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8 Tax Reform and Corporate Investment: A Microeconometric Simulation Study

Michael A. Salinger and Lawrence H. Summers

This paper develops a methodology for simulating the effects of alternative corporate tax reforms on the stock market valuation and investment plans of individual firms. The methods are applied to estimate the effects of alternative corporate tax reforms on the thirty Dow Jones companies. The estimates are all based on extensions of Tobin's q theory of investment to take account of the effects of tax policy. As well as providing the basis for the estimates of the effects of tax policy, the results here provide strong microeconometric support for the q theory of investment. The q theory approach provides a superior method for estimating the effects of investment incentives because it recognizes the effects of changes in the cost of capital on the desired level of output.

A central concern in the design of tax policy is the avoidance of windfall gains or losses. This concern is closely related to the goal of providing incentives only at the margin. A crucial virtue of the q approach employed here is that it provides a clear delineation of the impact of tax policies on the market value of existing capital as well as of new capital. It thus allows an examination of the incidence of tax changes on the holders of different assets. This represents an important extension of the incidence concepts usually used in public finance, which focus only on the rate of return on capital with no consideration of the wealth effects caused by short-run changes in its relative price.

The interaction of inflation and the corporate tax system has received widespread attention in recent years. As is by now well understood, inflation affects the corporate tax system in three important ways. Historic cost depreciation and firms' reluctance to use LIFO inventory accounting cause inflation to raise the tax burden on corporate capital.

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This is offset by the deductibility of nominal rather than real interest payments. While the impact of these interactions of inflation and the tax system on aggregate investment and stock market valuation has been discussed extensively, their effect on the behavior of individual firms has been little studied. Even if indexing the tax system had little effect on the level of aggregate investment or the stock market, the results in this paper suggest that it would have a large impact on the composition of investment among firms. Full indexing of the corporate tax system, for example, would raise the Dow Jones average by about 8%. The effects of the investment experience of individual firms would vary substantially.

The first section of the paper outlines the q theory of investment that provides the basis for the simulations reported in this paper. The analysis draws on the work of Hayashi (1982) and Abel (1979) in linking the Tobin q approach to investment with the firm's problem of determining an optimal investment path in the presence of adjustment costs. In particular, it shows how an investment equation relating the level of investment to tax-adjusted q can be used to infer the shape of a firm's adjustment cost function. The q theory provides an improved basis for estimating the effects of tax reform on investment because the process of adjustment is modeled explicitly.

The estimation of q investment equations for the thirty Dow Jones companies is discussed in the second section. These estimates require the estimation of a time series of tax-adjusted q for each company. These are developed using Compustat data. The time series estimates are quite supportive of the q theory. The data confirm the importance of the tax adjustments to q suggested by the theory.

In the third section, the impact of alternative tax returns on q and investment is examined. This requires calculating the present value of the expected change in revenue which would result from alternative reforms. It is also possible to calculate the impact of these policies on the market value of individual firms' equity. The results suggest that some reforms could have potent effects. Complete indexing would raise the Dow Jones average by an estimated 7.6%. The variance among companies is substantial, with the effect ranging from − 13% for Sears to 20% for American Brands.

The fourth section combines the results of the preceding sections to provide evidence on the response of investment to indexing the tax system and to various reforms. The results suggest that, because adjustment costs are very large, tax reforms are likely to have a much larger impact on long-run capital intensity than on investment in the short run. The results of the q theory approach are contrasted with those obtained using other methods.

A fifth (and final) section reviews some limitations of the analysis and suggests directions for future research.

8.1 Taxes in a q Theory of Investment

This section describes the procedure developed in Summers (1981*a*) for using investment equations involving Tobin's q as a basis for estimating the impact of tax policies on both investment and the stock market. Here the focus is on the investment decisions of individual firms. The essential insight underlying Tobin's theory is that in a taxless world, firms will invest so long as each dollar spent purchasing capital raises the market value of the firm by more than one dollar. Tobin goes on to assume that as a good approximation the market value of an additional unit of capital equals the average market value of the existing capital stock. That is, the value of the marginal "q" on an additional dollar of investment is well proxied by average q, which is the ratio of the market value of the capital stock to its replacement cost. It is natural then to assume that the rate of investment is an increasing function of the marginal return to investment as proxied by q.

An approach of this type has several virtues relative to other standard approaches to explaining investment. Perhaps most important, the q theory approach is supply oriented. In the formulation presented below, firms make output and capital intensity decisions simultaneously. This captures the essence of an important channel through which investment stimuli are supposed to work. By reducing the cost of one factor of production, firms are encouraged to supply more output. This channel is obscured in most of the standard econometric approaches to investment decision making, in which the level of output is taken as predetermined. In this section, we show that the q theory of investment can be derived from the assumption that firms face adjustment costs and make investment decisions optimally with the objective of maximizing market value. Output along with investment is treated as a choice variable.

A second virtue of the q theory approach is that it can be used to evaluate a wider menu of policy proposals than standard methods. Almost all of the empirical literature on tax policy and investment neglects entirely taxes levied at the personal level. These are difficult to introduce into investment equations of the flexible accelerator type. Since they do affect stock market values, they are easily handled by the q theory approach. In addition, because the q theory is derivable directly from the assumption of intertemporal optimization, it can be used to evaluate the effects of policy announcements and temporary policies. The approach is forward looking and so can be used to study the effects of future policies on current investment. As Robert Lucas has emphasized, standard econometric investment equations cannot be used to predict the effects of any fundamental changes in policy.[1] The approach developed

1. This criticism applies at two levels. First, most standard approaches of the type used in policy evaluation exercises do not include any forward looking variables. Thus there is no

here is immune from this criticism because the only parameters which are estimated are technological and do not depend on the policy rule.

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.[2] Hence share prices are proportional to the outstanding value of a firm's equity. We assume that equity holders require a fixed real after-tax return ρ in order to induce them to hold the outstanding equity. The approach here is partial equilibrium in that the required rate of return is assumed to be unaffected by changes in tax policy. While this assumption is obviously appropriate for an individual firm, its relevance to an economy-wide tax change is less clear. However, Summers (1981*a*, *b*) argues that any effects of tax reforms on the required rate of return are likely to be minor and of ambiguous sign. The required return ρ is the sum of the capital gains and dividends net of tax. It follows that

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

where c represents the effective accrual rate of taxation on capital gains,[3] θ^D the tax rate on dividends, and π 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

(2) $$\lim_{s \to \infty} V_s \exp\left[- \int_t^s \frac{\rho + \pi}{1 - c} \, du \right] = 0 \ .$$

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

(3) $$V_t = \int_t^\infty \frac{1 - \theta^D}{1 - c} \text{Div} \exp\left[- \int_t^s \frac{\rho + \pi}{1 - c} \, du \right] ds \ .$$

way to use them to contemplate the effect of an announced change in policy. Implicitly, they assume that all tax parameters are expected to remain permanently constant. Second, because expected tax changes are an important feature of the historic experience, the equations are misspecified so that parameter estimates are unlikely to be reliable. The substantial importance of these problems is demonstrated by the simulations below.

2. 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 (1979). For the issues considered here the assumption that shares are not repurchased is not likely to have important effects.

3. This corresponds to the statutory rate adjusted for deferral and the lack of constructive realization at death.

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

$$(4) \qquad V = \frac{(1 - \theta^D)\text{Div}}{\rho} .$$

In this case capital gains taxes do not matter because there are no capital gains. More generally, as in (3), capital gains taxes raise the discount rate on future dividends as well as affect the valuation of current dividends. Note that equation (3) implies that because of dividend taxes an extra dollar of promised dividends raises share valuation only by $(1 - \theta^D)$.

The firm seeks to choose an investment and financial policy to maximize (3) subject to the constraints it faces. It is constrained by its initial capital stock and by a requirement that sources equal uses of funds. It will also be necessary to assume that credit market constraints do not permit the firm to finance more than a fraction of its investment with debt.[4] This can be thought of as a measure of the firm's debt capacity. In the model presented below, the firm will always choose to borrow as much as possible; 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 the 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.[5] That is,

$$(5) \qquad \text{Div} = [pF(K,L) - wL - pbiK](1 - \tau) - [1 - \text{ITC} - b + (1 - \tau)\phi]pI + \tau D + pbK(\pi - \delta^R) ,$$

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, ϕ is the adjustment cost function, I represents investment, δ^R is the real rate of depreciaton, 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.

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

4. This is a crude way of modeling 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 recent American experience. McDonald (1980) treats the choice of financial policy in more detail.

5. The assumption here is that all marginal equity finance comes from retained earnings. This follows from the assumption made earlier of a constant number of shares. 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.

(6) $$D_s = \int_0^s \delta^T p_u I_u \exp\left[-\delta^T(s-u)\right] du \ .$$

Combining equations (3) and (5), making use of (6), and rearranging yield an expression for the value of a firm's equity at time t:

(7) $$V_t = \int_t^\infty [[pF(K,L) - wL - pbKi](1-\tau) - [1 - \text{ITC} - Z_s - b + (1-\tau)\phi]pI + pbK(\pi - \delta)] \frac{(1-\theta^D)\mu_s}{(1-c)\mu_t} ds + B_t \ .$$

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

(8a) $$\mu_s = \exp\left[-\int_0^s \frac{\rho + \pi}{1-c} du\right],$$

(8b) $$B_t = \int_t^\infty \tau_s \delta^T \exp[-\delta^T(s-t)] \frac{\mu_s}{\mu_t} \frac{1-\theta^D}{1-c} p_t K_t ds \ ,$$

(8c) $$Z_s = \int_s^\infty \tau\delta^T \exp[-\delta^T(u-s)] \frac{\mu_u}{\mu_s} du \ .$$

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 the time of the investment, on a dollar of new investment. In maximizing (7) the firm can ignore B_t, since it is independent of any future decisions. The constraint faced by the firm in maximizing (7) is that capital accumulation equals net investment:

(9) $$\dot{K}_s = I_s - \delta^R K_s \ .$$

The first-order conditions for optimality are[6]

(10a) $$F_L = \frac{W}{p} \ ,$$

(10b) $$[1 - \text{ITC} - Z_s - b + \phi(1-\tau)] = \frac{\lambda(1-c)}{p_t(1-\theta^D)} - (1-\tau)\frac{I}{K}\phi' \ ,$$

6. 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. Similar conditions differing because of assumptions about taxation have been derived by Hayashi (1981) and Abel (1982).

(10c)
$$\frac{\dot{\lambda}}{p_t} = \frac{\lambda}{p_t}\left[\frac{\rho + \pi}{(1 - c)} - \pi + \delta^R\right] - [(F_K - bi)(1 - \tau) + \left(\frac{I}{K}\right)^2 (1 - \tau)\phi' + b(\pi - \delta^R)] \frac{(1 - \theta^D)}{(1 - c)} .$$

Equation (10b) characterizes the investment function. It implicitly defines a function linking investment to the shadow price of capital λ/p_t and the tax parameters. The condition for zero investment is that

(11)
$$\frac{\lambda}{p_t} = \frac{(1 - \theta^D)}{(1 - c)} [1 - \text{ITC} - Z_s - b] .$$

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 (11) 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 (10b) is of no operational significance as a theory of investment unless an observable counterpart to the shadow price λ/p_t can be developed. Hayashi (1982) 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 (7) implies that

(12)
$$\frac{V_t - B_t}{p_t K_t} = \int_t^\infty \left[\frac{(pF_K K - pbiK)(1 - \tau)}{pK} - \frac{(1 - \text{ITC} - Z_s - b + (1 - \tau)\phi)I}{K} + b(\pi - \delta^R)\right] \frac{(1 - \theta^D)\, \mu_s pK}{(1 - c)\, \mu_t p_t K_t} ds$$
$$= \int_t^\infty \left[\left[\;\right] \frac{1 - \theta^D}{1 - c} \exp\left[- \int_t^s \left(\frac{\rho + \pi}{1 - c} - \pi - \frac{\dot{K}}{K}\right) du\right] ds\right.$$

using the definition of μ. The first-order conditions (10) imply that equation (12) can be rewritten

(13)
$$\frac{V_t - B_t}{p_t K_t} = \int_t^\infty \left[(F_K - bi)(1 - \tau) + b(\pi - \delta^R) - \frac{\lambda I}{p_t K_t} \frac{1 - \theta^D}{1 - c} + (1 - \tau)\phi' \left[\frac{I}{K}\right]^2 \frac{1 - \theta^D}{1 - c} \exp \left[- \int_t^s \left(\frac{\rho + \pi}{1 - c} - \pi + \frac{\dot{K}}{K}\right) du\right] ds .\right.$$

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

$$(14) \quad \frac{V_t - B_t}{p_t - K_t} = \int_t^{\infty}\left[\frac{\lambda}{p_t}\left(\frac{I}{K} - \frac{\rho + \pi}{1-c} - \delta^R - \pi\right) - \frac{\dot{\lambda}}{p_t}\right] \times \exp\left[-\int_t^s\left(\frac{\rho+\pi}{1-c} - \pi - \frac{I}{K} + \delta^R\right)du\right] ds = \frac{\lambda_t}{p_t}.$$

The 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 (14) in equation (10b) yields an investment function expressible entirely in terms of observables:

$$(15) \quad \frac{I}{K} = \frac{\dot{K}}{K} + \delta^R = h\left(\frac{\frac{(V-B)(1-c)}{pK(1-\theta^D)} - 1 + b + \text{ITC} + Z}{(1-\tau)}\right),$$

where $h(\ ) = (\phi + (I/K)\,\phi')^{-1}$. Equation (15) is a structural investment function relating investment and stock market valuation.

For simplicity we postulate that up to some level of I/K, adjustment is costless. Above that level, marginal adjustment costs rise linearly with investment. That is, total adjustment costs are

$$(16) \quad A = \frac{\beta}{2}\left(\frac{I}{K} - \gamma\right)^2 K \quad \left(\frac{I}{K} - \gamma\right) \geq 0$$
$$= 0 \quad \left(\frac{I}{K} - \gamma\right) < 0 .$$

It follows that the function $\phi(\ )$ is given by

$$(17) \quad \phi\left(\frac{I}{K}\right) = \frac{\beta\left(\frac{I}{K} - \gamma\right)^2}{2\frac{I}{K}},$$

which is homogeneous in I and K as required. This implies that the investment function (15) can be written as

$$(18) \quad \frac{I}{K} = h(Q) = \gamma + \frac{1}{\beta}Q,$$

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

$$Q = \frac{\dfrac{(V-B)(1-c)}{pK(1-\theta^D)} - 1 + b + \text{ITC} + Z}{(1-\tau)}.$$

By estimating equation (18) the parameters of the adjustment cost function $\phi(\ )$ can be inferred. This is the approach taken in the next section.

Before turning to the data, it is necessary to highlight the restrictiveness of the assumptions under which the stock market provides a proxy for the marginal q which drives investment decisions. The crucial assumption in the preceding derivation is that capital is both malleable and homogeneous. Only with this technological assumption does the market value of existing capital provide a proxy for the increment to market value arising from new investment. The assumption made here is inconsistent with putty-clay formulations in which existing capital can only be used in fixed proportions while new capital is malleable. It is also inconsistent with the view that the recent energy shocks have reduced the market value of existing energy-intensive capital but raised the incentive to invest in new energy-conserving capital.

A second restrictive assumption is that firms produce with constant returns to scale and earn no rents. If firms earn rents because of decreasing returns, intangible investments, or market power, these will be reflected in their market value and so measured q will not be a satisfactory proxy for the return to investment.

While these limitations are severe, they are in no way unique to the q theoretic approach to investment. Exactly the same issues arise in connection with variants on the flexible accelerator approach.

8.2 Construction of the Tax-adjusted Q Variable

This section presents estimates of the Q investment equations which provide the basis for an estimate of the impact of tax policy. With the early exception of Grunfeld (1960), almost all the empirical work using q has focused on aggregate or industry investment. Little or no account has been taken of tax effects. The construction of the necessary data is described in the appendix. The equations were estimated for the thirty Dow Jones companies.

In table 8.1, estimates of Tobin's q ratio of the market value of the firm to the replacement cost of its capital stock are displayed along with the tax-adjusted variant of Q for the companies included in the sample. Note that Q is the shadow price of capital less its acquisition cost. It is therefore comparable to $q - 1$ rather than q. The magnitudes of the estimates appear plausible. Moreover, companies whose prospects look dim, such as the steel companies, have low values of q whereas companies with rapid growth prospects, such as IBM, have high values of q. In all

Table 8.1 **1978 q and Q**

Company	q	Q
Allied Chemical	.644	.196
Aluminum Company of America	.658	.296
American Brands	.989	1.543
American Can	.569	−.007
American Telephone & Telegraph	.765	.480
Bethlehem Steel	.303	−.807
E. I. DuPont de Nemours	.964	1.513
Eastman Kodak	1.607	3.906
Exxon	.714	.674
General Electric	1.444	3.501
General Foods	.995	1.523
General Motors	.723	.934
Goodyear Tire	.554	−.181
International Nickel	.622	−.022
International Business Machines	3.083	9.845
International Harvester	.545	−.034
International Paper	.854	.992
Johns-Manville	.933	.728
Merck	3.026	8.829
Minnesota Mining & Manufacturing	2.129	5.850
Owens-Illinois	.599	−.010
Proctor & Gamble	1.783	4.625
Sears	2.010	4.255
Standard Oil of California	.791	.631
Texaco	.670	.177
United States Steel	.362	−.660
Union Carbide	.554	.036
United Technologies	1.170	2.198
Westinghouse	.517	.072
Woolworth	.544	−.222

likelihood, the high values of q for some companies also reflect the market's valuation of intangible assets. Lindenberg and Ross (1981) estimated q in a fashion similar to the estimates in this paper. They report eighteen year averages of q for each company. The correlation between the two sets of estimates of eighteen year averages of q for the twenty-five firms common to both samples is 0.953. On average, however, our estimates of q tend to be higher than theirs. We assume that capital depreciates faster than they do. Their calculations of capital-augmenting technical change only partially offset the difference in the depreciation rates. In estimating q, one needs to make many arbitrary assumptions. The high correlation between the two studies suggests that these assumptions have more of an effect on the level than on the variations in q.

Theory, failing to take account of taxes, suggests that firms should not invest when q is less than 1. This is the case for most of the firms in the sample. Only for a much smaller fraction of the sample is the tax-adjusted measure Q less than zero. The difference is due in large part to the fact that the Q measure takes account of the effects of dividend taxes, which reduce the opportunity cost of corporate retentions. Note, however, that even using this concept, eight companies appear to have no incentive to invest. The reason that these companies actually invest almost certainly involves the failure of the assumption made here that capital is homogeneous and malleable. In a world of heterogeneous capital, even firms with very low market values will find some investment worthwhile.

Estimates of equation (18) for the thirty companies are shown in table 8.2. The equations are all estimated using ordinary least squares. Because the estimates of Q are likely to be less reliable for the earlier years in the sample, we used only the last fifteen observations on each company. Some of the equations do exhibit serial correlation. Rao and Griliches (1969) show that when the error process is first-order autoregressive and the autocorrelation coefficient is relatively high (generally 0.4 or greater), the GLS transformation can improve efficiency even in small samples. If the error process is of higher order, then simply doing a first-order autoregressive transformation can reduce the efficiency of the estimator. With only fifteen data points, making higher-order autocorrelation corrections is not likely to improve efficiency, so we chose not to make any autoregressive transformations. When there is positive serial correlation, however, the t statistics for the OLS estimates will be overstated if we assume that the errors are white noise. Thus the t statistics reported are based on the assumption that the errors follow a first-order autoregressive process.

The results support the Q theory. In twenty-eight of the thirty regressions, the estimated slope coefficient is positive. Nearly half of the estimates are statistically significant. The low R^2 values indicate, however, that much of what affects investment decisions is not captured by the Q variable. The bottom rows of the table report estimates of the equations pooling the company data. Regardless of whether allowance is made for company-specific effects, the coefficient of Q is highly significant. If different firms have the same adjustment cost functions, then both the intercept and slope will be equal across firms. Because we do not do the GLS transformation, we cannot do an F test of this hypothesis. Instead, we do a χ^2 test, which overwhelmingly rejects the null hypotheses that both parameters are equal across firms. We also test for the equality of just the slopes and just the intercepts. In both cases, we reject the null hypothesis.[7]

7. To do a χ^2 test, we run the following regression:

$$\frac{I}{\text{RNPPE} + \text{RLINV}} = a_0 + a_1 Q + a_2\text{FRMDUM1} + \dots + a_{30}\text{FRMDUM29} + a_{31}\text{FRMDUM1} \times Q + \dots + a_{59}\text{FRMDUM29} \times Q,$$

where FRMDUM1 to FRMDUM29 are firm dummies. Let V be the estimated covariance

Table 8.2 Investment Equations Using Tax-adjusted Q

Company	Intercept	Slope	
Allied Chemical	.152	.018	$R^2 = .19$
	(5.93)	(1.31)	DW = 1.30
Aluminum Company of America	.115	.020	$R^2 = .34$
	(7.82)	(2.23)	DW = 1.56
American Brands	.101	.059	$R^2 = .55$
	(3.01)	(3.99)	DW = 2.01
American Can	.097	.038	$R^2 = .56$
	(7.07)	(3.75)	DW = 1.77
American Telephone & Telegraph	.157	.008	$R^2 = .26$
	(10.96)	(1.32)	DW = .64
Bethlehem Steel	.150	.073	$R^2 = .53$
	(11.74)	(3.45)	DW = 1.60
E. I. DuPont de Nemours	.206	.004	$R^2 = .12$
	(5.92)	(1.02)	DW = 1.09
Eastman Kodak	.111	.007	$R^2 = .58$
	(2.79)	(3.48)	DW = 1.25
Exxon	.177	−.003	$R^2 = .04$
	(10.05)	(−.55)	DW = 1.06
General Electric	.179	.013	$R^2 = .26$
	(2.81)	(1.77)	DW = 1.03
General Foods	.117	.011	$R^2 = .64$
	(5.39)	(3.45)	DW = 1.02
General Motors	.242	.007	$R^2 = .15$
	(7.26)	(1.41)	DW = 1.74
Goodyear Tire	.134	.037	$R^2 = .74$
	(10.56)	(6.11)	DW = 1.57
International Nickel	.122	.007	$R^2 = .13$
	(2.76)	(.96)	DW = .93
International Business Machines	.316	.006	$R^2 = .11$
	(2.59)	(.945)	DW = .45
International Harvester	.153	.015	$R^2 = .05$
	(5.43)	(.57)	DW = 1.00
International Paper	.151	.012	$R^2 = .02$
	(2.39)	(.46)	DW = 1.27
Johns-Manville	.181	−.009	$R^2 = .06$
	(5.72)	(−.76)	DW = 1.36
Merck	.245	.001	$R^2 = .03$
	(3.04)	(.51)	DW = 1.29
Minnesota Mining & Manufacturing	.193	.005	$R^2 = .18$
	(3.19)	(1.46)	DW = 1.42
Owens-Illinois	.130	.030	$R^2 = .29$
	(2.71)	(1.81)	DW = 1.22
Proctor & Gamble	.163	.002	$R^2 = .01$
	(3.12)	(.33)	DW = .95
Sears	.029	.016	$R^2 = .79$
	(1.07)	(7.28)	DW = 1.91
Standard Oil of California	.120	.020	$R^2 = .53$
	(9.17)	(3.48)	DW = 1.73
Texaco	.136	.009	$R^2 = .37$
	(8.14)	(2.19)	DW = 1.35

Table 8.2 (cont.)

Company	Intercept	Slope	
United States Steel	.090	.010	$R^2 = .04$
	(5.28)	(.85)	DW = .69
Union Carbide	.169	.009	$R^2 = .10$
	(7.37)	(.51)	DW = 1.10
United Technologies	.114	.068	$R^2 = .56$
	(2.25)	(3.18)	DW = 1.15
Westinghouse	.113	.022	$R^2 = .57$
	(4.30)	(3.24)	DW = 1.05
Woolworth	.181	.013	$R^2 = .25$
	(7.31)	(1.41)	DW = .68
All companies with common intercept	.166	.004	$R^2 = .28$
	(21.09)	(4.77)	
All companies with different intercepts	...	.006	$R^2 = .54$
		(4.32)	

The theory of investment developed in the preceding section implies that lagged values of q should not have any effect on current investment. It takes no account of delivery lags or lags in implementing investment plans. This is a potentially serious difficulty. The equations in table 8.2 were therefore reestimated including lagged values. While this improved their explanatory power a little bit, lagged Q was rarely significant, so these results are not reported here.

In table 8.3, the relative explanatory power of Q and q is contrasted. If equation (18) were the true investment function, then the coefficient on Q would be positive and significant and the coefficient on q would be insignificant. With only three exceptions, the coefficient of Q is positive; in over half the regressions, it is significant. Nearly all of the coefficients of q are negative, and nearly half are significant. This is not surprising. Because capital is not homogeneous and the stock market is extremely volatile, one would expect the stock market component of q to be a very noisy signal of the marginal return on incremental investment. The tax-adjustment parts of the Q series are much less subject to error. It is therefore reasonable to expect that their effect would be greater than that of the stock market. This is reflected in the negative coefficients on q. This point underscores the importance of making tax adjustments in studying the relation between investment and q.[8]

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matrix of the regression. Let V be the lower right-hand 58 × 58 submatrix of V. Let a be the column vector composed of a_2 to a_{59}. Under the null hypothesis that the adjustment cost functions are identical, $a'(V)^{-1}a^{A}\chi^2_{58}$. The test statistic is 357.8. The statistics for the tests that just the intercepts and just the slopes are equal are, respectively, 95.5 and 120.8. Notice that our estimate of the covariance matrix asymptotically approaches the true covariance matrix only as $t \rightarrow \infty$. Even though the pooled regression has 450 data points, T is still 15, so the asymptotic distribution of the test is unlikely to hold.

8. If we had a larger sample, we could handle the errors in variables with an instrumental variables procedure. The tax rates are appropriate instruments because they are measured

Table 8.3 Investment Equations Using Q and q

Company	Intercept	Q	q	
Allied Chemical	.407	.144	−.413	R^2=.33
	(2.44)	(1.82)	(−1.57)	DW=1.30
Aluminum Company of America	.207	.067	−.146	R^2=.39
	(1.98)	(1.26)	(−.89)	DW=1.56
American Brands	.077	.045	.042	R^2=.55
	(1.07)	(1.15)	(.40)	DW=1.96
American Can	.306	.147	−.346	R^2=.66
	(2.98)	(2.72)	(−2.04)	DW=2.22
American Telephone & Telegraph	.002	−.064	.231	R^2=.49
	(.028)	(−1.77)	(2.02)	DW=1.03
Bethlehem Steel	.561	.274	−.707	R^2=.67
	(3.10)	(3.06)	(−2.27)	DW=2.04
E. I. DuPont de Nemours	.323	.070	−.221	R^2=.35
	(5.32)	(2.48)	(−2.36)	DW=.98
Eastman Kodak	.195	.032	−.096	R^2=.85
	(6.54)	(5.28)	(−4.25)	DW=1.63
Exxon	.304	.084	−.258	R^2=.39
	(5.81)	(2.43)	(−2.53)	DW=1.50
General Electric	.325	.059	−.185	R^2=.26
	(1.77)	(1.06)	(−.84)	DW=1.04
General Foods	.168	.043	−.100	R^2=.74
	(6.29)	(3.02)	(−2.27)	DW=1.71
General Motors	.412	.105	−.339	R^2=.44
	(5.48)	(2.61)	(−2.44)	DW=1.76
Goodyear Tire	.164	.052	−.050	R^2=.74
	(1.46)	(.95)	(−.27)	DW=1.57
International Nickel	.341	.102	−.340	R^2=.13
	(5.70)	(4.23)	(−3.98)	DW=.93
International Business Machines	.494	.078	−.263	R^2=.70
	(5.88)	(4.47)	(−4.30)	DW=.95
International Harvester	.458	.161	−.493	R^2=.29
	(2.61)	(1.86)	(−1.74)	DW=1.40
International Paper	.631	.189	−.678	R^2=.49
	(3.94)	(3.15)	(−3.12)	DW=1.19
Johns-Manville	.172	−.013	.016	R^2=.06
	(1.05)	(−.18)	(.06)	DW=1.36
Merck	.309	.023	−.082	R^2=.44
	(5.12)	(3.00)	(−2.91)	DW=1.74
Minnesota Mining & Manufacturing	.260	.028	−.087	R^2=.34
	(3.76)	(1.95)	(−1.64)	DW=1.60
Owens-Illinois	.517	.201	−.601	R^2=.55
	(3.38)	(3.07)	(−2.64)	DW=1.47
Proctor & Gamble	.223	.058	−.182	R^2=.48
	(5.81)	(3.25)	(−3.20)	DW=1.75
Sears	−.019	−.002	.060	R^2=.79
	(−.170)	(−.043)	(.431)	DW=1.87
Standard Oil of California	.248	.087	−.221	R^2=.64
	(3.84)	(2.57)	(−2.00)	DW=2.07
Texaco	.238	.063	−.178	R^2=.47
	(3.33)	(1.70)	(−1.47)	DW=1.48

Table 8.3 (cont.)

Company	Intercept	Q	q	
United States Steel	.196	.070	−.170	$R^2=.04$
	(3.91)	(2.52)	(−2.38)	DW=.75
Union Carbide	.419	.142	−.428	$R^2=.38$
	(1.36)	(.83)	(−.73)	DW=1.87
United Technologies	.239	.122	−.195	$R^2=.60$
	(1.90)	(2.37)	(−1.10)	DW=1.34
Westinghouse	.122	.028	−.017	$R^2=.57$
	(1.96)	(.89)	(−.17)	DW=1.08
Woolworth	.254	.052	−.132	$R^2=.32$
	(3.45)	(1.36)	(−1.05)	DW=.99
All companies with common intercept	.226	.031	−0.90	$R^2=.33$
	(12.08)	(4.16)	(−3.48)	
All companies with different intercepts	. . .	.033	−.099	$R^2=.59$
		(5.15)	(−4.38)	

The results obtained in this section provide quite strong microeconometric support for the q theory of investment. The results parallel closely those obtained in Summers' (1981*a*) study of aggregate investment over the entire 1929–78 period. The aggregate results suggest a somewhat larger responsiveness of investment to q than is found here. This is probably because aggregation reduces some of the noise in individual firms' q. Future progress in reconciling micro- and macroestimates of the effects of q, and in improving the explanatory power of these equations, must await the development of methods for taking account of rents and the nonhomogeneity of the capital stock.

8.3 Tax Reform and Corporate Valuation

This section assesses the impact of alternative tax reforms on corporate profitability and on share valuation. The equations estimated in the previous section provide the basis for estimating the impact of a given tax reform on a firm's investment. In order to estimate the effect of a given tax reform on a firm's investment, one must first calculate its effect on Q. The principal difficulty in this calculation comes in estimating the effect of the reform on V, the market value of firm equity. The procedure followed here is to estimate the impact on the market value of equity by calculating the present value of the change in tax liabilities which a reform will cause assuming that the firm's growth is not affected by the tax change.

A proper calculation of this type would require the simultaneous estimation of the entire growth path of the firm. This path is of course

precisely compared with the value and replacement cost of the firm and because they are determined exogenously. In small samples, however, instrumental variable regressions are badly biased.

affected by tax reforms. Deriving the path of investment following a tax change requires the solution of a two-point boundary value problem as described in Summers (1981*a*). Because the response of investment to change in Q is estimated to be small, the approximation error involved is likely to be very small.

The first step in estimating the change in market value from a tax change is estimating its effect on after-tax profits. In this paper, we consider three alternative tax reforms: indexation of the tax system to adjust for inflation, 25% acceleration of depreciation deductions, and reduction in the statutory corporate tax rate from 46 to 40%.[9] It is easiest to begin by describing how the change in profits arising from the corporate rate reduction was calculated.

In general, reported profits differ from taxable profits. As a result, to estimate the effect of a change in the corporate tax rate, we look at actual taxes paid. With a tax rate of 46%, taxes are given by

$$T = 0.46\pi^T - \text{ITC} - \text{FTC},$$

where T = taxes, π^T = taxable profits, ITC = investment tax credit, and FTC = foreign tax credit. Reducing the corporate tax rate to 0.40 increases profits by $0.6\pi^T$. We assume that all foreign taxes paid can be claimed as a credit.[10] Thus we estimate the change in profits by

$$\Delta\pi(\text{tax reduction}) = \frac{6}{46}(T + \text{ITC} + \text{FTC}). \tag{19}$$

The change in profits from accelerating depreciation and using replacement cost depreciation are, respectively,

$$\Delta\pi(\text{depreciation acceleration}) = \left(\frac{8}{3L} - \frac{2}{L}\right)\text{NPL}^T \times 0.46,$$

$$\Delta\pi(\text{replacement cost depreciation}) = \frac{2}{L}(\text{NPL}^R - \text{NPL}^T) \times 0.46.$$

In indexing debt, we allow firms to deduct only real interest payments on the market value of the debt. Using an ARMA procedure based only on prior data, we estimate that at the beginning of 1978 the expected inflation rate over a long horizon was 0.053. We thus deduct from profits:

9. Specifically, we assume that the useful life for tax purposes is reduced by 25%. The reduction results in a 33⅓% increase in δ, the depreciation rate.

10. Firms may claim foreign taxes up to the United States statutory tax rate times foreign pretax profits as a tax credit. The maximum applies to all foreign taxes paid. Thus a firm can offset taxes above the United States corporate tax rate by operating in another country with a tax rate lower than the United States'.

$$(20) \qquad \Delta\pi(\text{debt indexation}) = 0.053 \times \text{MVDEBT} \times 0.46.$$

In general, the inventory adjustment is

$$(21) \qquad \Delta\pi(\text{inventory indexation}) = 0.46 \times \text{FRFIFO} \times \text{INV}_{-1} \times \frac{\text{CPI}}{\text{CPI}_{-1}}.$$

When inventories are drawn down, however, an adjustment also has to be made for liquidated LIFO inventories. As in the estimation of real inventories, we assume that the reduction in LIFO inventories comes from goods purchased in the previous year.

To estimate the change in market value, we need to project future values for each firm's taxes, net plant, debt, and inventories. We assume that the real value of these quantities grows at the same rate. We estimated the growth rate of real net property, plant, and equipment from 1964 to 1978. Over that period, some of the firms had growth rates exceeding 10% per year. In general, such growth rates reflect the adjustment to a new equilibrium and we do not expect them to continue. Thus we average the historic growth rate with 3% to get expected future growth.

In the calculations below, it is assumed that investors expect that the rate of inflation will remain permanently at 0.053. It is assumed that potential tax reforms are permanent and unanticipated. When considering, for example, the acceleration of depreciation, we assume that people did not foresee the tax law change. When the change occurs, people expect it to last forever. We assume that a real discount rate of 10% can be applied to all cash flows. This may be misleading, since the risk characteristics of depreciation allowances differ greatly from those of pretax profits.

The formula for the change in V from corporate tax rate reduction, inventory indexation, and debt indexation is

$$\Delta V = \frac{\Delta\pi}{0.1 - g} \frac{1 - \theta^D}{1 - c},$$

where g is the growth rate. To reduce the effect of wide annual fluctuations, we use three year averages of inventories and taxes paid rather than the 1978 values. The averages are calculated in real terms and adjusted for growth.

The change in V from a change in the depreciation tax law is the sum of the changes in the value of depreciation deductions on existing capital and on future additions to capital. The former is simply the change in B. New investment at time t is given by

$$\text{NI}(t) = \left(g + \frac{2}{L}\right)\text{RNPPE}(0)e^{gt},$$

where RNPPE represents the real value of net property, plant, and equipment. The change in the value of the depreciation deduction at time t of investment at time t is the change in Z. Thus the change in the value of depreciation deductions on all future new investment is the change in Z times the discounted stream of investment.

While most recent discussions of corporate tax reforms have focused on the likely impact on investment, issues of equity should be considered as well. Unsophisticated observers focus on the distinction between tax relief for business and for individuals. This is misleading, as corporations should be thought of as conduits. All taxes are ultimately borne by individuals in their role as labor suppliers, consumers, or suppliers of capital. The change in the value of the stock market following a tax change is a direct measure of the present value of the burdens it will impose on the suppliers of equity capital. It thus seems a natural candidate for measuring the incidence of capital tax reforms.

In addition to examining the impact of tax policy on the functional distribution of income, it is instructive to model the effects of tax reforms on the stock market for two other reasons. First, it is widely accepted that a good tax reform should minimize windfall gains and losses. The size of the policy-induced jump in the stock market is a good measure of its windfall effect. If, as available evidence suggests, investors fail to hold diversified portfolios, then differential effects of tax reforms on different securities create windfall gains and losses.

Second, the effect of tax policy on the stock market is of concern to those sensitive to issues of vertical equity. Virtually all corporate equity is owned directly or indirectly by the very wealthy. About 75% is held directly by individuals. Of this, available evidence indicates that about 50% is held by families with incomes in the top 1% of the population. This actually understates the true concentration because much of the remainder of the stock is held by individuals with deceptively low reported incomes due to successful sheltering or life-cycle effects. The remaining stock is mostly held by pension funds, foreigners, and insurance companies. Since almost all pension plans offer defined benefits, the pension's assets are ultimately owned not by the beneficiaries but by the shareowners in the corporations with pension liabilities. Hence this stock also should be assigned primarily to rich households. The distributional consequences of insurance company and foreign ownership are less clear. But the conclusion that any tax-induced change in profitability which shows up in the stock market redounds almost entirely to the very wealthy seems inevitable. Therefore the analysis below focuses on the effects of tax reforms on both investment and the stock market. Recent research suggests the importance of dividend clienteles. This implies that changes in the relative valuation of different firms may have large effects on the distribution of wealth.

In table 8.4 the effects of indexing the tax system are considered. The relative effects of the different components of indexing vary among firms. Indexing debt has a small impact on Kodak, which is almost entirely equity financed, and a large impact on AT&T, which is largely debt financed. Inventory indexation has no effect on firms already using LIFO but a large effect on American Brands, which primarily uses FIFO. With only two exceptions, the effect of total indexation is to increase firm value, thus suggesting that the interaction of inflation and corporate taxes has at least partially contributed to the decline in the real value of the stock market. In some cases, indexation has a significantly larger impact on profits than on firm value. This phenomenon is undoubtedly a result of some firms having unusually low real profits in 1978. In making these calculations, we implicitly assume that a reduction in taxable profits is of value to the firm. The effect of total indexation on firm value ranges from −13.3% for Sears to 20.4% for American Brands. Typically, indexation leads to an increase in firm value of between 5% and 10%.

This contradicts the results of several earlier studies (e.g. Shoven and Bulow 1975) which suggested that indexing would be approximately neutral or actually increase corporate income tax liabilities. The reason is that our calculation focuses on the long-run impact of increases in inflation rather than their immediate impact on the current income, which includes revaluations of outstanding long-term debt.

These calculations of the impact of indexation on stock market valuations implicitly assume that the market is rational with respect to inflation. This hypothesis is examined explicitly in Summers (1981*c*), who finds some evidence that at least historically the market has failed to fully recognize the effects of inflation-taxation interactions.

Table 8.5 considers the effect of reducing the corporate tax rate from 0.46 to 0.4 and of accelerating depreciation by 25%. On average, the latter reform increases firm value by 7%. Not surprisingly, the effect on capital-intensive firms is larger. The effect of a reduction in the tax rate ranges from 4.1% for Bethlehem Steel to 34.7% for Exxon. If taxable income equals real income, the tax rate reduction should increase firm value by 11%. Because the interaction of inflation and the tax system cause taxable profits to be higher than real profits, the tax rate reduction should increase firm value by more than 11%. In fact, the average increase in firm value from indexing in table 8.4 is consistent with the 13% average increase in firm value from a tax rate reduction. The variation among firms of the effect of indexing does not, however, explain the variation of the effect of the tax rate reduction. The 34.7% increase in Exxon's value, for example, cannot be explained by the inflation-induced overstatement of profits. In 1978, Exxon's foreign and federal taxes were 65% of its taxable income. A large portion of Exxon's taxes were foreign. Saudi Arabia levies a large "tax" on oil extraction. It is not clear that this

Table 8.4 **Effect of Indexation on Profitability and Stock Market Valuation**

Company	% Change in V				% Change in Profits			
	Inventories	Depreciation	Debt	Total	Inventories	Depreciation	Debt	Total
Allied Chemical	2.9	14.3	−13.6	3.6	.1	98.7	−78.0	20.9
Aluminum Company of America	4.0	11.3	−13.8	1.5	4.5	16.1	−12.4	8.4
American Brands	41.2	5.9	−26.7	20.4	39.5	5.5	−19.6	25.3
American Can	10.7	10.3	−9.1	11.9	31.6	37.2	−20.2	48.5
American Telephone & Telegraph	.5	18.4	−21.8	−2.9	1.3	47.5	−44.5	4.2
Bethlehem Steel	7.7	32.0	−24.0	15.7	.4	84.9	−33.5	51.9
E. I. DuPont de Nemours	2.9	8.7	−6.1	5.5	3.3	10.3	−5.4	8.2
Eastman Kodak	2.4	5.3	−.6	7.1	2.2	5.0	−.4	6.8
Exxon	.0	10.3	−5.5	4.8	.1	19.2	−7.8	11.5
General Electric	3.0	4.3	−4.3	3.0	4.4	6.5	−4.9	6.1
General Foods	13.3	5.2	−5.2	13.3	22.6	11.0	−7.0	26.5
General Motors	5.1	9.7	−2.5	12.3	3.4	6.0	−1.3	8.1
Goodyear Tire	14.6	18.9	−26.2	7.3	29.8	38.7	−40.9	27.6

International Nickel[a]	25.7	18.0	−28.7	15.0	*	*	*	*
International Business Machines	.8	3.8	−.2	4.4	2.1	9.1	−.6	10.6
International Harvester	16.7	8.4	−22.6	2.5	37.2	20.4	−38.1	19.5
International Paper	21.8	10.6	−12.2	20.2	3.3	16.8	−14.3	5.7
Johns-Manville	.0	10.9	−9.2	1.7	.0	9.6	−6.5	3.2
Merck	8.9	6.6	−5.6	9.9	6.8	3.9	−3.5	7.2
Minnesota Mining & Manufacturing	7.5	5.2	−3.5	9.2	7.2	4.7	−2.8	9.2
Owens-Illinois	7.0	17.3	−19.5	4.8	12.1	32.2	−26.4	17.9
Proctor & Gamble	2.2	3.7	−3.2	2.7	3.8	6.0	−4.2	5.6
Sears	.0	2.8	−16.1	−13.3	.4	4.5	−17.2	−12.2
Standard Oil of California	2.0	9.4	−5.1	6.3	.8	13.6	−4.8	9.6
Texaco	4.0	13.0	−9.3	7.7	2.2	25.3	−12.3	15.2
United States Steel[a]	.0	17.8	−16.3	1.5	*	*	*	*
Union Carbide	6.1	15.8	−15.7	6.2	.2	32.3	−27.0	5.5
United Technologies	12.6	3.7	−3.8	12.5	17.7	6.0	−4.7	19.0
Westinghouse	9.9	11.0	−7.0	13.9	9.9	12.9	−5.5	17.3
Woolworth	20.7	11.7	−17.1	15.3	21.0	13.2	−13.7	20.5

[a]Negative profits in 1978.

Table 8.5 **Effect of Tax Changes on Profitability and Stock Market Valuation**

	% Change in V		% Change in Profits	
Company	Tax Rate Reduction	Depreciation Acceleration	Tax Rate Reduction	Depreciation Acceleration
Allied Chemical	8.2	9.3	87.0	111.8
Aluminum Company of America	9.0	7.3	10.8	12.6
American Brands	25.5	3.9	21.2	5.7
American Can	11.6	6.6	25.8	27.6
American Telephone & Telegraph	3.8	12.0	11.1	46.1
Bethlehem Steel	2.6	20.7	13.6	55.0
E. I. DuPont de Nemours	8.2	5.7	9.4	12.1
Eastman Kodak	13.8	3.5	11.4	5.4
Exxon	34.7	6.7	46.9	19.0
General Electric	10.0	2.8	11.4	7.5
General Foods	14.1	3.4	19.6	9.1
General Motors	22.9	6.4	11.3	8.0
Goodyear Tire	18.5	12.3	28.8	38.2
International Nickel[a]	12.8	11.5	*	*
International Business Machines	9.1	2.6	20.6	17.2
International Harvester	9.6	5.5	25.1	20.4
International Paper	6.7	6.9	8.4	16.7
Johns-Manville	16.5	7.0	15.4	9.1
Merck	19.4	4.3	11.9	5.9
Minnesota Mining & Manufacturing	13.9	3.4	13.0	6.0
Owens-Illinois	12.3	11.2	15.8	29.8
Proctor & Gamble	10.7	2.4	14.3	5.6
Sears	4.6	1.8	4.8	3.8
Standard Oil of California	11.7	6.1	11.4	11.2
Texaco	15.2	8.4	15.8	21.7
United States Steel[a]	4.3	11.4	*	*
Union Carbide	5.6	10.3	10.1	37.5
United Technologies	13.6	2.5	18.3	7.4
Westinghouse	13.5	7.1	14.6	10.9
Woolworth	20.3	7.7	19.0	13.7

[a]Negative profits in 1978.

tax is an income tax, so it may not qualify for the foreign tax credit. Even if it does, the tax may be large enough to make Exxon's tax rate on foreign profits well above 0.46. In either case, our assumption that all foreign taxes can be claimed as a credit is likely to be violated.

8.4 Tax Reforms, Q, and Investment

In this section we derive estimates of the impact of the tax reform packages considered above on firm investment. The estimates are calculated first by using the estimates of the impact of tax changes on V displayed in tables 8.4 and 8.5 to find the estimated change in Q, and then by multiplying this figure by the coefficient on Q in the firm investment equation.

It should be stressed at the outset that these estimates are subject to very substantial error. Beyond the difficulties of inaccuracy in the data, a major limitation of the analysis is that for some firms the effect of changes in Q is estimated only with a large standard error. Moreover, the effect of tax reforms on V is estimable only approximately due to the somewhat arbitrary assumptions made about the choice of a discount and growth rate, and the neglect of the economy-wide feedback effects of increased capital accumulation. While these conclusions are, to say the least, tentative, they illustrate the potential of this methodology for a much richer analysis of the effects of tax changes.

An additional issue is posed by FIFO inventory accounting. As table 8.4 demonstrates, a substantial fraction of the gains to corporations from indexing arise from the elimination of the taxation of FIFO profits. There exist some reasons to believe that any extra taxes incurred as a result of FIFO inventory accounting do not discourage investment in plant and equipment. It is argued that the taxes are voluntary and so are unlikely to be paid if they impose a burden. In addition it is argued that taxes on inventory holdings should have no impact on the return to plant and equipment investment and so should not affect these investment decisions.

Table 8.6 presents the effects of indexation on Q and on investment. While there is considerable variation among firms, total indexation generally increases investment by less than 5%. Table 8.7 gives the projections of how lowering the corporate tax rate and accelerating depreciation affect Q and investment. Again, the increase in investment by most of the firms is between 0% and 5%. Comparing these results with tables 8.4 and 8.5, it is clear that the tax changes have a larger impact on firm valuation than on investment.

Comparing tables 8.6 and 8.7 with tables 8.4 and 8.5, it can be seen that in the short run the costs of these changes are large compared with their benefits. In many cases, the amendments would have a much greater impact on firm value than on investment. For example, completely indexing the tax system would increase International Paper's market value by 20.2%. At the same time, International Paper would increment its investments by only 0.6%. Similarly, a 15% growth in the value of International Nickel would stimulate additional investment of only 1.5%. While these firms are outliers, market value would increase twice as much as investment for most firms.

The large change in firm value would also have an undesirable impact on the distribution of wealth. These changes in the corporate income tax

Table 8.6 Effect of Indexation on Q and Investment

	Change in Q				% Change in Investment			
Company	Inventories	Depreciation	Debt	Total	Inventories	Depreciation	Debt	Total
Allied Chemical	.037	.256	−.176	.117	.4	2.9	−2.0	1.3
Aluminum Company of America	.054	.233	−.184	.103	.9	3.9	−3.0	1.8
American Brands	.830	.441	−.540	.731	26.2	13.9	−16.7	23.4
American Can	.130	.215	−.110	.235	5.2	8.6	−4.4	9.4
American Telephone & Telegraph	.007	.298	−.309	−.004	.0	1.5	−1.5	.0
Bethlehem Steel	.037	.218	−.116	.139	2.9	17.0	−9.0	10.9
E. I. DuPont de Nemours	.076	.353	−.158	.399	.1	.6	−.3	0.4
Eastman Kodak	.126	.445	−.030	.541	.6	2.2	−.1	2.7
Exxon[a]	.000	.292	−.110	.182	*	*	*	*
General Electric	.134	.385	−.188	.331	.8	2.2	−1.1	1.9
General Foods	.351	.284	−.136	.499	3.0	2.4	−1.2	4.2
General Motors	.117	.409	−.057	.469	.3	1.2	−.2	1.3
Goodyear Tire	.121	.315	−.218	.218	3.6	9.2	−6.4	6.4

International Nickel	.267	.287	−.297	.257	1.6	1.7	−1.8	1.5
International Business Machines	.087	.498	−.027	.558	.1	.8	−.0	.9
International Harvester	.135	.245	−.183	.197	1.4	2.5	−1.8	2.1
International Paper	.042	.283	−.239	.086	.3	2.1	−1.8	.6
Johns-Manville[a]	.000	.308	−.179	.129	*	*	*	*
Merck	.853	.980	−.537	1.296	.4	.5	−.3	.6
Minnesota Mining & Manufacturing	.514	.584	−.240	.858	1.1	1.2	−.5	1.8
Owens-Illinois	.076	.288	−.210	.154	1.7	6.6	−4.8	3.5
Proctor & Gamble	.128	.352	−.184	.296	.1	.4	−.2	.3
Sears	.000	.323	−.651	−.328	.0	5.5	−11.0	−5.5
Standard Oil of California	.040	.257	−.098	.199	.6	3.9	−1.5	3.0
Texaco	.057	.277	−.133	.201	.4	1.8	−.9	1.3
United States Steel	.000	.170	−.105	.065	.0	1.9	−1.2	.7
Union Carbide	.070	.286	−.179	.177	.4	1.5	−1.0	.9
United Technologies	.400	.292	−.120	.572	10.7	7.8	−3.2	15.3
Westinghouse	.136	.320	−.096	.360	2.7	6.3	−1.9	7.1
Woolworth	.174	.331	−.144	.361	1.3	2.4	−1.0	2.7

[a]Change in investment not projected when estimated coefficient of tax-adjusted Q is negative.

Table 8.7 Effect of Tax Reforms on Q and Investment

Company	Change in Q		% Change in Investment	
	Tax Rate Reduction	Depreciation Acceleration	Tax Rate Reduction	Depreciation Acceleration
Allied Chemical	.065	.167	.7	1.9
Aluminum Company of America	.064	.151	1.1	2.5
American Brands	.286	.287	9.0	9.1
American Can	.109	.140	4.3	5.6
American Telephone & Telegraph	−.006	.193	−.0	1.0
Bethlehem Steel	.076	.141	5.9	11.0
E. I. DuPont de Nemours	.028	.233	.0	.4
Eastman Kodak	.262	.291	1.3	1.4
Exxon[a]	.544	.189	*	*
General Electric	.035	.254	.2	1.5
General Foods	.165	.185	1.4	1.6
General Motors	.356	.270	1.0	.8
Goodyear Tire	.135	.205	3.9	6.0
International Nickel	.110	.184	.7	1.1
International Business Machines	−.052	.333	−.0	.5
International Harvester	.045	.161	.4	1.6
International Paper	.009	.184	.0	1.4
Johns-Manville[a]	.206	.199	*	*
Merck	.811	.641	.4	.3
Minnesota Mining & Manufacturing	.269	.384	.6	.8
Owens-Illinois	.105	.187	2.4	4.3
Proctor & Gamble	.092	.227	.1	.2
Sears	−.269	.211	−4.5	3.6
Standard Oil of California	.129	.167	2.0	2.5
Texaco	.163	.180	1.1	1.2
United States Steel	.076	.109	.9	1.2
Union Carbide	.038	.186	.2	1.0
United Technologies	.151	.192	4.1	5.2
Westinghouse	.137	.208	2.7	4.1
Woolworth	.144	.218	1.0	1.6

[a]Change in investment not projected when estimated coefficient of tax-adjusted Q is negative.

are being considered along with reductions in personal income taxes for people in top income brackets. Combined, these policies may cause a large shift of wealth to those who are already wealthy.

If the government's objective is to increase investment, it should implement the reforms which most directly affect the relative cost of capital. Indexing or accelerating depreciation induces more investment for a given increase in market value than do the other changes. Consider, for example, the effects of indexing inventories and depreciation for

American Can. The two changes have a nearly equal effect on firm valuation, but depreciation indexing has almost twice the effect on investment that inventory indexing does. Similarly, the tax rate reduction would increase the value of Goodyear by 20.4% while the depreciation acceleration would increase it by only 12.3%. The latter change would, however, increase Goodyear's investment more than the former.

Investment studies that use aggregate data miss the effect of policies on the composition of investment. Yet, the results in this study suggest that the impact of tax changes would vary significantly across firms. Since these results are for a small number of firms, it is difficult to say whether most of the variation is across or within industries. Insofar as adjustment costs are part of an industry's technology, one might expect similar results for firms in the same industry. On the other hand, the analysis in section 8.1 assumed a competitive market structure. Especially for the Dow 30, this assumption is tenuous. It is possible that the response to a tax change could depend on a firm's competitive position within an industry. The three chemical firms in the sample show similar responses to all the changes. In contrast, though, Bethlehem Steel's investment is much more sensitive to tax changes than United States Steel's. An important extension of this paper would be to explore more systematically the effect of taxes on the composition of investment.

8.5 Conclusions

This preliminary attempt to examine the impact of alternative tax reforms on the investment decisions of individual firms has yielded promising results. The q theory approach has substantial predictive power at the microlevel. The econometric results suggest that explanatory power is enhanced even further when tax effects are recognized. The simulation results confirm that tax policies can have large effects on both stock market valuations and investment incentives in both the short and the long run. They also indicate that the effects of investment incentives are likely to differ very substantially across firms.

The differences arise from variations both in the magnitude of tax effects on firms' incentives to invest and in the responsiveness of firms' investment to changes in investment incentives. The latter are due, according to the model, to differing adjustment cost functions.

While these results are informative and encouraging, a great deal needs to be done before it will be possible to make accurate predictions of the impact of tax reforms on individual corporate or even industry investment decisions. The most important area for further investigation is the relaxation of the stringent assumptions about the homogeneity of capital and absence of rents that were made here. This will probably necessitate the addition of other variables to Q investment equations. Ultimately, work along these lines promises us a greater understanding not just of tax effects on investment but also of tax effects on the other components of a firm's net worth such as intangibles.

Appendix

The source of the data is the Compustat tapes and spans the years 1959 to 1978. To estimate tax-adjusted Q, we need estimates of the market value of equity, the market value of debt, the replacement value of inventories, the replacement value of the capital stock, and the taxable capital stock. Throughout the analysis, we tried to get these figures for the beginning of each year.

Market Value of Equity

Compustat gives the closing price of a share of stock for each company. The value of common stock at the beginning of the year is estimated as the closing value in year $t-1$ times the number of shares outstanding at $t-1$. The value of preferred stock is estimated by dividing preferred dividends by the Standard and Poor's preferred stock yield.

Market Value of Debt

Compustat lists the book value of both long-term and short-term debt. We assume that the market value of short-term debt equals the book value. In principle, to estimate the market value of long-term debt, we need to know the years to maturity, coupon rate, and default characteristics of all debt issues. Compustat does not have this information. Following Brainard, Shoven, and Weiss (1980), we assume: (1) All new issues of long-term debt have a maturity of twenty years. (2) The coupon rate is the BAA rate prevailing in the year of issue, and the default characteristics of the bonds continue to warrant a BAA rating until they reach maturity. (3) In 1959, the maturity distribution of bonds for each firm was proportional to the maturity distribution of aggregate outstanding issues.[11] (4) New issues of long-term debt for the years 1960 to 1978 are given by

$$N_t = \mathrm{LTD}_t - \mathrm{LTD}_{t-1} + N^*_{t-20,t-1} \quad \text{if } \mathrm{LTD}_t - \mathrm{LTD}_{t-1} + N^*_{t-20,t} \geq 0,$$
$$N_t = 0 \quad \text{if } \mathrm{LTD}_t - \mathrm{LTD}_{t-1} + N^*_{t-20,t} < 0,$$

where LTD_t = new issues of long-term debt in year t, $N^*_{i,t}$ = debt issued at time i still outstanding at time t, and LTD_t = long-term debt in year t. We add $N^*_{t-20,t-1}$ because, each period, the debt issued twenty years

11. The data on aggregate outstanding issues come from *Historical Statistics of the United States*, series X 499–509, p. 1005.

earlier is retired. (5) If $LTD_t - LTD_{t-1} + N^*_{t-20,t-1} < 0$, the issues from each previous year are reduced proportionately. That is,

$$N^*_{i,t} = N^*_{i,t-1} \frac{LTD_t}{LTD_{t-1} - N^*_{t-20,t-1}}.$$

Each year the market value of debt issued in year i ($MVN^*_{i,t}$) is calculated using the familiar formula for the value of a coupon bond:

$$MVN^*_{i,t} = N^*_{i,t} \left[\frac{BAA_i}{BAA_t} \left[1 - \left(\frac{1}{1 + BAA_t} \right)^{i+20-t} \right] + \left(\frac{1}{1 + BAA_t} \right)^{i+20-t} \right].$$

The value of all long-term debt outstanding in year t($MVLTD_t$) is, then,

$$MVLTD_t = \sum_{i=t-19}^{t} MVN^*_{i,t}.$$

The Replacement Value of Inventories

To estimate the replacement value of inventories, one needs to know the method of inventory valuation. For companies using FIFO, the reported level of inventories equals the market value of inventories. For companies using LIFO, the reported level of inventories bears little relation to the market value. Compustat does give the inventory valuation method. In addition to LIFO and FIFO, it allows for specific identification, average cost, retail method, standard cost, and replacement cost inventory valuation. We assume that all methods except for LIFO are identical to FIFO. When companies report more than one method of inventory accounting, Compustat lists them in descending order of importance but gives no estimate of the relative weights. We assume that the first method reported accounts for ⅔ of the real value of inventories and the second method accounts for the remaining ⅓. We make this assumption even when more than two methods are reported. Finally, we assume that the methods reported in 1978 were also used from 1959 to 1977.

We assume that reported LIFO inventories equal the market value of LIFO inventories in 1959. This assumption is plausible because there was a sustained period of price stability before 1959. For a company that uses only LIFO, reported inventories will stay constant if the real value of inventories does not change. To get the new replacement cost of inventories under such circumstances, we multiply the old replacement cost by the inflation rate. Throughout this paper, increases in the consumer price index are used for the inflation rate. Reported inventories increase or decline as the real level of inventories increases or declines. When reported inventories rise, the addition is evaluated at current prices.

When reported inventories fall, the price level at which liquidations are valued is not clear since we do not know when they were purchased. We assume that they were purchased the previous year. Thus, letting INV_t be reported inventories at time t and $RLINV_t$ be real inventories at time t, we calculate real inventories as follows:

$$RLINV_t = RLINV_{t-1}\frac{CPI_t}{CPI_{t-1}} + INV_t - INV_{t-1} \quad \text{if } INV_t \geq INV_{t-1},$$

$$RLINV_t = (RLINV_{t-1} + INV_t - INV_{t-1})\frac{CPI_t}{CPI_{t-1}} \quad \text{if } INV_t < INV_{t-1}.$$

When more than one inventory valuation method is used, we need to decompose inventories into a LIFO and a FIFO component. The calculation is complicated because inflation changes the fraction of reported LIFO and FIFO inventories. For example, consider a firm that in year t has 100 units of LIFO inventories and 100 units of FIFO inventories. Assume that both the LIFO and FIFO inventories are valued at $1 per unit. Thus the fraction of both real and reported inventories for which FIFO is used is ½. In year $t + 1$, the company produces and sells 100 units of both LIFO and FIFO goods. Suppose the price level doubles in year $t + 1$. The firm reports $100 of LIFO inventories and $200 of FIFO inventories. While the fraction of real inventories for which FIFO is used is still ½, reported FIFO inventories are now ⅔ of total reported inventories.

Let $FRFIFO_t$ be the fraction of reported inventories for which FIFO is used in year t. When the real value of inventories is unchanged, reported inventories increase by a factor of $FRFIFO_{t-1}\,((CPI_t/CPI_{t-1}) - 1)$. Let

$$\Delta = INV_t - INV_{t-1}\left[1 + FRFIFO\left(\frac{CPI_t}{CPI_{t-1}}\right)\right].$$

The term Δ is the change in reported inventories caused by a change in real inventories. Let $\Delta RLINV_t$ be the change in real inventories, evaluated at prices in time t. We can decompose Δ into LIFO and FIFO components (ΔLIFO and ΔFIFO, respectively). Similarly, let ΔRFIFO and ΔRLIFO be the fractions of the change in real inventories for which FIFO and LIFO are used.

In general,

$$\text{(A1)} \qquad RLINV_t = \frac{CPI_t}{CPI_{t-1}} \times RLINV_{t-1} + \Delta RLINV_t,$$

$$\text{(A2)} \qquad \text{FRFIFO}_t = \frac{\dfrac{\text{CPI}_t}{\text{CPI}_{t-1}} \times \text{FRFIFO}_{t-1} \times \text{INV}_{t-1} + \Delta\text{FIFO}}{\text{INV}_t}.$$

Equation (A1) says that real inventories in year t are real inventories in year $t - 1$, evaluated at year t prices, plus the change in real inventories. The numerator on the right-hand side of (A2) is the level of reported FIFO inventories. Thus equation (A2) merely says that the fraction of reported inventories for which FIFO is used is reported FIFO inventories divided by total inventories. Not all of the variables in (A1) and (A2) are observable. In order to calculate RLINV_t and FRFIFO_t, we need to find expressions for ΔRLINV_t and ΔFIFO_t in terms of observable variables.

Consider the case in which ⅔ of real inventories is FIFO and ⅓ is LIFO. When the real valuation of inventories rises (i.e. when $\Delta \geq 0$), the new LIFO inventories are evaluated at current prices. While it is logically possible that they are evaluated at past prices, our assumption is reasonable because inventory-to-sales ratios are much less than 1. Thus

$$\text{(A3)} \qquad \Delta\text{FIFO}_t = \Delta\text{RFIFO}_t = \tfrac{2}{3}\Delta_t,$$

$$\text{(A4)} \qquad \Delta\text{LIFO}_t = \Delta\text{RLIFO}_t = \tfrac{1}{3}\Delta_t.$$

Plugging (A3) and (A4) into (A1) and (A2) yields

$$\text{RLINV}_t = \text{RLINV}_{t-1}\left(\frac{\text{CPI}_t}{\text{CPI}_{t-1}}\right) + \Delta,$$

$$\text{FRFIFO}_t = \frac{\text{INV}_{t-1}\text{FRFIFO}_{t-1}(\text{CPI}_t/\text{CPI}_{t-1}) + 2\Delta/3.}{\text{INV}_t}$$

When Δ is negative, decreases in FIFO inventories must be valued at current prices. As before, decreases in LIFO inventories must be valued at the previous year's prices. Thus

$$\text{(A5)} \qquad \begin{aligned} \Delta\text{FIFO}_t &= \Delta\text{RFIFO}_t, \\ \Delta\text{LIFO}_t &= \Delta\text{RLIFO}_t \frac{\text{CPI}_{t-1}}{\text{CPI}_t}, \end{aligned}$$

$$\text{(A6)} \qquad \Delta = \Delta\text{RFIFO} + \frac{\text{CPI}_{t-1}}{\text{CPI}_t}\Delta\text{RLIFO}.$$

Remembering that real LIFO inventories are half of real FIFO inventories, equations (A5) and (A6) imply

$$\text{(A7)} \qquad \Delta\text{RFIFO}_t\left(1 + \frac{1}{2}\frac{\text{CPI}_{t-1}}{\text{CPI}_t}\right) = \Delta$$

$$\text{(A8)} \qquad \Delta\text{RLINV}_t = 3\Delta/\left(2 + \frac{\text{CPI}_{t-1}}{\text{CPI}_t}\right).$$

Finally, putting (A8) into (A1) and putting (A5) and (A7) into (A2) yields

$$\text{(A9)} \qquad \text{RLINV}_t = \text{RLINV}_{t-1} \frac{\text{CPI}_t}{\text{CPI}_{t-1}} + 3\Delta / \left[2 + \frac{\text{CPI}_{t-1}}{\text{CPI}_t} \right],$$

$$\text{(A10)} \qquad \text{FRFIFO}_t = \left[\text{FRFIFO}_{t-1} \times \text{INV}_{t-1} \times \frac{\text{CPI}_t}{\text{CPI}_{t-1}} + \frac{\Delta}{1 + \frac{1}{2} \frac{\text{CPI}_{t-1}}{\text{CPI}_t}} \right] / \text{INV}_t .$$

Equations (A9) and (A10) have only observable variables on the right-hand side.

When real FIFO inventories are ⅓ of total real inventories, the equations are as follows:

$$\Delta = I_t - I_{t-1} \left[\text{FRFIFO}_{t-1} \left(\frac{\text{CPI}_t}{\text{CPI}_{t-1}} - 1 \right) + 1 \right].$$

If $\Delta > 0$, then

$$\text{RLINV}_t = \text{RLINV}_{t-1} \frac{\text{CPI}_t}{\text{CPI}_{t-1}} + \Delta,$$

$$\text{FRFIFO}_t = \frac{\text{FRFIFO}_{t-1} \times \text{INV}_{t-1} \times \text{CPI}_t/\text{CPI}_{t-1} + \frac{1}{3}\Delta}{\text{INV}_t}.$$

If $\Delta < 0$, then

$$\text{RLINV}_t = \text{RLINV}_{t-1} \frac{\text{CPI}_t}{\text{CPI}_{t-1}} + \Delta \frac{3\text{CPI}_t}{2\text{CPI}_{t-1} + \text{CPI}_t},$$

$$\text{FRFIFO}_t = \left[\text{FRFIFO}_{t-1} \frac{\text{CPI}_t}{\text{CPI}_{t-1}} \text{INV}_{t-1} + \Delta \frac{\text{CPI}_t}{\text{CPI}_t + 2\text{CPI}_{t-1}} \right] / \text{INV}_t .$$

In the model in section 8.2, production and sales occur simultaneously. As a result, the model does not allow for inventories. In estimating the model, however, inventories must be considered because they are reflected in the value of the firm. In the results reported here, inventories are added to the denominator of the expression $(V_t - B_t)/p_t K_t$. An alternative treatment is to subtract them from the numerator. Since inventories are not completely liquid assets, one might choose to subtract only a fraction of the real value of inventories from the numerator. We experimented with all three methods and got virtually identical results.

Capital Stock

In general, reported net property, plant, and equipment (NPPE) differs not only from replacement cost but also from taxable net property, plant, and equipment (RNPPE and TNPPE, respectively). To estimate RNPPE and TNPPE, we construct an investment series and estimate depreciation rates.[12] In doing so, we assume: (1) All of a firm's capital has the same useful life (L). (2) Firms use the straight-line method for book depreciation.[13] (3) Both tax and actual depreciation are exponential with depreciation rate $2/L$. This method is identical to double declining balance depreciation.[14] (4) All investments are made at the beginning of the year, and all depreciation is taken at the end of the year. (5) Investment for years $1959 - L + 1$ to 1978 is proportional to aggregate investment in these years and is consistent with gross property, plant, and equipment in 1959.

Under these assumptions, we can estimate the useful life in any year by

$$L_t^* = \frac{\text{GPPE}_{t-1} + I_t}{\text{DEP}_t},$$

where GPPE_t = book value of gross property, plant, and equipment in year t, I_t = investment in year t, and DEP_t = book depreciation in year t. In practice, L^* fluctuates from year to year, so the L we use is an average of L^* from 1960 to 1978.

Assuming that NPPE is 0 in year $1959 - L$, we estimate TNPPE and RNPPE from $1959 - L + 1$ to 1978 as follows:

$$\text{TNPPE}_t = (\text{TNPPE}_{t-1} + I_t)(1 - 2/L),$$

$$\text{RNPPE}_t = \left(\text{RNPPE}_{t-1}\frac{\text{CPI}_t}{\text{CPI}_{t-1}} + I_t\right)(1 - 2/L).$$

12. In general, there are serious problems with using property, plant, and equipment figures reported by companies. For example, one can go far awry by estimating gross plant in year t by adding gross plant in year $t - 1$ to investment in year t and subtracting estimated retirements. Even if one goes to the annual report and gets actual retirements, the procedure is not foolproof. Depreciation method changes and mergers are the most common causes for the estimates to fail.

13. The Compustat footnotes in principle gave the method of depreciation, but we found it impossible to use information. First, Compustat says whether depreciation is straight-line, accelerated, or a combination of both. Many companies reported a combination of methods. Second, the depreciation method often changes from year to year. Third, the footnote was often out of position on the tape, so we could not use the footnote in a computer program.

14. Companies that use double declining balance depreciation can switch to straight-line depreciation on the remaining balance once during the life of the asset. As a result, exponential depreciation only approximates actual depreciation. See Shoven and Bulow (1975).

The estimates of TNPPE_t and RNPPE_t for the years prior to 1959 use less than $L - 1$ years of data. As a result, they are essentially meaningless. Starting with 1959, enough years of investment enter the calculations but the data come almost entirely from aggregate figures. For the years nearer the end of the sample, more firm-specific data are available so the estimates are more reliable.

In estimating μ_s, B_t, and Z_t, we assume that expected inflation and the required return on investments are constant. Specifically, we estimate $\rho + \pi$ by adding 0.06 to the BAA bond rate. The dividend and the capital gains tax rates vary among individuals. We use the effective tax rates estimated by Feldstein and Poterba (1980), who calculated a weighted average of tax rates across taxpayers. In each period, people expect existing tax rates to last forever. Given the assumption that ρ, π, c, θ^D, and τ are constants, the integrals in equation (8a), (8b), and (8c) are easy to estimate:

$$\frac{\mu_s}{\mu_t} = \exp\left[-\frac{\rho+\pi}{1-c}(s-t)\right],$$

$$B_t = \frac{1}{\delta + \frac{\rho+\pi}{1-c}} \tau\delta \frac{1-\theta}{1-c} P_t K_t,$$

$$Z_t = \frac{1}{\delta + \frac{\rho+\pi}{1-c}} \tau\delta .$$

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Comment Robert J. Shiller

Salinger and Summers here present and estimate a model of firm behavior that is used to evaluate the effects of changes in tax laws on the value of the firm and on the level of investment. The estimation and simulation problems posed by the basic model are very simple when compared to the problems posed by other models currently used to answer the same questions. There is, in fact, only one estimated coefficient whose value influences the results Salinger and Summers present. In contrast, the answers provided by a conventional large-scale macroeconometric model might depend in varying degrees on hundreds of parameters estimated in diverse equations. Moreover, conventional simulations would require additional information, such as the form monetary policy takes after the tax law changes. The simplicity of the Salinger-Summers model is due partly to their merely ignoring effects considered by other models. It is also due, however, to an elegant simplicity of the model itself, which I find quite intriguing.

The basic model presented here was presented in an earlier paper by Summers (1981) and draws on earlier work by Abel (1982) and Hayashi (1982). Two critical assumptions are responsible for the estimated investment function which appears here: the assumption of stable adjustment

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cost function of a certain form and the assumption of homogeneity of degree one in both production and demand. Their function does *not* depend on any assumption of a stable production function, demand function, factor supply function, or expectation function. It is entirely consistent with the investment function estimated that these functions may jump around erratically and even that the discount rate used by the market to capitalize dividends may be erratic. The claim that I have made elsewhere that stock prices are too "volatile" to be accounted for entirely in terms of information about future dividends does not, strictly speaking, contradict this model. The investment function derived here is not immediately vulnerable to the rational expectationist criticism that parameters of estimated functions depend on the government policy rule. This criticism would be relevant only if adjustment costs were for some reason a function of the policy rule. It should be added, of course, that if these other functions cannot be modeled, then we will be unable to answer most of the basic questions we are interested in regarding the tax policy. The simulations they do with the model in this paper do depend on such stability assumptions and are vulnerable to rational expectationist criticism.

The reason why the investment function estimated here is so simple is that the model implies that the *price* of the firm's stock (relative to the capital stock) captures all the information relevant to the investment decision if this price is transformed as described in the text to produce tax-adjusted Q. Thus any shifts in the production function, demand function, or factor supply functions as well as information about future shifts are reflected in the price of stock. Earlier investment functions also depended on the price of the firm's stock but for different reasons. For example, in the MIT–Penn SSRC (MPS) model the cost of capital which enters the investment function depends on the dividend price ratio, but this ratio is taken to reflect the rate of discount in the market, not information about future technology or demand, and is ultimately a reflection of the monetary policy in force. Expectations of future demand are modeled by different variables. In practice, the same statistical correlation between investment and stock price may be reflected in the MPS investment function.

The assumption of homogeneity of degree one is crucial for the Salinger-Summers investment function because investment decisions are made at the margin, i.e. with respect to a marginal Q. The observed Q is in effect an average Q. The assumption of constant returns to scale may not be altogether reasonable when one considers some of the individual firms studied here. If we take the model literally, it is assumed that, were it not for costs associated with acquisition of new plant and equipment, General Motors (one of the firms for which the investment function had a poor fit) could at any point of time double its size and expect its value to double. This is inconsistent with the notion that the price of General Motors stock is a reflection of rents accruing because of its monopoly on some popular makes, rents which could rise or fall without engendering any investment opportunities. The model would imply that Exxon (a firm for which the coefficient in the estimated investment function had the wrong sign) would contract its investments after the oil-crisis-induced fall in its share price in 1975. The fact that it increased its capital expenditures then (on new domestic production and exploration facilities) suggests that average and marginal Q moved in opposite directions.

While we may have no clear or hard evidence that many firms do or do not face homogeneous constraints in production and demand and factor supply in the sense required by this model, we have more concrete knowledge about the kind of inhomogeneities imposed by the tax system. That the tax system destroys homogeneity is in itself no problem as long as the tax system does not make it impossible to infer marginal Q from average Q. Unfortunately, there is a problem in inferring marginal Q and this problem reintroduces the well-known problems of modeling expectations into this otherwise simple framework. In order to infer marginal Q, Salinger and Summers make a number of assumptions. Interest on debt is made equal to a constant b times the current nominal interest rate times the nominal value of the current capital stock. They are assuming that debt is issued so that the real value of debt is always b times the real capital stock. Thus new purchases of debt (which must be subtracted from retained earnings in equation [12] to arrive at dividends) is equal to $Pb(I - \pi + \delta^R)$. If the firm were assumed to follow another debt policy or were to finance with long-term debt, then the state of the firm at time t would not be summarized by its capital stock at time t. Additional information would be required about how much debt was outstanding and what interest rates it bore. They might better have handled interest deductibility on debt by assuming new debt was proportional to I, say, was long-term, and distinguishing between interest deductions on past debt and new debt. They did something analogous to this in their separation of the depreciation deduction into two parts, B_t and Z_t. The term Z_t depends on expected future variables, so that expectations must still be modeled.

The other crucial assumption for the analysis is that costs of adjustment are a stable function of investment divided by the capital stock. That adjustment costs depend only on I/K causes the maximization problem to have only one shadow price, which is good since we observe only one price of the firm. Formally, the model also assumes that the function is perfect, although of course the estimated regression involves an error term. The natural interpretation for the error term is that it reflects stochastic variations in the costs of adjustment. It would be good if such variations were explicitly allowed for in the model, though I suspect the resulting changes may not be fundamental. What is required for consistent ordinary least squares estimation of a model which can be used for judging the effects of tax policy or investment, then, is that this error term be uncorrelated with Q. If Q varies primarily because of exogenous changes in tax parameters, this may be reasonable. In fact, the time series behavior of Q depends primarily on behavior of the share price. This share price could be fluctuating because of changes in the cost of adjustment. Consider a firm which produces a commodity whose price follows, say, a sine wave through time. If its cost of adjustment should decline by a multiplicative factor for a while, the value of the firm and hence Q should rise. If this firm were in the sample on the rising portion of its cost of adjustment curve, then this higher Q would coincide with higher investment. This implies, then, an upward bias on the estimated coefficient which would tend to cause an overstatement of the effects of tax changes on investment.

Other sources of fluctuations in the residual might include errors in measurement in Q or I/K, or nonlinearities in the adjustment cost function. Purely unsystematic errors in measuring I/K would cause no bias, while such errors in Q would cause a downward bias in the regression coefficient. Some systematic errors in measurement might also be expected. If their estimates of K (which result from a simple cumulation of investment) were contaminated by unsystematic measurement error, then both I/K and Q would be affected in the same direction by the error, which would tend to cause an upward bias in the regression coefficient. New "information" about future variables ought in itself to cause no residuals in this estimated investment function as it might in conventional investment functions for which such information is not part of the hypothesized expectations mechanism.

By estimating an adjustment cost function rather than a production function, demand function, or the like, Salinger and Summers bring us into unfamiliar territory. Knowing very little about such functions, one feels little reason to doubt that they are stable through time or that they have the form indicated. We should not allow ourselves to be complacent about these assumptions, however, just because we know little about them.

One is tempted to imagine, from the description in the text, that adjustment costs are the costs of paying real estate agents to find new floor space, hiring planners to decide on the layout of new plants, and hiring workers to uncrate and install new machines. In practice, I think such costs are a trivial component of the true costs of adjustment modeled here. These costs represent the real barriers which prevent AT&T or IBM, say, from doubling their size. These firms would need to penetrate new markets in order to do so. We might imagine that these firms have a monopoly, not in the markets for the individual products we associate them with, but on a sort of organizational structure which enables them to aggressively and creatively pursue new product lines and incur "adjustment costs" in doing so. These costs of adjustment are then quite intangible. Should they be made a function of I/K? Why should they not be a function of I/L? It is easy to make this change in the model, which yields an investment function whose dependent variable is I/L rather than I/K. Why should adjustment costs not be a function of H/L, where H is new hires? This would yield a very different model, in which q need not equal one but in which firms would always hold an "optimal" capital stock and I_t would depend on the change in a conventional cost of capital figure. Alternatively, why should adjustment costs not depend on $I/(K-$ inventories)?

The Salinger-Summers model does not distinguish between the price of capital goods and the price of aggregate output. It would certainly be in the spirit of the model and a technical improvement to assume that investment costs are reflected in a new capital goods price index P_K. Then the model would relate Q to $V/(P_K K)$ rather than $V/(PK)$. Such a model would then make Q inversely related to the relative price of capital goods P_K/P. In contrast, the Witte (1963) model would suggest that investment is a *positive* function of P_K/P. The difference is one of demand versus supply. The Witte model is a supply function of producers of capital goods, which we expect to find upward-sloping in P_K and inversely related to the general level of costs for capital goods producers which might be measured by P. If we estimated the Salinger-Summers investment function with Q based on $V/(P_K K)$, we would have to ask what *identifies* the investment function here. For the Salinger-Summers demand for investment function to be identified, it would have to be the case that some other variables influence supply, and for proper consistent estimation of the investment demand function we would need these variables as instruments. Ordinary least squares would be biased, the extent of the bias depending on the relative magnitudes of demand versus supply shocks. The coefficient in the investment function could be so biased as to have the wrong sign, if shocks to the adjustment cost function cause corresponding moves in the price of capital goods and hence opposite moves in Q. In practice, the Salinger-Summers model, which uses P rather than P_K, does not allow this effect.

The regression results for 1964–78 in table 8.2 often look very good when one considers how simple the model is. Of the twenty-eight firms, twenty-five had slope coefficients with the right sign. In most cases, the R^2 is around 0.4. In contrast, in Summers's earlier paper (1981), which used aggregate investment data from 1930 to 1978, the R^2 was only 0.046, while the coefficient of 0.013 is actually larger than the coefficient of 0.010 estimated in this paper in the pooled regression. Perhaps the higher R^2 in the individual firm regression reflects a much higher variance in the independent variable Q. Some firms do very badly (e.g. Chrysler stock had a nearly steady decline over the period 1964–78), and others do very well (IBM stock rose dramatically).

The coefficients in the regression have a simple interpretation. The time variation in Q is due primarily to time variation in the price of the firm (which is why the table 8.3 regressions cannot tell whether Q or q belongs, since the two variables are fairly collinear). In the absence of taxes, $Q = q - 1$, where q is Tobin's q. In the presence of taxes, aggregate Q is roughly equal to $2q - 1$ (though this approximation works poorly in explaining the cross-firm variation in Q shown in table 8.1). Suppose Q moves from 0 to 1 because the price of the firm, which had been equal to ½ the value of the capital, had doubled. Then the predicted change in I/K is equal to the coefficient in the regression. Thus an estimated coefficient of 0.02 implies that the firm whose price doubled will increase in size by only 2% per year. Inverting the investment cost function, we find that marginal adjustment costs as a function of I increase by a factor of 50 when I doubles.

Why are the estimated coefficients so small? The first explanation which comes to mind is that there are really decreasing returns to scale for the individual firms. Other sources of estimation bias may be involved. I am also inclined to imagine that stock prices may be vulnerable to "fads" or the like, and that firm managers who decide on earnings retention do not see their true shadow price of capital in the market price.

The paper performs simulations of the effects on the value of the firm V and on investment I of several tax reforms: indexation, reduction in the corporate tax rate, and acceleration of depreciation. As the authors acknowledge, the "procedure cannot be justified within the model." The model implies that in order to predict the impact on V the authors must return to making stability assumptions of the kind which the investment function approach here obviated. They must make some assumption about the effect on macroeconomic variables, the discount rate, the level of demand, and the wage rate. In turn, they would then have to make assumptions about firm production functions and solve the intertemporal optimization problem after the tax reform to get the new V. Summers discussed such simulations in his earlier paper. In this paper they are less ambitious or more realistic. A key feature of their argument is their claim that, since the coefficient in the investment function is small, the effect on future revenues is small. For the purpose of the simulation, future pretax profits are assumed to continue on a growth path, unchanged by the reform, discount rates are assumed to be constant, and tax policy changes are assumed to be permanent. These simulations are in the nature of simple "back of the envelope" calculations. While the avowed purpose here is to simulate the effects of tax changes which are permanent and presumably announced to be permanent, any shorter-run tax policy simulation would be vulnerable to a rational expectationist criticism. If tax changes are perceived as temporary i.e. are generated by a policy rule, the impact on V and I could be greatly misstated. In contrast, the advantage of the investment function studied here is that investment depends only on *current* tax parameters and V regardless of expectations about future taxes because information about these future taxes is incorporated in V. In the simulation methodology used here, such information would not be incorporated in V.

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