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INFLATION, TAXATION AND CORPORATE INVESTMENT: A Q THEORY APPROACH

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ABSTRACT

This paper examines the role of taxation and inflation in determining the market valuation of corporate capital and the level of investment. It extends previous work on the q theory of investment by incorporating the effects of taxes levied at the individual level and by focusing on the impact of inflation. The q theoretic approach makes it possible to study the effect of policy announcements and of temporary policies. The resulting model of the investment process is immune from the "Lucas critique". The estimated relationships are technological and independent of the choice of policy rule.

The empirical results indicate that tax policy and inflation have potent effects on both the stock market and investment. These effects depend critically on whether or not policy is announced in advance. Simulations based on q investment equations indicate that an increase in the rate of inflation from 0 to 8 percent would cause an immediate 23 percent decline in the stock market, and a 35 percent increase in the capital stock. Changes in tax policy also have a large effect. The estimated speed of adjustment of the capital stock is surprisingly slow, with less than half the adjustment occurring within 10 years following typical shocks.

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I. INTRODUCTION

The last decade has witnessed a striking decline in the market valuation of corporate capital. In 1967, the Dow Jones Industrial Average stood at 1600 expressed in today's dollars compared to 800 as this is written. As theory would predict, the reduction in the valuation of existing corporate assets has retarded investment. Indeed, the rate of growth of the non-financial corporate capital stock has fallen considerably from 4.8 percent during the 1960's to 3.9 percent during the 1970's. This paper examines the extent to which the interaction of inflation and taxation can account for these phenomena. It also provides an alternative to the traditional econometric framework for estimating the effects on investment and the stock market of changes in corporate and individual tax rules.

The dependence of aggregate investment on the level of the stock market has been widely recognized. As Tobin argued, increases in the return to capital will raise the market value of existing capital signaling the profitability of additional investment. Additional investment will drive down the marginal product of capital, reducing the asset price of capital goods until equilibrium is restored. While models linking the stock market to investment have been estimated, they have not been used to examine the impact of economic policies on investment. This paper develops a method of using investment equations based on stock market valuation to evaluate the effects of changes in capital income taxes. The model relies on the assumption that the stock market valuation of corporate capital represents the present value of its future profit stream. By calculating the effects of tax changes on future profits their impact on the stock market is estimated. This is used as a basis for estimates of their effect on corporate capital accumulation.

This approach has several advantages when compared to previous empirical approaches to modelling investment. Almost all previous evaluations of tax policy's impact on investment have relied on single equation models linking investment to its proximate determinants, usually output and the cost of capital. For the most part, individual taxes have been ignored and the process of adjustment has been handled in an *ad hoc* fashion. Most critically, existing approaches to modelling investment decisions are subject to the "Lucas criticism". The estimated parameters are not likely to be invariant to the choice of policy rules. The equations thus do not provide a basis for estimating the true effects of changes in policy rules. This failing is seen by considering the effect on investment of a tax change announced in year 1, which will take effect in year 2. Standard "backward looking" investment equations imply that such announcements have no immediate impact on investment. The general theoretical approach developed here makes use of the fact that stock market valuation reflects expectation of future policies as well as the effects of taxes levied at the individual level. It can be used to assess a richer variety of tax changes than are normally considered.

The results suggest that changes in inflation and tax rules have very important effects on capital accumulation and asset prices. However, because adjustment costs appear to be substantial, the effects of tax policy on investment are slow to manifest themselves. For example, the results suggest that the elimination of capital gains taxes would raise the ultimate capital stock by 29 percent, but raise the capital stock by only 4 percent within five years. It appears, however, that the interaction of inflation and taxation can account for a significant fraction of the decline in the stock market and capital formation which has occurred during the 1970's.

The second section of the paper outlines a "q" model of investment and uses it to examine the dynamics of market valuation and capital accumulation. The effects of introducing a simple tax system are considered.

The third section of the paper considers explicitly the optimization problem of a value maximizing firm in the presence of taxation and adjustment costs. It is shown that the optimal investment decision at any point in time can be written as a simple function of the firm's market value, its capital stock and the tax parameters. The results of estimating this "tax adjusted q" investment equation are reported in section four. This section also discusses the estimation of the other parameters of the model. The fifth section of the paper uses the estimates developed in the previous section to examine the effect of increases in inflation on capital accumulation and taxation. It is shown that the non-indexed character of the tax system can account for a large part of the decline in the stock market and investment which has taken place over the last decade. The likely effects of continued inflation on capital accumulation are also examined, along with the effects of indexing the tax system. Estimates of the effects of tax reforms on the stock market and investment are presented in the sixth section of the paper. Reforms considered include changes in the investment tax credit, corporate tax integration, corporate tax rate reduction, and the abolition of capital gains taxation. The dynamics of the response to announced changes in future tax rates are also examined. The seventh and final section of the paper discusses some implications of the results and suggests directions for future research.

II. THE STOCK MARKET AND CAPITAL ACCUMULATION

This section examines the dynamics of investment and market valuation in a simplified model where all investment is financed through retained earnings and the only tax is a proportional levy on corporate income. In this setting it is reasonable to assume that investment depends on the ratio of the market value of existing capital to its replacement cost. Unless the market value of the firm will be increased by more than one dollar by a one dollar investment, there is no reason for it to be undertaken. Given costs of adjustments and lags in recognition and implementation, there is no reason to expect that all investments which will raise market value by more than their cost will be made immediately. As Tobin (1969) has argued, these considerations lead to an investment equation of the form:

$$I = I\left(\frac{V}{K}\right) K \qquad (1)$$

$$I(1) = 0 \qquad\qquad I' > 0$$

where I represents gross investment and V/K is the "q" ratio of market value to replacement cost. The assumption that it is I/K which depends on q insures that the growth rate of the capital stock does not depend upon the scale of the economy.

It is assumed that equity owners require a fixed real rate of return ρ to induce them to hold the existing stock of equity. This return comes in the form of dividends, equal to after tax profits less retentions for new investment, and capital gains. Hence we have the condition:

$$\rho = \frac{Div}{V} + \frac{\dot{V}}{V} \qquad (2)$$

which implies:

$$\dot{V} = \rho V - (1-\tau)\; F'(K)K + I\left(\frac{V}{K}\right)K + \delta K \qquad (3)$$

where τ is the corporate tax rate, and F(K) is the production function for net output.

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(1) A rigorous foundation for an investment equation of this type is provided in the next section. The analysis in this section is only intended to be illustrative since adjustment costs are neglected. An important implicit assumption of this approach is the homogeneity of capital. If capital is heterogeneous, shocks may reduce the market value of existing capital but raise the return on new investment. The recent energy shock illustrates this phenomenon.

It will be most convenient to examine the dynamics in terms of K and $q \equiv \frac{V}{K}$. Equations (1) and (3) imply that the system's equations of motion are:

$$\dot{K} = I(q)K - \delta K \tag{4}$$

$$\dot{q} = [\rho - I(q) + \delta]q + I(q) - (1-\tau)F'(K) - \delta \tag{5}$$

where δ is the rate of depreciation.

The steady state properties of the model are easily found by imposing the conditions $\dot{K} = 0$ and $\dot{q} = 0$. These imply:

$$q = I^{-1}(\delta) \tag{6}$$

$$(1-\tau)F'(K) = \rho q \tag{7}$$

The former equation indicates that the steady state value of q must be greater than 1 by an amount just large enough to induce sufficient investment to cover depreciation. The latter equation holds that firms equate their net marginal product of capital to the cost of capital. Inspection of (6) and (7) makes it clear that a change in the corporate tax rate affects the steady state capital stock but has no effect on steady state q. This is a consequence of the assumption that it is investment relative to the capital stock which varies with q.

The phase diagram of the system (4) and (5) is displayed in Figure 1. It is readily verified that the pair of equations is saddle point stable[(2)]. The arrows indicate the directions of motion and the heavy line represents the saddle point path along which the system will converge. A change in the corporate tax rate is depicted in Figure 2[(3)]. If the expectations about pre-tax profits were static, the value of q would jump from E to A when the tax change took place. This expectations assumption has been used in previous work on the effects of taxation on the stock market, (Feldstein (1979), Hendershott (1979). It neglects the effect of the induced changes in investment on the present value of future profits. With perfect foresight, as assumed here, the value of q will jump only to B. The magnitude of the jump will depend upon the speed of adjustment of the capital stock to the shock.

The system of equations (4) and (5) can be solved numerically to estimate the impact of any type of shock on the path of q and the capital stock. The effect of

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(2) This is a common feature of models with asset prices. Abel (1979) was the first to use an approach of this type to analyze investment incentives.

(3) It is assumed that the market selects the unique stable perfect foresight path.

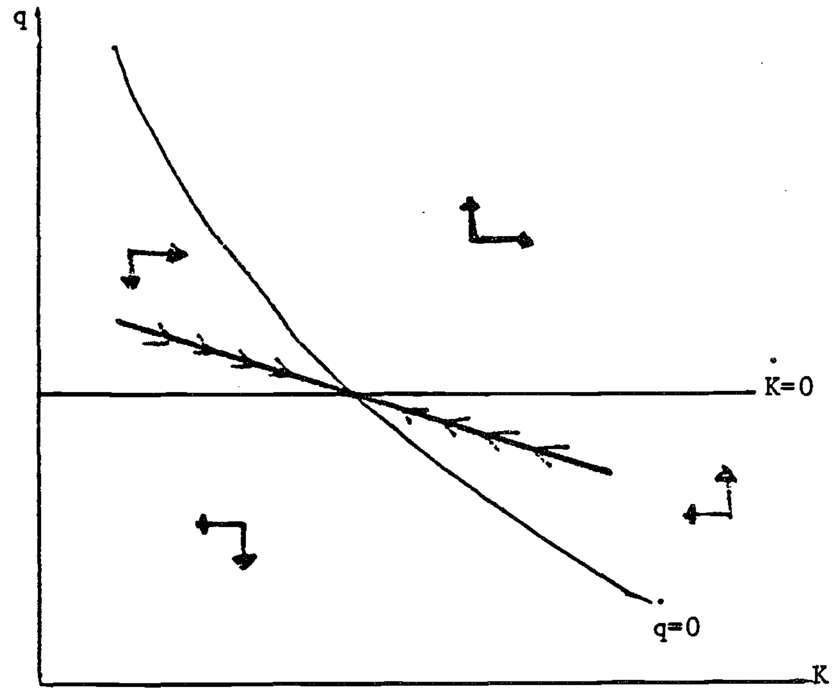

Figure 1

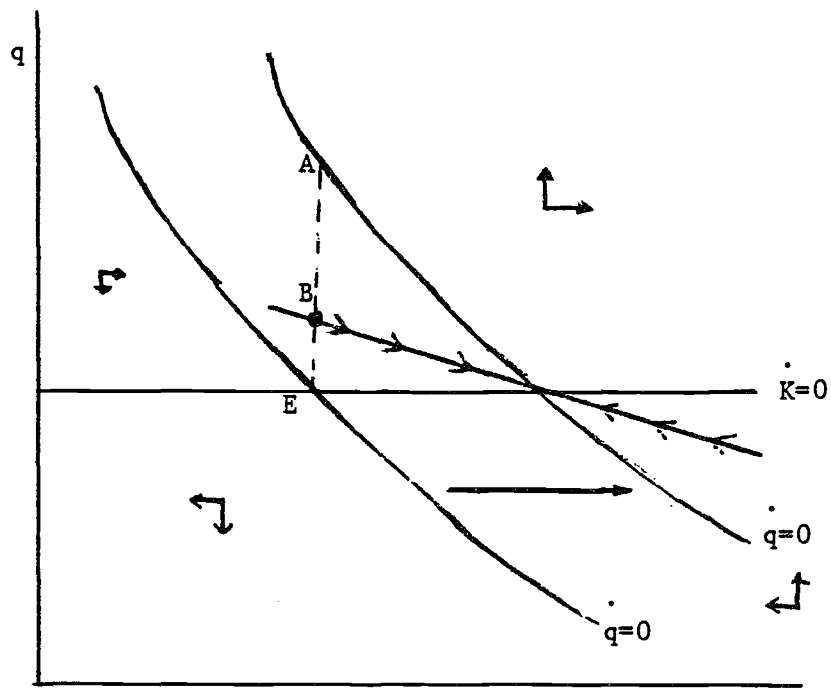

Figure 2

tax changes on the level of the stock market can then be easily calculated. This is the approach taken below to estimating the effects of tax changes. In the next section the firm's optimization problem is considered explicitly, and the tax structure is enriched. The dynamics parallel those described above.

III. THE FIRM'S OPTIMIZATION PROBLEM

In what follows the behavior of a representative, competitive firm seeking to maximize the market value of its equity is considered. We begin by examining how individuals value corporate stock, and then turn to the firm's decision problem. Throughout, it is assumed that firms neither issue new equity, nor repurchase existing shares[(4)]. Hence share prices are proportional to the outstanding value of a firm's equity. We continue to assume that equity holders require a fixed real after tax return ρ in order to induce them to hold the outstanding equity. The value of ρ is not affected by either changes

(4) Under the conditions described below firms would never want to issue new equity. Legal restrictions severely limit firms' ability to repurchase their own shares. A discussion of these restrictions and the limitations of other mechanisms which might seem to be functionally equivalent to repurchasing shares is contained in Auerbach (1979a).

in the tax rules or the quantity of equity. While this assumption may seem extreme, Summers (1980a) shows that in plausible general equilibrium models, tax changes are unlikely to have a large impact on the real after tax return required by equity holders. The required return ρ is the sum of capital gains and dividends net of tax. It follows that:

$$(\rho + \pi)V_t = (1 - c)\dot{V}_t + (1 - \theta^D)\mathrm{Div} \qquad (8)$$

where c represents the effective accrual rate of taxation on capital gains[5], and θ^D the tax rate on dividends, and π is the rate of inflation. Differences in the tax rates faced by different investors are ignored. To solve this differential equation it is necessary to impose a transversality condition. We do this by requiring that at time t;

$$\lim_{s\to\infty} V_s \cdot e^{-\int_t^s (\rho+\pi)du} = 0 \qquad (9)$$

This condition precludes the possibility of an explosive solution to (1).

With the transversality condition satisfied and the assumption of perfect foresight, the solution to (1) becomes:

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(5) This corresponds to the statutory rate adjusted for deferral, and the lack of constructive realization at death.

$$V_t = \int_t^\infty \frac{(1-\theta^D)}{(1-c)} \text{Div} \quad e^{\int_t^s \frac{\rho+\pi}{1-c} du} ds \tag{10}$$

In the steady state where taxes, the price level and dividends are held constant, this expression reduces to:

$$V = \frac{(1-\theta^D)\text{Div}}{\rho} \tag{11}$$

In this case capital gains taxes do not matter because there are no capital gains. More generally, as in (10) capital gains taxes raise the discount rate on future dividends, as well as affecting the valuation of current dividends. Note that equation (10) implies that because of dividend taxes an extra dollar of promised dividends raises share valuation by only $(1-\theta^D)$.

The firm seeks to choose an investment and financial policy to maximize (10) subject to the constraints it faces. It is constrained by its initial capital stock and by a sources equal uses of funds requirement. It will also be necessary to assume that credit market constraints do not permit the firm to finance more than a fraction(6) of its

(6) This is a crude way of modelling the effects of bankruptcy costs on the firm's choice of a debt equity ratio. As noted below, the assumption of a constant debt-capital ratio is a fairly good representation of the recent American experience. McDonald (1980) treats the choice of financial policy in more detail.

investment through debt finance. In the model presented below, this constraint will always be binding, so we assume that a share b of all new investment comes from debt issues and the remainder is financed through retained earnings. Finally, the firm cannot change its capital stock costlessly. The cost of installing extra capital is assumed to rise with rate of capital accumulation. For convenience, it is assumed that the cost function is convex and homogeneous in investment and capital. Under these conditions dividends may be derived as after tax profits less investment expenses.[7] That is:

$$Div = [pF(K,L) - wL - pbiK](1-\tau) - \Big(1 - ITC - b + (1-\tau)\phi\Big)pI + \tau D + pbK(\pi - \delta^R) \qquad (12)$$

where K and L refer to factor inputs, p is the overall price level, F(K,L) is the production function, w is the wage rate, i is the nominal interest rate, τ is the corporate tax rate, ITC is the investment tax credit,

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(7) The assumption here is that all marginal equity finance comes from retained earnings. This follows from the assumption of a constant number of shares made earlier. It accounts for some of the apparently paradoxical results described below. The last term reflects the net receipts from new debt issues (withdrawals) necessary to maintain the debt-capital ratio as the capital stock depreciates and the price level rises.

ϕ is the adjustment cost function which is assumed to be convex, I represents investment, δ^R is the real rate of depreciation, and D represents the value of currently allowable depreciation allowances. It has been assumed that adjustment costs are expensed and ineligible for the investment tax credit.[8]

The tax law is assumed to allow for exponential depreciation at rate δ^T that may differ from δ^R, but to be based on historical cost. This implies that:

$$D_s = \int_0^\infty \delta^T p_u \ I_u \ e^{-\delta^T (s-u)} du \tag{13}$$

Combining equations (2) and (5), making use of (6) and rearranging yields an expression for the value of a firm's equity at time t:

$$V_t = \int_t^\infty \Big[\Big(pF(K,L) - wL - p\,bKi \Big) (1-\tau) - \Big(1 - ITC - Z_s - b + (1-\tau)\phi \Big) pI + PbK(\pi-\delta) \Big] \frac{(1-\theta^D)}{(1-c)} \mu_s \, ds + B_t \tag{14}$$

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(8) Assuming that adjustment expenses were treated as investment under the tax law would not importantly alter the results. If these costs are taken to represent managerial effort, or as interference with concurrent production, the assumption in the text is appropriate.

All the tax parameters can be arbitrary functions of time. For ease of exposition the following symbols have been introduced:

$$\mu_s = \exp\left(\int_0^s \frac{\rho+\pi}{1-c}\, du\right) \tag{15a}$$

$$B_t = \int_0^\infty \tau_s\, \delta^T\, e^{-\delta^T s}\, \mu_s\, \frac{(1-\theta^D)}{(1-c)}\, ds \tag{15b}$$

$$Z_s = \int_0^\infty \tau \delta^T\, \frac{\mu_u}{\mu_s}\, du \tag{15c}$$

These rather formidable expressions have simple interpretations. B_t represents the present value of depreciation allowances on existing capital, Z_s is the present value, evaluated at times of the depreciation on a dollar of new investment. In maximizing (14) the firm can ignore B_t since it is independent of any future decisions. The constraint faced by the firm in maximizing (14) is then:

$$\dot{K}_s = I_s - \delta^R K_s \tag{16}$$

holding that capital accumulation equals net investment. The first order conditions for optimality are(9):

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(9) Similar conditions differing because of assumptions about taxation have been derived by Hayashi (1979) and Abel (1979).

$$F_L = \frac{w}{p} \tag{17a}$$

$$\left(1 - ITC - Z - b + \phi(1-\tau)\right) = \frac{\lambda(1-c)}{p(1-\theta^D)} - (1-\tau)\frac{I}{K}\phi' \tag{17b}$$

$$\dot{\lambda} = \lambda\left(\frac{\rho+\pi}{(1-c)} + \delta^R\right) - \left((p\,F_K - bi)\;(1-\tau) - p\left(\frac{I}{K}\right)^2(1-\tau)\phi' + b(\pi-\delta)\right)\frac{(1-\theta^D)}{(1-\theta^C)} \tag{17c}$$

Equation (17b) characterizes the investment function. It implicitly defines a function linking investment to the real shadow price of capital λ/p and the tax parameters. The condition for zero investment is that:

$$\frac{\lambda}{p} = \frac{(1-\theta^D)}{(1-c)}\,[1 - ITC - Z - b] \tag{18}$$

This result can be characterized in intuitive terms. It implies that the shadow price of additional capital goods is equated to their marginal cost in after tax dollars. Equation (18) implies that there will be investment even if the shadow price of new capital goods is less than 1. This is because taxes and debt finance reduce the effective price of new capital goods.

Equation (17b) is of no operational significance as a theory of investment unless an observable counterpart to the shadow price λ/p can be developed. Hayashi (1979) has shown in a similar model with a less elaborate tax system how the shadow price is linked to the market valuation of existing capital. The derivation below follows his very closely. Equation (14) implies that:

$$\frac{V_t-B_t}{p_tK_t} = \int_t^\infty \left[\frac{(pF_KK-biK)(1-\tau)}{pK} - \frac{(1-ITC-Z+(1-\tau)\phi)I}{K} + bK(\pi-\delta^K)\right]\left(\frac{(1-\theta^D)}{(1-c)}\,\mu\,\frac{pK}{p_tK_t}\,ds\right) \tag{19}$$

$$= \int_t^\infty \left[\qquad\right]\frac{(1-\theta^D)}{(1-c)}\, e^{\int_0^s \frac{\rho+\pi}{(1-c)} - \pi - \frac{\dot{K}}{K}\,du}\, ds$$

using the definition of μ. The first order conditions (17) imply that equation (19) can be rewritten:

$$\frac{V_t-B_t}{p_tK_t} = \int_t^\infty \left[(F_K-bi)(1-\tau) + b(\pi-\delta^R)\right] - \frac{\lambda I}{pK}\,\frac{(1-\theta^D)}{(1-c)} + (1-\tau)\phi\left(\frac{I}{K}\right)^2 \frac{(1-\theta^D)}{(1-c)}\, e^{-\int_0^s \frac{\rho+\pi}{1-c} + \pi + \frac{\dot{K}}{K}\,du}\, ds \tag{20}$$

Now using the first order condition for λ, it can be seen that:

$$\frac{V_t - B_t}{p_t K_t} = \int_t^{\infty} \left[\frac{\lambda}{p} \left(\frac{I}{K} - \frac{\rho + \pi}{(1-c)} - \delta^R - \pi \right) - \left(\frac{\dot{\lambda}}{p} \right) \right] e^{-\int_0^s \left(\frac{\rho + \pi}{(1-c)} + \pi - \frac{I}{K} + \delta^R \right) du} ds \tag{21}$$

$$= \frac{\lambda}{p}$$

The real shadow price of additional capital may thus be expressed as a function of the firm's market value. The term B_t is subtracted from market value since the depreciation allowances the firm will receive on existing capital provide no inducement to further investment. Substituting equation (21) in equation (17b) yields an investment function expressable entirely in terms of observables.

$$\frac{I}{K} = \frac{\dot{K}}{K} + \delta^R = h \left(\frac{\frac{(V-B)(1-c)}{pK(1-\theta^D)} - 1 + b + ITC + Z}{(1-\tau)} \right) \tag{22}$$

where $h(\quad) = (\phi + \frac{I}{K}\phi')^{-1}$. Equation (22) is the structural investment function relating investment and stock market valuation which will be estimated in the next section. It also implies an equation of motion for the capital stock, and so is the rigorous generalization of equation (1).

The equation of motion for q, the ratio of stock market value to the value of the capital stock can be written as:

$$\dot{q} = \frac{\rho + \pi}{(1-c)} q - \frac{(1-\theta^D)}{(1-c)} \frac{Div}{pK} - q\left(\pi + \frac{\dot{K}}{K}\right) \tag{23}$$

where Div is given by equation (12), and $\frac{\dot{K}}{K}$ is defined by equation (22). We begin by examining the steady state properties of the system (22) and (23). Solving for the steady state values of q and K yields the conditions.

$$q^* = h^{-1} \ (\delta+g) \ (1-\tau) + \left(\frac{B}{pK} + 1 - b - ITC - z\right)\frac{(1-\theta^D)}{(1-c)} \tag{24}$$

$$(1-\tau) \ F'(K) = \left[\rho+c(g+\pi)\right] q^*(1-\tau) + bi + \\ + (\delta^R + g) - b(g+\pi) \tag{25}$$

where g is the growth rate of effective labor. In the special case where adjustment is costless, these expressions take on a more familiar form. In this case if we also assume $\delta^R = \delta^T$, the steady state conditions become:

$$q^* = \frac{(1-\theta^D)}{(1-c)} \left[1 - b - ITC \right] \tag{26}$$

$$(1-\tau) F'(K) + (ITC)(g+\delta) = \frac{(\rho+c\pi)(1-b)}{(1-c)} + b\Big((1-\tau)i-\pi\Big) \tag{27}$$

These expressions are equivalent to those derived by Auerbach (1979a, 1979b). Assuming all equity finance and ignoring the investment tax credit, equation (26) yields his formula for steady state q. The value of steady state q is less than one because of the difference between dividend and capital gains tax rates. Firms find it optimal to invest past the point where a dollar's expenditure raises market value by a dollar, since the alternative is to pay out heavily taxed dividends. The latter expression holds that the cost of capital is a weighted average of the costs of debt and equity capital. Note that cost of equity capital depends only on the capital gains tax rate and not on the dividend rate. That is to say permanent dividend taxation has no distortionary effects. Permanent increases in the dividend tax rate are the cause of an immediate fall in the stock market, exactly offsetting the reduced opportunity cost to shareowners of investment funds.

9b - The symbol b here refers to the debt capital ratio. In Auerbach's work it refers to the debt-market value ratio. The results here would not be importantly altered but the calculations would become much more complex if a constant debt-market value ratio were assumed.

For given tax parameters, the phase diagram for the system (22) and (23) looks just like that one depicted in Figure 1. It also exhibits saddle point stability. There is again a unique path, indicated by the heavy arrows, along which the system can converge to equilibrium. On this perfect foresight path, investment is just sufficient to actualize the market's expectations about future dividends. This phase diagram can be used to study the relationship between tax changes, market valuation and investment.

Consider for example an increase in the investment tax credit as shown in Figure 3. The steady state capital stock unambiguously increases. In the long run the value of q falls since the credit reduces the "effective" replacement cost of capital goods. The short run impact on stock market valuation is ambiguous, depending on the rapidity of adjustment. It is possible for q to jump to any point between A, corresponding to no capital stock adjustment, and B, corresponding to an instantaneous adjustment of the capital stock. It is thus possible that the stock market may decline even though investment has been encouraged. Exactly parallel results hold for a decline in the capital gains tax rate, or acceleration of tax depreciation. An increase in the corporate tax rate, as shown in Figure 4, has an ambiguous effect on long run capital accumulation.

Increase in the Investment Tax Credit

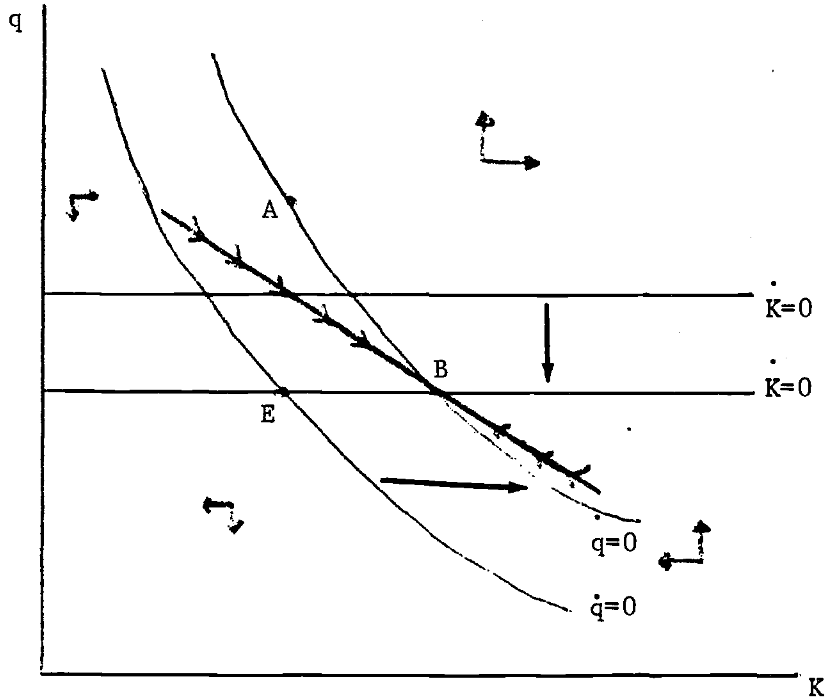

Figure 3

Increase in the Corporate Income Tax

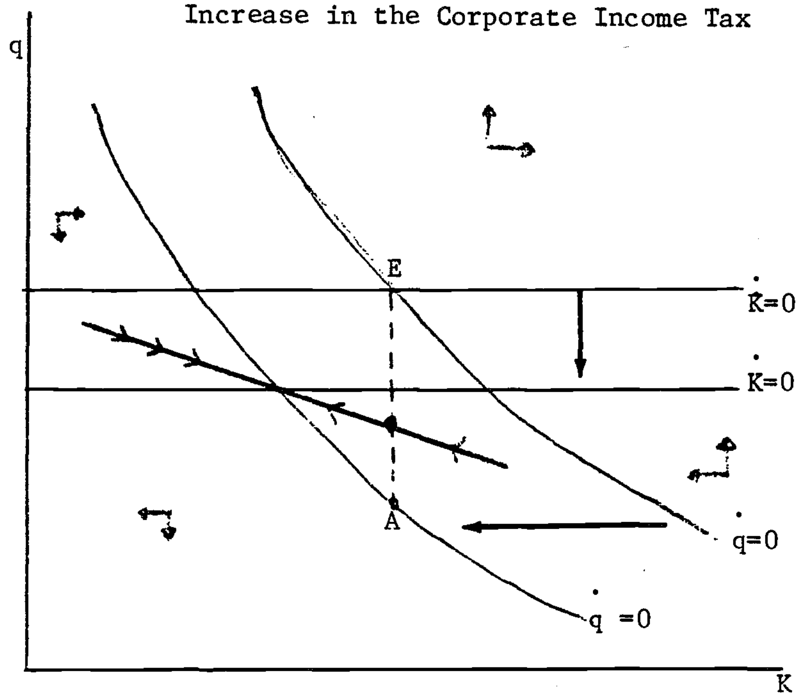

Figure 4

The $\dot{q} = 0$ schedule is likely to shift backwards, reflecting the effect of increased taxes in reducing dividends. However, the $\dot{K} = 0$ locus will shift downwards because of the expending of adjustment costs and the increased value of untaxed depreciation allowances. Hence the value of the market will unambiguously decline in the short run, but the short run impact on investment and the long run impact on the capital stock are indeterminate.

A substantial virtue of the approach to modelling investment decisions developed here is that it can easily be used to analyze the effects of announced but not yet implemented tax changes, and temporary tax measures. This can be illustrated by considering the effects of an announcement that at some point in the future, the dividend tax rate will be increased. This situation is shown in Figure 5. There is no immediate effect on either schedule. At time t, when the tax increase takes effect, both schedules shift downwards as shown by the dashed lines. As already noted, a dividend tax change has no impact on long run capital intensity. But the change does alter the timing of investment decisions. Firms have an incentive to pay extra dividends before the dividend tax increase takes effect, and to pay lower subsequent dividends. Following the announcement, stock market declines to point A; as firms raise dividends and reduce investment, the system moves towards B. At time t when the

Announcement Effect: Dividend Tax Increase

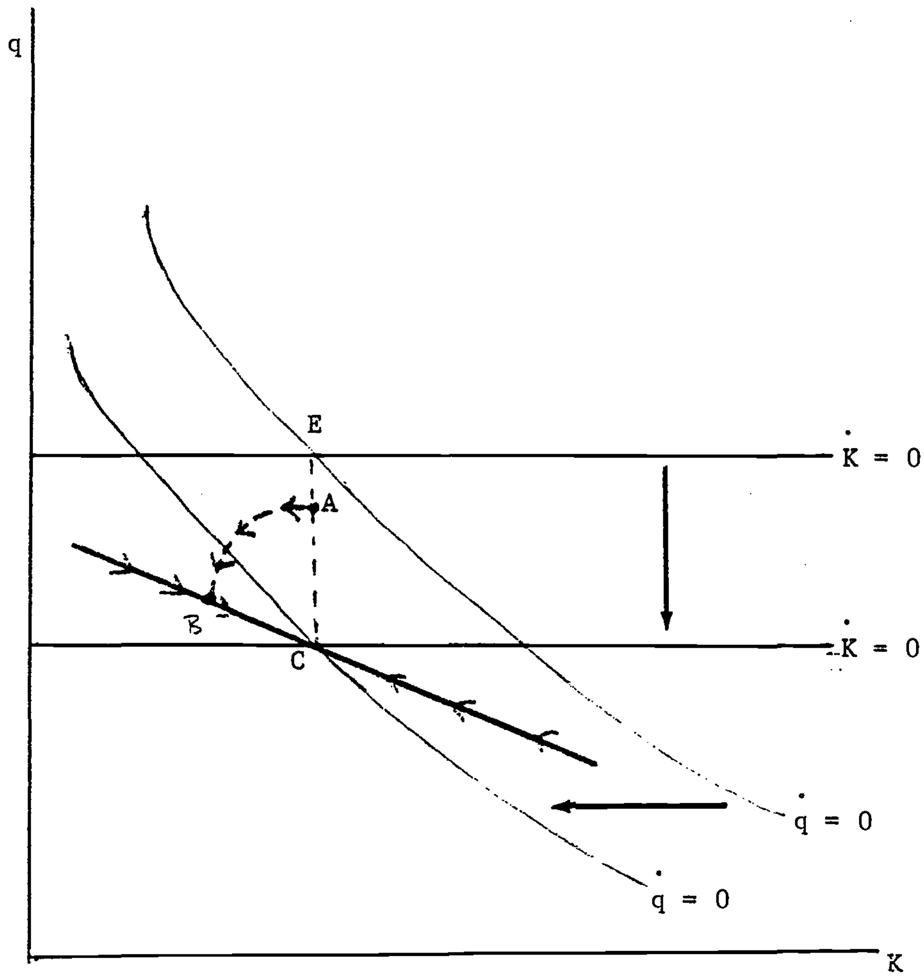

Figure 5

dividend tax is increased to economy moves along the stable arm from B to the new equilibrium C. Note that the announcement of the tax reduces investment but that investment rises sharply at the moment when it takes effect.

All these examples illustrate cases where tax changes can have opposite effects on the stock market and investment. This demonstrates the importance of taking tax factors into account in estimating relations between market valuation and investment. This is done in the next section which describes the estimation of the model outlined above.

IV. ESTIMATING THE MODEL

This section describes the empirical estimation of the model outlined in the preceeding section. There are two behavioral functions describing adjustment costs and production which have to be estimated along with ρ, the required real return on equity.

A. The Investment Function

For simplicity we postulate that the adjustment costs are piecewise linear with adjustment costless up to some normal level of investment, and then rising linearly with investment above a threshold. That is:

A. The Investment Function.

$$A = \frac{\beta}{2}\left(\frac{I}{K} - \gamma\right)^2 K \qquad \left(\frac{I}{K} - \gamma\right) \geq 0 \tag{28}$$

$$= 0 \qquad \left(\frac{I}{K} - \gamma\right) < 0$$

It follows that the function ø ( ) is given by:

$$\phi\left(\frac{I}{K}\right) = \frac{\frac{\beta}{2}\left(\frac{I}{K} - \gamma\right)^2}{I/K} \tag{29}$$

which is homgoeneous in $\frac{I}{K}$ as required.

This implies that the investment function (22) can be written as:

$$\frac{I}{K} = h^{-1}(Q) = \gamma + \frac{1}{\beta} Q \tag{30}$$

where Q represents "tax adjusted" Tobin's q and is given by

$$Q = \left(\frac{\frac{(V-B)(1-c)}{pK(1-\theta^D)} - 1 + b + ITC + Z}{(1-\tau)} \right) \tag{31}$$

By estimating equation (30) the parameters of the adjustment cost function $\phi(\ )$ can be inferred. This is the approach taken below.

Several authors including Von Furstenberg (1977), Ciccolo (1975, 1977) and Engle and Foley (1975) have estimated variants on equation (30). With the exception of Ciccolo (1977), no account was taken of tax effects. Ciccolo's tax adjustments differ from those used here because he takes no account of individual taxes, and implicitly makes different assumptions about the tax treatment of adjustment costs. These studies have all related components of business fixed investment to q, which may not be appropriate for non-corporate investment. They have all been confined to the post-Korean War period during which tax changes have been relatively minor.

In order to focus on tax effects, the work reported here examined the determinants of non-financial corporate investment over the entire 1932-1978 period. The extension of the sample period allows the substantial variation in tax parameters. The dividend tax rate has varied between .15 and .58 during the period while the corporate rate has varied between .18 and .70. Extending the equation back this far necessitates some crudeness in the calcualtion of Q, and forces the use of annual data. Since the focus here is on long run issues, this is probably not too serious a problem.

The calculation of the various components of Q is described below. A full listing of all the series is included in the paper's data appendix.

V --- The stock market value of non-financial corporations is estimated by capitalizing non-financial corporate dividends using the Standard and Poor's dividend yield.

K --- The capital stock K is taken to be the sum of equipment, structures and inventories all valued at current replacement cost.(10)

B --- The present value of depreciation allowances is estimated in several stages. First, the value of the depreciable capital stock, KDEP is calculated using the perpetual inventory method, and annual data an investment and tax depreciation. Second, the tax depreciation rate is estimated as the ratio of tax depreciation to KDEP. Third, B is calculated from equation (15b) assuming static expectations about the corporate tax rate, a constant value of $\rho = .06$, and autoregressive inflation expectations.(11)

b --- The fraction of investment which is debt financed is assumed to equal the ratio of the market value of outstanding debt to the capital stock. The market value of debt is estimated by capitalizing net interest payments at the BAA interest rate.(12)

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(10) The data on capital stocks, stock market values, and market value of debt are taken from Holland and Myers (1979).

(11) In particular π^e is generated using the rolling ARMA approach described in Feldstein and Summers (1978). To

C --- It is difficult to measure the effective capital gains tax rate because of the problems inherent in estimating the effects of deferral and the absence of constructive realization at death. Following Bailey (1969) we assume that each of these factors halves the effective rate. From 1932-1969, the statutory rate on capital gains was half the rate on dividends. Hence for this period the capital gains rate was estimated at 12.5% of the average marginal dividend tax rate.(13) For the 1969-1978 period, the effect of the 1969 capital gains reforms is proxied by assuming that the capital gains rate is 50% higher or 18.75% of the dividend rate.(14)

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find expected inflation in year t, an ARMA (1, 1) process is fitted to the previous 20 years' data. Expected inflation is then a 10 year discounted average of the forecasts of the future inflation rates. The discount rate is .08. The calculation is performed using the consumer price index.

(12) This procedure would only be strictly appropriate if all bonds were consols. Comparing the results with those of Von Furstenberg's (1977) more careful adjustment suggests that the error is not likely to be large.

(13) The construction of this series is discussed below.

(14) These reforms included the minimum tax, maximum tax, and special provisions relating to preference income. The estimate that these reforms raised effective rates by about 50 percent is derived from the NBER TAXSIM model.

Θ^D --- The marginal tax rate on dividends is estimated as a weighted average of individual marginal rates with weights equal to the share of dividends going to taxpayers in each marginal rate class.[15] Because of data limitations, no account is taken of equity owned outside the household sector.

ITC --- The effective rate of the investment tax credit is the statutory rate, as adjusted by DRI to reflect the effects of eligibility rules, times the share of investment devoted to equipment.

Z --- The present value of future depreciation allowances on a dollar's investment is calculated on the basis of tax lifetime and depreciation methods reported by DRI. Static expectations about future corporate tax rates are assumed.

ζ --- The corporate tax rate is the maximum statutory marginal tax rate on corporate income.

The estimated values of Q are shown in Table 1 along with estimated values of q as normally calculated. The most striking feature of the table is the pronounced drop in q over the fifty year period. The value of q actually peaked in 1937. Tax factors can account for a large part of this decline. Rising dividend and corporate tax rates have reduced equilibrium market values. Indeed, such factors would lead one to predict a drop of about 30 percent in q

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(15) The series are taken with adjustments from Wright (1969) and Brinner and Brooks (1979).

TABLE 1

Tax Adjusted and Unadjusted Measures of Q

Year	q	Q
1930	1.871	1.206
1931	1.541	0.775
1932	0.942	0.131
1933	0.881	0.035
1934	1.300	0.632
1935	1.454	0.861
1936	1.833	2.161
1937	2.039	2.590
1938	1.514	1.180
1939	1.303	0.809
1940	1.369	1.083
1941	1.087	0.546
1942	0.878	0.300
1943	0.999	0.651
1944	1.183	1.494
1945	1.195	1.386
1946	1.201	1.765
1947	0.997	1.256
1948	0.803	0.520
1949	0.727	0.194
1950	0.680	0.153
1951	0.667	0.097
1952	0.664	-0.035
1953	0.666	0.019
1954	0.725	0.234
1955	0.850	0.739
1956	0.894	0.946
1957	0.854	0.793
1958	0.870	0.864
1959	0.995	1.241
1960	1.075	1.469
1961	1.156	1.762
1962	1.199	1.872
1963	1.240	2.022
1964	1.350	2.138
1965	1.413	2.181
1966	1.323	1.939
1967	1.234	1.741
1968	1.240	2.213
1969	1.178	1.865
1970	1.002	1.046
1971	0.959	0.930

Table 1. (continued)

Year	q	Q
1972	1.055	1.236
1973	1.029	1.176
1974	0.815	0.517
1975	0.697	0.309
1976	0.743	0.517
1977	0.747	0.522
1978	0.671	0.273

Source: Calculations are described in the text. q is the standard measure of q as used by Von Furstenberg and others. Q is the tax adjusted series discussed in the text.

between 1932 and 1978. Taxes also account for another apparent anomaly in the data. Despite the fact that many assets of firms, such as intangibles, are excluded from the denominator of the q ratio, it appears that q averages substantially less than 1, and positive investment takes place. In contrast, the tax adjusted variable Q is greater than the investment threshold of zero in every year except 1932.[16] Indeed, viewed in terms of Q it appears that on average, the market if anything overvalues corporate assets.

Table 2 presents estimates of simple investment functions using Q and q as explanatory variables. The dependent variable is defined as the change in the net capital stock plus depreciation divided by the value of the beginning of year capital stock. Before examining the results, it is necessary to make several comments on the estimation. First, the estimates here are not intended to provide the best possible fit of actual investment behavior during the sample period. They undoubtedly could be improved by adding additional variables reflecting business cycle conditions to the estimated equations.[17] Since the concern here is with long run issues, this approach is not pursued here. Second, the appropriate treatment of autocorrelation

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(16) Note that in a world without taxes, $Q = q - 1$.

(17) Inclusion of such variables would make it very difficult to interpret the coefficient on Q.

TABLE 2

Q Investment Equations [a]

Equation Number	Constant	q-1	Q	ρ	R^2	D.W.
1.	.080 (.009)	-	.013 (.007)	-	.046	.290
2.	.094 (.005)	-.026 (.017)	-	-	.027	.375
3.	.071 (.021)	-	.016 (.007)	.882	.724	1.39
4.	.083 (.027)	.035 (.020)	-	.909	.711	1.40
5.[b]	.060 (.024)	-	.027 (.007)	.900	.750	1.42
6.[b]	.078 (.034)	.050 (.020)	-	.933	.712	1.50
7.	.130 (.036)	-.077 (.043)	.041 (.015)	.760	.724	1.34

Note: a) Equations are estimated using time series data for the period 1932-1978. Equations 1 and 2 are estimated without correction for autocorrelations.

b) Sum of coefficients on variable and lagged variable is unclear in this context. As Engle and Foley emphasize, theory suggests that most of the power in the relation between investment and Q is at low frequencies. Shiller (1979) has shown that there is substantial noise in share price movements. Transforming the data to correct for autocorrelation places greater weight on the high frequencies and therefore may be inappropriate.[18] Third, while not strictly justified by the theory, lagged Q's are included in the investment equations to take account of delivery lags and the inevitable arbitrariness in the time when investment projects show up in the national income accounts.

The results provide mild evidence that tax adjustments enhance the power of movements in market valuation in explaining investment. Using ordinary least squares, q has the wrong sign, while Q is marginally significant with the right sign.[19]

These equations exhibit extreme serial correlation. When an autocorrelation correction is made as in the third and fourth equations, there is little to choose between the two specifications. The Q equation provides a marginally better fit and exhibits somewhat less autocorrelation.

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(18) This point is amplified in Sims (1972). It is a variant in the frequently made observation that autocorrelation corrections exacerbate the errors in variables problems.

(19) Since OLS gives inconsistent estimates of the standard errors, not too much can be made of this observation.

Including lagged values raised the explanatory power of both equations but does not alter their relative performance. When both concepts are entered together, the Q variable completely dominates the unadjusted variable which becomes statistically significant with the wrong sign. Alternative specifications not shown here suggest that these results are not significantly affected by the inclusion of additional lags, time trends, or the exclusion of the War years from the sample. Estimates for the 1954-1978 period yield quite similar results, though for this shorter period there is no basis at all for choosing between the q and Q specifications.

The parameter estimates are comparable to those suggested by previous work. The fifth equation suggests that

$$\frac{d(\frac{I}{K})}{dQ} \approx .027 \tag{32}$$

Since equation (27) implies that

$$\frac{dQ}{(\frac{dV}{K})} \approx 3.$$

the implied estimate is that a 10 percent increase in the value of the stock market raises $\frac{I}{K}$ by about .008. This result parallels closely to the implications of earlier studies. These equations can be used to solve for the parameters of the adjustment cost function. Equation (5) for example implies that

$$\Phi(\frac{I}{K}) = 18.5\left((\frac{I}{K}) - .060\right) \tag{33}$$

This is the equation used in the simulations reported below.

B. The Production Function

It is assumed that production in the non-financial corporate sector is Cobb-Douglas. This assumption is borne out by the approximate constancy of factor shares, and appears to be consistent with the available empirical evidence.[21] The share of capital in the output of the non-financial corporate sector averaged .16 during the period 1970-1978. This is taken to be the share of capital in the production functions.

C. Other Parameters

The required after tax real return on equity is taken to be .06. This corresponds closely to the average pre-tax real return of 8.4 percent reported by Ibbotson and Sinquefield (1976) for the period 1926-1976. The real interest rate is taken to be .02 which corresponds closely to the real BAA yield over the same period. Following Feldstein and Summers (1978) it is assumed that inflation raises interest rates point for point.[22] The value of δ is estimated at .067 from the data used in estimating the investment equation. The growth rate

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(20) Cross sectional production function estimates generally suggest an elasticity of substitution of close to 1, while time series studies usually yield lower estimates. The relative merits of these approaches are assessed in Lucas (1969).

(21) This assumption appears to fit the rent data, but need not be even approximately accurate in the presence of non-indexed taxes.

of effective labor, γ is taken to be .03.

The remaining parameters to be discussed characterize the tax system. Tax parameters are calculated as described above and are in the base case set equal to their 1978 values. These are: $\zeta = .48$; ITC = .056; $\theta^D = .44$; c = .083; $\delta^T = .10$. In the simulations, one additional complication is introduced. Inflation raises the effective tax rate on corporate capital by taxing nominal inventory profits of firms using FIFO accounting. In 1978 when the rate of inflation was 7.4, these profits represented 24.3 billion or .33 percent of non-financial corporate output per point of inflation. It is assumed in the simulations that each point of inflation raises the corporate tax base by this fraction of corporate output.

At this point, the effects of tax and inflation changes can be studied. The system of equations (22) and (23) can be solved numerically(23) to find the path of investment and the stock market. This is done in the next section. Table 3 characterizes then no inflation steady state of the model under the assumptions made here. This steady state appears to afford a reasonable benchmark for studying tax changes. The pre-tax marginal product of capital is .147. Net of

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(22) The model is solved using the multiple shooting algorithm described in Lipton, et al. (1980).

steady state aadjustment costs the pre-tax rate of profit is .134. While this number is somewhat higher than standard estimates of the rate of profit, this reflects the fact that land is omitted from consideration here. Adjustment costs are estimated to comprise 9 percent of gross profit. It is difficult to evaluate this assumption since adjustment costs are not directly observable.[24] If adjustment costs are neglected, estimates of the effects of tax changes are altered only slightly. The effective tax rate on corporate source income is fairly close to the value that was observed prior to the period of rapid inflation. Finally, the earnings price ratio and dividend yield appear to be reasonable. In any event experimentation suggested that the estimated impacts of tax changes were not very sensitive to the initial choice of parameters.

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(24) The level of investment does enter with a significant negative sign in standard cyclical profit equations of the type estimated by Feldstein and Summers (1977).

TABLE 3

The No-Inflation Steady State

Variable	Steady-State Variable
$\frac{V}{K} + b$	1.063
F_K	.147
A/K	.013
$TAXES^{(a)}/(F_K K-A)$	.44
$\frac{F_K K-TAXES-A}{MV}$	.086
$\frac{DIV}{V}$	.058

Notes: [a] includes only taxes levied at the corporate level

V. INFLATION EFFECTS

In this section, the model of investment and market valuation described in the preceeding section is used to evaluate the impact of inflation on the non-financial corporate sector. Four separate non-neutralities of the tax system lead to real effects of inflation.[25] First, historical cost depreciation causes inflation to raise the effective corporate tax rate. It is important to note that the understatement of depreciation for tax purposes depends on the entire history of the inflation rate not just on its current level. In 1977, historic cost depreciation raised corporate tax liabilities by $19.1 billion or 32.4 percent of actual tax liabilities. Second, firms which use FIFO inventory accounting incur extra tax liabilities on their nominal inventory profits.[26] The size of this effect varies with the inflation rate. In 1977, tax liabilities were

(25) These non-neutralities are discussed in more detail in Summers (1980b). Evidence of their aggregate importance can be found in Feldstein und Summers (1979).

(26) Although the extra taxes due to FIFO accounting are in a sense voluntary, managements presumably pay these taxes because they believe that there would be greater costs of some other kind if they used LIFO and reported lower profits. As long as firms pay higher taxes based on FIFO accounting, these taxes do affect investment decisions.

increased by $7 billion or 12.1 percent of actual tax liabilities. By 1979, this had risen to $19 billion or 27 percent of tax liabilities. Third, firms are permitted to deduct nominal rather than real interest payments for tax purposes. Equivalently stated, they are not taxed on the capital gain which they realize as inflation erodes the value of their outstanding debt. This offsets the effects of historic cost depreciation and nominal inventory accounting and reduces the tax burden on corporate capital by 26.4 percent in 1977.[27] Fourth, the taxation of nominal rather than real capital gains leads to an increase in the pre-tax real return on equity demanded by investors. This effect is potentially very large. Nominal capital gains on corporate capital stock totalled $112 billion in 1977, implying an extra tax liability of about $10 billion.[28]

On balance, these effects imply that inflation substantially increases the effective tax rate on corporate equity. Feldstein (1979a) has suggested that this could

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(27) This discussion and calcualtion ignore the one-time capital gains firms realize on the revaluation of their long term debt when the inflation rate rises. Summers (1980b) shows that this effect can be very substantial for some firms.

(28) This effect is masked by the downwards recapitalization of the market caused by unexpected increases in the rate of inflation.

provide an explanation for the observed decline in the stock market. This conclusion has been challenged by Hendershott (1979), Fama (1979) and Modigliani and Cohn (1974). None of these analyses have taken account of the endogneity of capital accumulation and its impact on market valuation. Nor have they recognized that taxes complicate the determination of the long run relationship between market valuation and the replacement cost of the capital stock. Only Feldstein considers the implications of his analysis for the long run growth of the corporate sector. He does not however consider the nature of the adjustment path after an inflation shock.

Before turning to the results one qualification must be stressed. The assumption is maintained throughout that inflation has no impact on the rate of return required by equity owners. This assumption is open to question.[29] Many observers have argued that inflation reduces real after tax interest rates and so should also be assumed to reduce required after tax returns on equity. This argument presumes that

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(29) The arguments of Hendershott (1979), Gordon and Malkiel (1979), and Modiglian and Cohn (1979) that inflation should not discourage investment are based on the assumption that it reduces the real return on other assets particularly bonds.

inflation has no effect on the equity risk premium and that bonds are the relevant alternative asset. If the alternatives to holding equity, include tax sheltered forms of saving such as owner occupied housing, this assumption is inappropriate. Further, there is theoretical reason to believe that in the very long run inflation should raise real interest rates.(30)

The effect of inflation on market valuation and investment is gauged by simulating the effects of an unexpected permanent increase from 0 to 8 percent in the rate of inflation. The paths of the variables of interest are shown in Table 4. All variables are measured as percentage changes from the benchmark steady state values displayed in Table 3. The results indicate that inflation can have very large effects on capital accumulation in the corporate sector. The immediate effect of the 8 percent inflation shock is to reduce the value of the stock market by 22.7 percent. This is associated with a 16.8 percent reduction in the rate of investment.

As the capital output ratio declines, raising the pre-tax marginal product of capital, the stock market tends to rise relative to the replacement cost of the capital stock.

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(30) Summers (1980) suggests that this will take place in almost any plausible model with non-indexed taxes on capital income.

TABLE 4

Dynamic Response to an 8 Percent Inflation Shock

Year	V	I	K	$\frac{V}{K} + b$
1	-22.7	-16.8	0	-17.4
2	-24.0	-17.8	-1.6	-17.3
3	-25.0	-18.8	-3.2	-17.2
4	-25.9	-18.8	-4.7	-17.0
5	-26.6	-19.8	-6.1	-16.7
10	-29.2	-22.8	-12.1	-14.9
15	-30.7	-24.8	-16.8	-12.8
20	-31.9	-26.7	-20.4	-10.9
50	-34.8	-32.7	-30.9	- 4.42
STEADY STATE	-36.0	-34.4	-34.4	- 2.16

In the long run the 8 percent rate of inflation reduces the capital stock by 34.4 percent and the value of the stock market by 36 percent. The transition is quite slow as only three quarters of the ultimate adjustment of the capital stock takes place within 20 years. The impact of inflation on the rate of investment actually increases over time reflecting the reduced need for replacement investment as the capital stock contracts.

These results suggests that inflation can account for a large part of the decline in the stock market and investment which has occurred during the last decade. After 10 years of 8 percent inflation, the stock market is almost 30 percent lower in real terms than it would have been in the absence of inflation. The 22 percent decline in gross investment indicated by the simulation is somewhat larger than the decline which has actually occurred. This probably reflects the increases in the investment tax credit, and the acceleration of tax depreciation which have taken place during the 1970's.[31] As shown in the next section, these measures are a significant spur to investment, but are not likely to significantly increase stock market values.

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(31) The investment tax credit was suspended at the beginning of the decade and applied at a 9 percent rate in 1979. The ADR system introduced in 1971 has shortened depreciation lifetimes by about 20 percent.

The results in Table 4 suggest that 8 percent inflation slows the rate of growth of the capital stock by about 1.1 percent a year for the first decade. The production function used here implied that this leads to a decline of about .2 percent a year in the rate of growth of productivity. The long run impact of inflation according to these calculations is to reduce corporate sector output and wages by about 6 percent below the level that would have been reached in the absence of inflation. This is a quite substantial effect. It implies that if inflation continues at current ratio until the year 2000, per-capita output of the corporate sector in that year will be reduced by $420 a year below its no inflation level.

These results suggest that inflation has substantial effects on market valuation and investments. It is frequently proposed that these non-neutralities be remedied through indexation of the tax system. The effects of inflation on the stock market and investment under various partial indexing schemes is shown in Table 5. As well as illustrating the effects of indexing, the Table make it possible to examine the relative importance of the various distortions associated with inflation. Full indexing leaves the tax system completely neutral, so it is not shown in the Table.

Indexing depreciation allowances and inventory accounting while doing nothing about the profits firms realize on their outstanding debt would lead to a situation where inflation significantly encouraged investment. Under such indexing rules, an 8 percent increase in the expected rate of inflation would raise the stock market by 10 percent. This is because the non-neutrality associated with the deduction of nominal interest payments is greater than the distortion due to the taxation of capital gains. These results imply that indexing depreciation allowances would reduce the equilibrium ratio of the stock market values to the replacement cost of the capital stock. This is because indexation raises the value of reducing the effective price of new capital goods.

The effects of full indexing at the corporate level are shown in column (2). The remaining distortion, the taxation of nominal capital gains, leads a reduction in the stock market and capital formation. The capital gains distortion alone is sufficient to cause 8 percent inflation to reduce the steady state capital stock by over 11 percent. Thus the taxation of nominal capital gains is responsible for about one-third of the total reduction in capital accumulation caused by inflation.

Indexation at the individual level but not at the corporate level is considered in the third column of the Table. The results show that corporate tax non-neutralities are responsible for a large fraction of inflation's impact on capital formation. They show clearly that contrary to assertions made by some authors, the effect of inflation on inventory profits and depreciation allowances more than offsets the deductibility of nominal interest payments. This is because the analysis here takes explicit account of the growth in the understatement of depreciation allowances which accompanies prolonged inflation.

Space does not permit a detailed discussion of the robustness of these results to changes in the assumptions about the underlying parameters. The qualitative results and long run estimates are almost completely unaffected by plausible changes in the parameters. Reductions in the assumed elasticity of substitution reduce the sensitivity of the steady state capital stock to inflation. Plausible changes in the adjustment cost function alter the size of the initial jump in the stock market and the speed of adjustment, but the effects are not very large.

TABLE 5

Effects of Indexation[a]

Year	Indexed[b] Depreciation and Inventory		Full Corporate[c] Indexing		Indexed[d] Capital Gains	
	V	I	V	I	V	I
1	+ 9.3	+12.9	- 7.7	- 6.9	-15.7	-11.8
2	+ 9.9	+12.9	- 7.9	- 6.9	-16.8	-11.8
3	+10.5	+13.9	- 8.2	- 6.9	-17.7	-12.9
4	+11.1	+14.9	- 8.4	- 7.9	-18.5	-13.9
5	+11.7	+15.8	- 8.6	- 7.9	-19.1	-13.9
10	+13.9	+18.8	- 9.5	- 8.9	-21.4	-15.8
15	+15.8	+20.8	-10.2	- 9.9	-22.7	-17.8
20	+17.4	+22.8	-10.7	-10.9	-23.5	-19.8
50	+21.8	+29.7	-12.3	-13.9	-26.0	-23.8
Steady State	+23.8	+32.7	-11.5	-12.9	-27.3	-24.8

Notes:

(a) All numbers shown are percentage changes from the benchmark steady state shown in Table 3.

(b) It is assumed that replacement cost depreciation is allowed on existing assets as well as new investments.

(c) It is assumed here that firms are only permitted to deduct real interest payments for tax purposes.

(d) Only real capital gains are taxed. The simulation in this column assumes no indexation at the corporate level.

VI. ALTERNATIVE TAX REFORMS

This section begins by considering the impact of the investment tax credit, since this issue has been a focus of previous work. Standard single equation approaches to the investment function have yielded divergent results. In perhaps the most widely cited study, Hall and Jorgenson (1971) conclude that the investment tax credit has a potent impact, which reaches its peak after about 3 years. They estimated that the 7 percent credit on equiptment enacted in 1962 raised the 1970 capital stock by about 4 percent above the level it would have reached in the absence of the credit. Other estimates typically suggest much smaller estimates of the effect of the credit. None of the estimates takes explicit account of the possibly temporary nature of changes in the level of the credit.

In Table 6 the effects of alternative tax credit policies are considered. The first column considers the effects of a correctly perceived permanent removal of the credit. The results indicate that the credit has potent effects on investment, even though it has only a small impact on market valuation in the short run.(32) Its immediate effect is to reduce investment by about 6 percent, and it decreases the capital stock by 8.9 percent in the long run. The estimated response is

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(32) This illustrates the point made in Section III, that changes in unadjusted q may be a poor guide to investment incentives.

TABLE 6

Permanent and Temporary Removal of the Investment Tax Credit[a]

	PERMANENT			TEMPORARY[b]		
Year	V	I	K	V	I	K
1	-2.8%	-6.0%	0%	-2.0%	0%	0%
2	-3.0%	-4.8%	-0.4%	-0.5%	0%	-0.1%
3	-3.0%	-4.9%	-0.9%	-0.5%	0%	-0.1%
4	-3.3%	-6.1%	-1.3%	-0.6%	-4.9%	-0.1%
5	-3.5%	-6.2%	-1.7%	-0.6%	-3.7%	-0.4%
10	-4.0%	-6.4%	-3.5%	-0.3%	0%	-0.9%
15	-4.4%	-7.9%	-4.8%	-0.3%	0%	-0.7%
20	-4.7%	-8.1%	-6.0%	0%	0%	-0.6%
50	-5.6%	-8.8%	-8.9%	0%	0%	-0.1%
Steady State	-5.6 %	-9.6 %	-9.6 %	0%	0%	0%

Notes: (a) The numbers shown in the table are the changes relative to the 8 percent inflation path in the absence of tax reform.

(b) The temporary investment tax credit is imposed in year 4 for 3 years.

much more gradual than that predicted by standard investment equations. The effect on invesment declines between the first and second years and then rises steadily as the reduced capital stock requires less replacement investment. Since the change considered here is the removal of 9 percent investment credit, these results indicate a slightly larger effect than those of Hall and Jorgenson, and a much larger effect than that found in most other studies.

The right-hand half of the table considers the impact of a temporary removal of the ITC. Such a measure leads to a sharp decrease in investment during the suspension period. This leads to an increase in net investment after the suspension is removed. Gross investment does not increase because the lower capital stock requires less replacement investment. Note that the catch up following the restoration of the credit is very slow. Two thirds of the gap caused by the suspension in the capital stock remains 15 years later. These results show the importance of adjustment costs. In the absence of any adjustment costs, one would expect to see substantial disinvestment during the period of the suspension. Because the adjustment costs of returning to the steady state capital stock would be high, this does not take place. These simulations suggest that a countercyclical investment credit might not be destabilizing. Adjustment costs are sufficiently large to negate substantial anticipatory effects.

The effects of reductions in the corporate tax rate are examined in Table 7. An immediate rate reduction from .48 to .40 is contrasted with an announcement that in year 4, such a tax cut will take place. Both measures are equivalent in the long run, and raise the steady state capital stock by 15.7 percent. They increase the long run value of the stock market significantly more because the reduced corporate tax raises the effective price of new capital goods by diminishing the value of accelerated depreciation and the expanding of adjustment costs.

The simulations show that the announcement policy has a significantly greater short run impact on investment than the immediate implementation policy. The former raises the capital stock by 3 percent after 3 years compared with 2 percent for the latter. This occurs even though the immediate implementation policy has a greater immediate impact on the capital stock. The reason again is the effects of accelerated depreciation and the expanding of adjustment costs. Firms find it optimal to accelerate their investment plans to take account of the lower effective price of capital goods which prevails before the tax reduction actually takes place. This implies that if the goal of the corporate rate reduction is to increase capital formation, the measure should be announced well in advance of its enactment. Similar considerations suggest that a temporary increase in the corporate tax rate would actually spur investment.

TABLE 7

Unanticipated and Anticipated Permanent Corporate Tax Cut[a]

	UNANTICIPATED			ANTICIPATED[b]		
Year	V	I	K	V	I	K
1	+18.6%	+7.1%	0%	+15.1%	+9.5%	0 %
2	+19.4%	+7.2%	+0.5%	+16.9%	+10.8%	+0.8%
3	+20.0%	+8.5%	+1.1%	+19.0%	+12.2%	+1.6%
4	+20.4%	+7.3%	+1.6%	+20.9%	+ 8.5%	+2.5%
5	+20.7%	+8.6%	+2.0%	+21.2%	+ 8.6%	+3.0%
10	+22.3%	+9.0%	+4.5%	+22.7%	+10.3%	+5.1%
15	+23.2%	+10.5%	+6.5%	+23.5%	+10.5%	+7.0%
20	+24.1%	+10.8%	+8.1%	+24.3%	+10.8%	+8.6%
50	+25.9%	+14.7%	+13.5%	+25.9%	+14.7%	+13.8%
Steady State	+26.7%	+15.3%	+15.3%	+26.9%	+15.3%	+15.3%

Notes: (a) Same as Table 6

(b) Tax cut takes place in year 4

The effects of reforms in the individual tax system are considered in Table 8. Eliminating capital gains taxes would raise the stock market by 7.3 percent in the short run. Because it would increase the advantages to the firm of retaining earnings, the impact on investment is substantially greater. Its long run effect would be to raise the capital stock by 29.5 percent. The transition is however very gradual with only half the adjustment occurring within the first decade. Comparison of Table 8 with Table 5 suggests that a significant part of the effect of capital gains taxes takes place because of inflation.

The second reform considered is an announcement that in year 4, the dividend tax will be eliminated. This corresponds to an extreme form of partial integration of the corporate income tax. As explained in Section III, changes in the dividend tax rate have no effect on steady state capital intensity. The announcement that a dividend tax reduction will occur however gives firms a very large incentive to defer paying of dividends. This is done by accelerating investment. The simulations suggest that the announcement effect raises investment by 40.5 percent.

TABLE 8

Reforms in Individual Taxes[a]

	CAPITAL GAINS TAX ELIMINATED			ANTICIPATED[b] DIVIDEND RELIEF		
Year	V	I	K	V	I	K
1	+ 7.3%	+11.9%	0%	+60.3%	+40.5%	0%
2	+ 8.1%	+12.0%	+ 0.9%	+68.5%	+47.0%	+ 3.2%
3	+ 8.5%	+13.4%	+ 1.8%	+77.3%	+53.7%	+ 6.7%
4	+ 8.9%	+12.2%	+ 2.7%	+86.3%	+ 6.1%	+10.7%
5	+ 9.3%	+13.6%	+ 3.6%	+85.7%	+ 6.2%	+10.2%
10	+10.8%	+16.7%	+ 7.5%	+83.7%	+ 5.1%	+ 8.5%
15	+12.1%	+17.1%	+11.1%	+82.5%	+ 4.0%	+ 7.0%
20	+13.2%	+20.3%	+14.0%	+82.0%	+ 2.7%	+ 5.7%
50	+16.1%	+26.5%	+24.0%	+79.3%	+ 1.5%	+ 1.7%
Steady State	+17.3%	+27.7%	+27.7%	+78.6%	0	0

Notes: (a) Same as 6

(b) Expected abolition of the dividend tax in year 4

VII. SUMMARY AND CONCLUSIONS

This paper has developed and applied a market valuation approach to evaluating investment incentives. The results demonstrate that tax and monetary policies have large effects on the stock market and investment. The non-indexed character of our tax system causes inflation to have strong impact on market valuation and investment. Indeed, it appears that inflation can account for a large fraction of the decline in the stock market and investment which occurred during the 1970's. Reducing the rate of inflation would do more to increase capital formation than even quite substantial changes in the tax law. However the results do strongly suggest that tax policies have quite significant effects on capital formation. The market valuation approach implies that the lagged response of investment to tax changes is quite pronounced. Only half of the response to shocks takes place within a decade. This may explain why the estimates reported here imply much larger long run effects of tax policies than previous studies which have focused on a shorter horizon.

There are several directions in which the analysis in this paper could be usefully extended. Probably the most important would be placing the model of investment developed here in a general equilibrium context. Since the corporate sector represents a substantial fraction of the economy, measures which affect it will impact on investors' required rate of return. Feldstein and Summers (1977) estimate that tax changes which raise the interest rate firms can afford to pay on given investment projects 1 percent, increase the actual interest rate by .25 percent. Summers (1980c) examines the steady state properties of a general equilibrium model with three assests, corporate capital, owner occupied housing and land. The findings suggest that taking account of general equilibrium effects would reduce somewhat the partial equilibrium estimates of tax effects reported here. Appropriate government monetary policies could be directed at keeping the required real return constant if it were considered desirable to achieve the full partial equilibrium effect of tax changes.

A second important direction for future research is the implications of uncertainty. A more satisfactory treatment of uncertainty would make it possible to model the determinants of corporate financial policy and the required risk premium on equity. By introducing a diversification motive, an explicit treatment of uncertainty would make it possible to meaningfully model the heterogeneous tax rates faced by different investors. It is difficult to predict how the introduction of uncertainty would alter the conclusions reached here. The principal new feature would be a risk sharing effect of taxation which might tend to encourage investment.

The empirical approach described here is potentially applicable to a wide variety of problems. Poterba (1980) has used a similar model to evaluate the impact of inflation on the market for owner occupied housing. The approach could also be applied to modelling the effects of shocks on investment in different industries for a different regions.[33] With some adaptation the market valuation approach could be used to evaluate a wide variety of shocks, including regulatory policy changes, and movements in factor prices.[34] Its reliance on observable market valuations and consistancy with rational expectations of economic actors makes it a desirable tool of analysis.

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(33) Industry "q" investment equations of the type estimated by von Furstenberg, Malkiel, and Watson (1980) could be utilized for this purpose. Summers (1980b) shows that inflation shocks are likely to have divergent effects on industry "q"s.

(34) This apprach is being used by Poterba and Summers (1980) to evaluate the effects of local property tax changes.

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