, as opposed to the risky equity portfolio.[45] Thus, one may think of the investor's decision between debt and equity as a trade-off between risk and return. This distinction is important because it introduces an additional element to the firm's leverage decision in the presence of differential taxation.

VII. Uncertainty and Taxation

The analysis of the previous section showed that there are a number of reasons why financial policy may influence firm valuation and the cost of capital with uncertainty present. Two additional arguments rest on the interaction of taxes and uncertainty. One involves the fact that there may be complete markets for state-contingent commodities, but only if one is willing to hold debt as well as equity. The other relates to a realistic modelling of the corporate tax as one with asymmetric treatments of gains and losses.

Recall that the Miller model of capital market equilibrium under certainty predicts that investors will specialize their holdings in debt or equity according to whether their personal tax rate is less than or greater than some critical value θ^* (see Section V). In this equilibrium, firms are indifferent between debt and equity finance, and the cost of capital for each source is the interest rate. In contrast, the Capital Asset Pricing Model predicts that individuals will choose a combination of riskless debt and the market portfolio of risky equity according to their willingness to bear risk. However, here too, the choice of debt-equity ratio by firms has no effect on market value, by the Modigliani-Miller theorem. The cost of capital, measured as the required expected rate of return for the firm, exceeds the risk-free interest rate by a risk premium (see equation (VI.1)), but is independent of the firm's debt-equity ratio.

It may seem something of a paradox, then, that the combined effect of risk and taxation would lead to a situation in which financial policy matters, but this indeed is the outcome that occurs. For a given financial policy for each firm, both tax and risk preferences will influence an investor's choice between debt and equity, as well as the specific equity portfolio held. Investors who would prefer to hold only equity for tax purposes ($\theta > \theta^*$) may nevertheless hold some debt because a portfolio containing only equity may be too risky. They will also tend to concentrate more in less risky types of equity for a given amount of risk (Auerbach and King, 1983).[46] A corollary is that investors with a tax preference for, say, debt would prefer to hold more debt themselves, and have the firms in which they hold equity borrow more. This merely generalizes the result of Modigliani and Miller (1963) that a corporate tax alone should cause investors to prefer that firms do whatever borrowing is done. The difference here is that only some individuals have a tax preference for debt ($\theta < \theta^*$) when personal taxes are taken into account. Thus, a high-bracket investor may gain if a firm in which he holds equity chooses to borrow less, for then he can purchase less debt and hold shares in the now less risky firm in greater amounts, while a low bracket investor will lose for the same reason. Only when "tax spanning" occurs, i.e., the firm's action has no tax consequences for investors because the same state contingent returns are available from holding debt as from holding equity, will the disagreement dissolve and the Miller equilibrium be reestablished (Auerbach and King, 1983). Otherwise, the usual problem of determining the cost of capital with incomplete markets is present.[47]

Evidence certainly suggests that investors do diversify as this model would predict. The model also predicts that the equity portfolios of investors will vary systematically with their tax rates, with higher bracket investors purchasing less risky stocks and, given risk, stocks with lower dividend payout rates. While evidence based on the behavior of share prices around <u>ex</u> dividend days appears to support the latter proposition, which was first put forward by Miller and Modigliani (1961) (Elton and Gruber, 1970), it does not seem to support the former (Auerbach, 1983).[48]

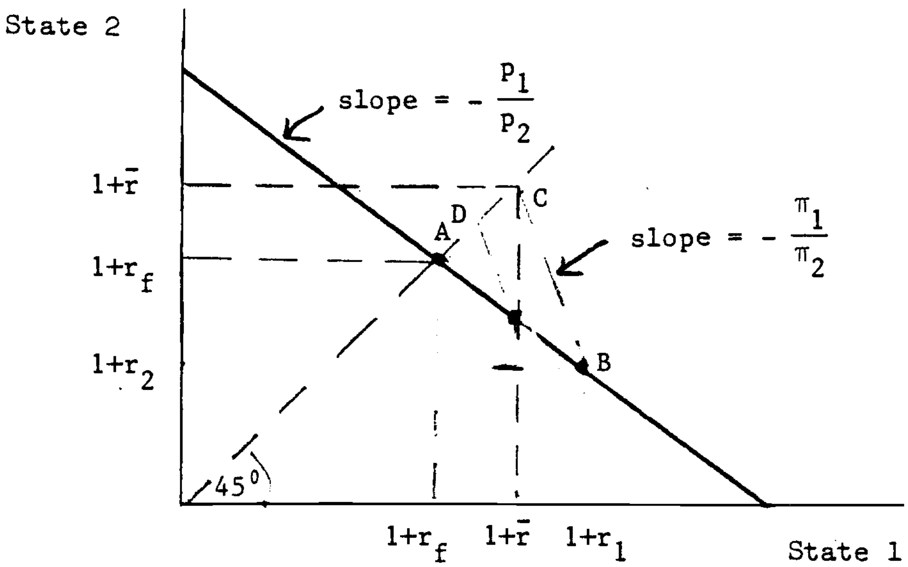
A second way in which taxes influence the leverage decision in the presence of uncertainty is through the asymmetric treatment of gains and losses under the corporate income tax. In the U.S., as in most countries, negative taxable income does not entitle the corporation to a tax refund at the corporate tax rate. Rather, losses may be used immediately to offset previously taxed income to a limited extent ("carried back") and held on account, without interest, to offset future taxable income ("carried forward").[49] The lack of full refundability means that the more a firm finances with debt, the more likely it will lose some of the value of the interest deduction through having to carry a loss forward for one or more years.[50] This led De Angelo and Masulis (1980a) to suggest that the optimal debt-equity ratio occurs at a point where the marginal loss in value of interest deductions just offsets the normal tax advantage of debt finance. An implication of this model is that, even in the absence of personal taxes, the cost of capital exceeds the interest rate, because of the partial expected deductibility of expected interest payments. Another implication is that assets with different risk characteristics may have different optimal fractions of debt finance. For example, a firm investing in completely safe capital may lever more fully because there is no possibility of losing an interest deduction. This potential outcome of greater debt finance for safer investments also characterizes other models of optimal capital structure, such as the bankruptcy cost model, for similar reasons.[51] Such a breakdown in the separation between real and financial decisions may have important implications for effective tax rate calculations, such as those presented in Section V. For example, the result that investment in structures relative to equipment is discouraged may be overturned if leverage costs are lower for investments in structures. Little work has been done on this issue.

Uncertainty also influences the meaning of measured effective tax rates. For example, a project that yields 10 percent before tax but 6 percent after tax would face a 40 percent tax rate if both returns were certain. However, if both returns are uncertain, the fraction of income extracted by taxation, adjusted for risk, depends on the risk characteristics of both before-tax and after-tax returns. A safe return of 6 percent is worth more than a return of 6 percent with a high beta.

A simple case to start with is a pure income tax. In an Arrow-Debreu model, an income tax would extract the same fraction of an asset's return in each state of nature; there would be no ambiguity about the effective tax rate here. Even in this case, however, one must be careful in interpreting this effective rate. For example, suppose that the risk free rate of return is zero. Then, as shown first by Tobin (1958), the investor's welfare is unaffected by the income tax. Moreover, as shown by Gordon (1981), if the tax revenue received by the government is put back into the economy in lump sum fashion, such a tax will have no effects at all. In general, an income tax on excess returns above the safe rate will have no real effects. We may hypothetically separate an asset's return into two parts: a safe return at the riskless rate, plus a risk premium that has zero value (Auerbach, 1981c). Taking away part of the latter does not affect the consumer's welfare. This is easily demonstrated in a two-state diagram, as shown in Figure 7.1. Here, the riskless asset yields r_f in both states, as shown at point A, while the risky asset yields r_1 in the "good" state and r_2 in the bad state. The budget line between A and B has slope $-\frac{p_1}{p_2}$, where p_1 and p_2 are the implicit prices of the state contingent commodities. Assuming the risky asset has an expected return in excess of r_f, then $\pi_1/\pi_2 > p_1/p_2$, where π_1 is the investor's subjective probability of the

Figure 6.1

A Tax with No Effect



occurrence of state i. The risky asset's expected return equals $\bar{r}$, as shown at point C in the diagram. An income tax assessed on the excess of the risk-free rate will shift the post-tax return on the risky asset to point D. Though this yields a lower post-tax expected return, it leaves the consumer on the same budget line.

This result has the important implication that taxation matters only to the extent that an asset's risk-adjusted return before and after taxes differ. Gordon (1981) argues that the real risk-adjusted gross return has been approximately zero in the U.S., so that income tax rates, like those estimated in the empirical studies discussed in Section V, do not impose a loss in welfare on investors and do not distort the incentive to invest.

There are a number of difficulties with this result, even if the real risk-adjusted return to investors is zero. If tax revenues are simply valueless risk premium reductions, then they would have to be negative in some states of the world. Since aggregate tax revenues have not displayed this characteristic over time, something is amiss. One likely problem is the fundamental assumption in the foregoing analysis that what has no value to the investor also has none to the government. This would be true if the government was a taker of implicit prices for the state-contingent commodities. However, if markets are incomplete, as in the case where no private stock market exists for diversifying risks, the collective tax revenue may be pooled to yield a fund with positive value to investors. This situation would yield an even more striking result, that the positive expected tax collections not only do not reduce the welfare of investors but, if redistributed to them, actually improve it.

A second problem with the analysis is that it assumes the presence of an income tax. Since assets depreciate, an income tax would involve stochastic depreciation allowances, with firms allowed a greater deduction in states of nature in which heavy depreciation occurs. (Alternatively, this would require nonstochastic depreciation allowances based not on expected depreciation but risk-adjusted depreciation (Bulow and Summers, 1981).) Without such depreciation allowances, an asset's effective tax rate will differ across states of nature, and the value of resources extracted from the investor will depend on the nature of the asset's depreciation pattern. This means that, even if one explicitly allows for risk in making effective tax rate calculations, the resulting measure does not apply generally to all assets with a given expected rate of depreciation.

VIII. Conclusion

Modigliani and Miller (1958) cut through an extremely complicated field with a single result, compelling and intuitively appealing: use the interest rate as the (risk-adjusted) cost of capital. Taxes have made things more complicated, though Miller's (1977) attempt to bring back the original message has exerted some force.

Not all taxes need distort the incentive to invest or influence the cost of capital, either because they may be capitalized in the value of assets, or because they may affect only an asset's expected but not risk-adjusted return. If they do change the cost of capital, they may do so in different ways for different investors. How these changes are to be aggregated into a single effect on the firm is an open question. It is likewise difficult to obtain a simple result when markets are incomplete, or when firms can use financial policy to influence the market perception of their characteristics. Indeed, if managers act in their own interests rather than those of their shareholders, how does the cost of capital relate to the preferences of these owners of the firm? Though we have learned much in recent years, we have raised many new questions in the process.

Footnotes

1. A pure income tax would also tax the initial gain on infra-marginal investments, purchased for less than the present value of their future returns. Therefore, (3.1') should be interpreted at $t = 0$ as the value of an asset after the payment of the initial tax. This component of the income tax is simply a tax on pure economic rent.

2. See Andrews (1975) for an initial treatmennt; U.S. Treasury (1977) and Institute for Fiscal Studies (1978) for more comprehensive analyses. The idea of a consumption tax itself goes back to Irving Fisher (1939) and beyond.

3. Thus, the outcome for expensing with r fixed is the same as that for economic depreciation with $(\frac{r}{1-\tau})$ fixed (Hall and Jorgenson, 1971).

4. This assumes the tax on capital gains and losses to apply as well to initial revaluations after purchase. See Footnote 1. A slightly different result, that $\phi = (\frac{1-\alpha}{1-\alpha\tau})$ and gross rents are multiplied by $(\frac{1-\tau}{1-\alpha\tau})$, holds if we ignore taxation of initial gains and losses, in which case $P_0 = 1 - \alpha\tau$. This corresponds to the approach in Auerbach (1979a).

5. It is not possible to present here even a partial list of references to papers on this topic. For early applications and extensions, see Hall and Jorgenson (1967, 1971), Bishoff (1971), Eisner and Nadiri (1968), and Feldstein and Flemming (1971).

6. This depreciation could also come about as the result of a constant rate of embodied technological growth, making new capital goods more productive than old ones less so. See Feldstein and Rothschild (1974).

7. The function ϕ is sometimes assumed to have (I/K) rather than I as its argument. This is not important for the current expositional purpose.

8. Historically, there have been several ways of treating the credit in terms of its impact on an asset's depreciable base. Between 1962 and 1963, investors were required to write down their basis by the full value of credits received, under the so-called Long Amendment. Since passage of the Tax Equity and Fiscal Responsibility Act of 1982, a fifty percent basis adjustment has been required. Between these two periods, no adjustment was requested. We deal primarily with this case in the following analysis. For further discussion, as well as an analysis of related incentives, see Auerbach (1982c).

9. Sometimes, investors may do better by selling assets and repurchasing new ones to take continued advantage of such provisions as accelerated depreciation. This is discussed in Auerbach (1981b) and Auerbach and Kotlikoff (1982).

10. As in Auerbach (1979a).

11. For attempts at estimating economic depreciation from asset resale market data, see Hulten and Wykoff (1981). Such a procedure is tricky, because of the special tax treatment of the sale and purchase of used assets and the "lemons" problem of adverse selection (Akerlof 1970) that owners, knowing the quality of their assets better than prospective purchasers, will offer only inferior capital goods at the going price.

12. This follows from the results of Diamond and Mirrlees (1971). For a specific treatment of capital taxation, see Auerbach (1979d; 1982a). The measurement of the efficiency loss from differential taxation of capital income was explained first by Harberger (1966) with respect to the corporation income tax. Also see Shoven (1976).

13. See Feldstein (1978) for further discussion.

14. This result can be extended to any type of capital good with a pattern of returns over time that produces a single internal rate of return, since an increase in the discount rate makes existing marginal projects unprofitable. However, for projects with multiple internal rates of return, such as those with negative cash flows at the end as well as the beginning of the project's lifetime (as discussed in Hirshleifer, 1970), an increase in the discount rate may actually make marginal projects profitable. For example, a nuclear power plant with large terminal clean-up costs might be made more attractive as an investment by an increase in the discount rate that lessens the weight of those terminal costs relative to the positive cash flows generated by the plant during its operation.

This ambiguity relates to the "reswitching controversy", which included a discussion of whether one could think of capital as a productive factor receiving a rate of return.

15. This discussion follows Auerbach (1979a). The general model without taxes has been used by Swan (1970) and others to address different issues. Abel (1981) demonstrates how adjustment costs may be incorporated into the model with taxes.

16. This "tree" model goes back to Wicksell (1954). For a general treatment of taxation in Austrian models, see Lippman and McCall (1981), Kovenock and Rothschild (1983) and the references contained therein.

17. It is especially important here to remember that an income tax would collect a constant fraction of annual cash flow <u>plus</u> capital gains. With an appreciating asset such as this, such a tax would amount to a tax on accrued capital gains, with no tax on the cash flow at date T, as it is offset by the decline in asset value (from B(T) to zero).

18. The ambiguous concept of tax "neutrality" has been used by different authors to describe tax systems that impose the same cost of capital on all projects and those that, in current terms, do not affect the choice of asset life. These two criteria are obviously inconsistent with each other, and both are inconsistent with a third use of the term to refer to tax systems, such as expensing, that have no distortionary effects at all. See Auerbach (1982a).

19. For early discussion and measurement of this effect, see Shoven and Bulow (1975) and Tideman and Tucker (1976).

20. A method of price-level indexing based on the assumption that $r-\pi$ is constant, proposed by Auerbach and Jorgensen (1980), would have granted a single first-year depreciation allowance equal to $\frac{\delta}{r-\pi+\delta}$ for each asset.

21. This ambiguity has been noticed by Feldstein (1981) and Kopcke (1980), among others. As with the definition of "neutrality" (footnote 18), one must be careful when asking how inflation biases the choice of asset durability.

22. An accrual-equivalent capital gains tax rate is one that would yield the same terminal after-tax wealth for an investor realizing a capital gain. For example, suppose an asset grows in value at rate g from an initial value of V_0, and is sold at date T. Then the accrual-equivalent, c, of a capital gains tax rate μ is defined by:

$$V_0(1 + g(1-c))^T = \{(1-\mu)[(1+g)^T - 1] + 1\}V_0$$

or

$$c = \frac{(1+g) - \{(1-\mu)[(1+g)^T - 1] + 1\}^{\frac{1}{T}}}{g}$$

For example, if $\mu = .20$ (the current U.S. maximum), T = 10 and g = .10, c = .143. Naturally, c depends on g and T, as well as μ. A longer holding period increases the deferral advantage of a capital gains tax, since only the simple gain over basis is taxed. Similarly, a faster growth rate makes deferral more valuable. Thus, there is no single value of c, given μ. Indeed, it is the decline in the value of c as T increases that contributes to the "lock-in" effect that discourages investors from realizing their gains. One proposed method of alleviating this effect would be a lifetime averaging scheme (Vickrey, 1939) that would effectively tax realized gains at a rate increasing with the holding period.

23. For any T, application of (5.4) successively up to T yields

$$V_0 = \sum_{t=1}^{T}(1 + \frac{r}{1-c})^{-t} (\frac{1-\theta}{1-c})(1-\tau)x + (1 + \frac{r}{1-c})^{-T}V_T$$

Thus, we are assuming in (5.5) that the remainder $(1 + \frac{r}{1-c})^{-T}V_T$ approaches zero as T approaches ∞.

24. See Auerbach (1979c, 1982e).

25. Inframarginal equity may arise in Stiglitz's model through the retention by the original entrepreneur of the value of his initial "idea" in the form of equity ownership. For the firm to be entirely debt financed, the owner would have to receive an initial taxable payment equal to the value of this idea. No such tax would be due if this residual value were simply retained in the form of equity ownership. For example, a firm which is worth $120 but only invests $100 in capital goods will borrow the $100 to purchase the capital. If it borrows any more, the proceeds will go to the entrepreneur whose idea led to the firm's positive value. He may buy this extra debt with the money received but first must pay a tax on it.

26. Over the past twenty years, dividends as a fraction of corrected, after-tax profits has averaged over 55 percent (Auerbach, 1982d).

27. According to calculations done by Gordon and Malkiel (1981), the ratio of debt to value for U.S. nonfinancial corporations averaged 23.5 percent between 1957 and 1978.

28. This is discussed in greater detail in Auerbach and King (1983).

29. Corporations are the one important exception, since they receive an 85 percent exclusion on intercorporate dividends and hence face an effective tax rate of only 6.9 percent, while being fully taxed on capital gains at a rate of 28 percent. Although some authors have used this fact to explain the payment of dividends, intercorporate holdings do not seem to be sufficiently large to justify such a position.

30. The following line of argument closely follows that in Auerbach (1979b).

31. The derivation of the firm's cost of capital in such a model has been discussed by Edwards and Keen (1983) and Auerbach (1982e).

32. This was first pointed out by King (1974).

33. The fact that retentions are a cheaper form of finance than new issues has been recognized for a long time (see, for example, Baumol and Malkiel, 1967; Farrar and Selwyn, 1967). However, it is the explanation of the existence of dividends in light of this advantage that remained unclear.

34. See Bradford (1981). A change in θ may indirectly influence the cost of capital through its effect on r via the taxation of alternative assets. However, one may imagine this neutrality result as applying strictly to a change in the tax rate on dividends rather than all personal income.

35. Auerbach (1982e) estimated the cost of capital required for different forms of finance by relating observed earnings to previous financial policy.

36. Poterba and Summers (1981) used the relationship of investment to q (discussed above) to test the new view. Under the new view, changes in θ influence q but should not affect investment, while changes in q caused by other factors (such as expectations about future profitability) should. They found that investment responds to changes in q that, under the new view, would have been caused by changes in θ. This led them to reject the new view in favor of the classical view, where q is not influenced by tax rate changes. In considering such "q" models of investment, it is important to distinguish between the definition of q used in this section, as the ratio of market valuation to marginal cost of a new unit of capital, including any costs of adjustment, and Tobin's q, which is the ratio of market value to replacement cost excluding such adjustment costs. Indeed, what lies behind the Poterba-Summers approach is that it is the difference between these two notions of q that relates to investment.

37. See Auebach (1982c) for a more detailed discussion of these changes.

38. This is also true of debt, of course, but to a lesser extent, since common stock is much risker.

39. This need to allow explicitly for risk will be dealt with in the remainder of the paper.

40. Feldstein and Summers (1979); Feldstein, Poterba and Dicks-Mireaux (1983).

41. See, for example, Grossman and Stiglitz (1980).

42. A particular kind of managerial misrepresentation is in the form of lying about the types of new investments the firm plans to undertake (Jensen and Meckling; 1976, Myers, 1977). The explanation of dividend payments as a signal has also been made (Bhattacharya, 1980).

43. Ross (1976) discusses alternative assumptions leading to the same asset pricing structure.

44. The static CAPM has been extended in many ways. See Jensen (1972) for a survey. Merton (1973) first considered the extension of the CAPM to a multiperiod context. More recently, Breeden (1979) showed that the multiperiod CAPM takes on a partiuclarly simply form if one relates individual returns to consumption rather than the "market", with the "consumption beta" determining the expected risk premium.

45. This separation theorem does not always hold in more general models. See Cass and Stiglitz (1970).

46. This follows from the solution for equilibrium in a capital asset pricing model with taxes. Earlier work on this topic may be found in Brennan (1970), Eltòn and Gruber (1978) and Gordon and Bradford (1980).

47. This issue has also been discussed by De Angelo and Masulis (1980b) and Taggart (1979).

Even this spanning result holds only if equity finance is through new share issues. If additions to equity come through retentions, then the wealth of each investor depends on the tax rate he faces on dividends. Thus, the relationship between firm value and investor wealth differs across investors in different tax brackets; even if the conditions for weath maximization are met, investors will disagree on the firm's optimal policy. See Auerbach (1979c, 1983).

48. The use of *ex* dividend day stock price behavior has been criticized as a method of determining the tax brackets of stockholder clienteles. See Miller and Scholes (1981). Also see the discussion in Modigliani (1982). While some direct evidence is available on portfolio behavior by tax bracket (Blume *et al.*, 1974; Lewellan *et al.*, 1978), these data are not rich enough to allow the assessment of the *partial* effects of dividend policy and risk on clientele composition.

49. The more generous the depreciation deductions of a tax system, and hence mo likely the occurrence of tax losses for a firm with given gross cash flow, more important an issue this asymmetry becomes. One of the methods of diminishing the asymmetry involves permitting the sale of tax deductions by companies with tax losses. This was facilitated in the U.S. under "safe harbor leasing" provisions that applied briefly in 1981-1983 but has always been present to a certain extent. See Auerbach (1982b) and Warren and Auerbach (1982) for further discussion.

50. Cross section data on the extent to which this occurs in the U.S. is presented by Cordes and Sheffrin (1981).

51. This "limited tax shield" model and the other models of corporate leverage mentioned above, such as the bankruptcy cost model, do have different implications about certain aspects of the behavior of firms with different characteristics and, in the aggregate, over time. See Gordon (1982) for further discussion and proposed tests.

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