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5 Anticipated Tax Changes and the Timing of Investment

Alan J. Auerbach and James R. Hines, Jr.

Since 1981, important changes in the federal tax provisions affecting investment in business plant and equipment have occurred in every year except 1983. There is no reason to believe that 1986 will be another exception. Yet the methods economists commonly use to measure the impacts of tax law changes not only generally assume that such changes will be permanent but also ignore problems of transition. Such analysis can be valuable for understanding the underlying differences among alternative tax systems, but may be unhelpful, even misleading, if one is attempting to understand the short-run impact on investment of a tax change that may have been anticipated and may be foreseen as temporary.

The purpose of this chapter is to present and use a framework for tax analysis that is closely related to previous approaches but capable of assessing the short-run impact on investment of very complicated combinations of tax policies undertaken at specified dates with different degrees of anticipation on the part of investors. At the same time, the model generates predictions about the impact of these changes on the market value of corporate securities that are consistent with the predicted path of investment.

Because the model's parameters are based on empirical evidence for the United States, its predictions are not simply illustrative, but should convey an impression of the actual quantitative effects of tax policy

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changes. Because it is a historical model, based on data beginning in 1953, it also allows us to perform counterfactual experiments to estimate the effects of historical policies. Thus, we can (and do) evaluate the performance of the activist tax policy of the last three decades in altering the level and stability of investment over that period.

Another primary objective, however, concerns the future. In the past couple of years, numerous tax reform plans have surfaced that would make important changes in the incentives for business fixed investment. Most would rationalize the treatment of depreciation for different types of assets, remove the investment tax credit, and compensate, at least in part, for the reduction in these investment incentives through reductions in the statuary corporate tax rate. Among the most influential such plans have been the Bradley-Gephardt "Fair Tax" (originally formulated in 1983), the first and second Treasury plans (introduced in November 1984 and May 1985), and the Rostenkowski plan formulated by the House Ways and Means Committee and passed by the full House in January 1986.

Each of these plans has been greeted with mixed but predominantly negative responses from the business community, the primary criticism being that they would reduce investment. The analysis below evaluates these criticisms by estimating the marginal effects of several of the proposals on the level and distribution of investment and on the value of the stock market. An interesting point that surfaces in this analysis is that, even to the extent that such plans may harm investment, they should be very beneficial for the value of corporate equity. It is thus somewhat ironic that they should be so vehemently opposed by many of those who would appear to benefit.

Before turning to these results we describe the model used in this paper, based on that developed in Auerbach and Hines (1986), and the choice of parameter values used for the simulations.

5.1 Modeling Investment Behavior

The model of investment used in this chapter assumes that there are two types of fixed investment (structures and equipment) and costs to adjusting the capital stock. These costs may be separate or mutual and may differ between structures and equipment. It is, in other words, a q investment model with two types of capital. We choose this level of aggregation to allow comparability with previous work, and because the greatest variation in tax treatment has historically been between these two broad classes of assets.

Consistent with the data, ours is a discrete time model with one-year intervals. Each capital good is assumed to decay exponentially, and the representative competitive firm produces its output using labor and the two types of capital subject to a constant returns to scale, Cobb-Douglas production function, with α_1 and α_2 representing the gross shares (including depreciation) of the equipment and structures, respectively, in production. The adjustment cost function is assumed to have the following form:[1]

$$(1) \qquad A(I_t) = {}^1\!/_2[\beta_0(I_t/K_{t-1})^2K_{t-1} \\ + \beta_1(I_{1t}/K_{1t-1})^2K_{1t-1} + \beta_2(I_{2t}/K_{2t-1})^2K_{2t-1}]$$

where I_{it} and K_{it} are net investment and capital of type i in year t, I_t and K_t are sums over both types of investment and capital, and β_0, β_1, and β_2 are adjustment cost terms reflecting joint costs and costs specific to the two types of capital, respectively.

Given the homogeneity of the production function and adjustment cost function with respect to the scale of the firm, the value of the firm will be proportional to the size of its capital stock and the behavior of all firms can be represented by a single, aggregate representative firm.

The quadratic adjustment cost function in (1) is a two-capital-good version of the one used by Summers (1981) in his empirical analysis. It also differs in two other respects. First, it is based on net rather than gross investment. Second, there is no constant subtracted from the ratio I/K in each quadratic term. However, one may equivalently view the current model as being based on gross investment, with a constant equal to the rate, δ, of economic depreciation being subtracted. Either way, the notion is that minimum average adjustment costs (in this case, zero) occur when net investment is zero. This makes sense if one views the costs as general ones involving changing the scale of operations rather than bolting down the new machines. Summers's preferred estimate of the constant term (.088) is quite consistent with this interpretation.

We ignore changes in relative prices between capital goods and output and between different types of capital, and assume that all new investment goods have a real price of unity in every year. The adjustment costs are assumed to be "internal," in that they relate not to an upward sloping supply schedule for capital goods but to the costs of absorption at the firm level. This is consistent with the observation that historical fluctuations in capital goods prices are relatively minor compared to estimated costs of adjustment.

The firm's optimization problem consists of choosing equipment, structures, and labor at each time t, taking account of current and (to the extent of the assumed planning horizon) future economic conditions. There is no risk from the firm's point of view; whatever it expects about the future (right or wrong) is expected with certainty. If we let the production function in the three factor inputs be $F(\cdot)$, then the firm seeks to maximize its value at time t, equal to the discounted value of its real, after-tax cash flows:

$$(2)\quad V_t = \sum_{s=t}^{\infty} (1 + r)^{-(s+1-t)} \{(1 - \tau_{s+1})(F(K_{1s}, K_{2s}, N_s) - w_s N_s) \\ - (1 + r)(1 - \tau_s)A(I_s) + (1 + r) \sum_{i=1}^{2} [-(1 - k_{is})\, G_{is} \\ + \tau_s \sum_{x=-\infty}^{s} ((1 + r)/(1 + r + \pi))^{(s-x)} D_i(s,x) G_{ix}]\}$$

where N_s is the labor input in period s; r is the real, after-tax required return; w_s is the real wage rate paid at the end of year s; $D_i(s, x)$ is the depreciation allowance at the beginning of year s for assets of type i purchased at the beginning of year x; k_{it} is the investment tax credit received on investment of type i at the beginning of year t; π is the rate of inflation; δ_i is the rate at which capital of type i depreciates; G_{it} is gross investment of type i at the beginning of year t; and τ_t is the tax rate at the beginning of year t.[2] Depreciation allowances decay at the inflation rate because they are not indexed.

We use the convention that year t investment occurs at the beginning of the period, while quasirents occur at the end, with period t investment yielding its first return at the end of the same period. We also assume that adjustment costs are immediately expensed, as would be the case for internal adjustment costs that require extra factors or reduce productivity. Gross and net investment of type i are related by the identity:

$$(3)\qquad G_{it} = I_{it} + \delta_i K_{it-1}$$

For labor, the optimal condition derived by differentiating (2) with respect to N calls for the firm to set the marginal product of labor equal to the real wage. As usual in models of this sort with constant returns to scale, the labor demand equation is omitted from explicit analysis. For each type of capital good i, it is most convenient to derive the first-order condition with respect to gross investment at each date t, G_{it}. Assuming, for the moment, an infinite horizon and perfect foresight, this yields:

$$(4)\qquad \rho_{it} = [(1 + r)/(1 - \tau_{t+1})]\, [q_{it} - k_{it} \\ - \sum_{s=t}^{\infty} (1 + r + \pi)^{-(s-t)}\, \tau_s D_i(s - t) \\ - \sum_{s=t+1}^{\infty} (1 - \delta_i)^{(s-t)} (1 + r)^{-(s-t+1)} (1 - \tau_{s+1}) \rho_{is}]$$

where (using (1) and (3))

$$(5)\qquad \begin{aligned} \rho_{it} &= dF_t/dK_{it} - dA_{t+1}/dK_{it} \\ &= dF_t/dK_{it} + {}^1\!/_2\beta_0[(I_{t+1}/K_t)^2 + 2\delta_i(I_{t+1}/K_{it})] \\ &\qquad + {}^1\!/_2\beta_i[(I_{it+1}/K_{it})^2 + 2\delta_i(I_{it+1}/K_{it})] \end{aligned}$$

is the "total" marginal product of capital at the end of period t, taking account of reduced concurrent costs of adjustment, and q_{it} is the marginal cost of a unit of capital, less tax savings associated with costs of adjustment:

$$(6)\qquad q_{it} = 1 + (1 - \tau_t)[\beta_0(I_t/K_{t-1}) + \beta_i(I_{it}/K_{it-1})]$$

Equation (5) reminds the reader that there are two components to the firm's marginal value of an additional piece of capital this year: the marginal product of capital (dF_t/dK_{it}) and the reduction in next year's adjustment costs (dA_{t+1}/dK_{it}). Expression (4) says that firms should invest in capital of type i at date t until its marginal product, after tax, equals its after-tax cost (multiplied by $(1 + r)$ because costs are borne at the beginning of the period) less the present value of investment credits, depreciation allowances, and future quasirents. Thus, the expression is the result of the optimal backward solution for firm behavior. When expectations are static, as is commonly assumed, (4) reduces to the standard user cost of capital formula:

$$(7)\qquad \rho_{it} = q'_{it}(r + \delta_i)(1 - k_{it} - \tau_t z_{it})/(1 - \tau_t)$$

where z_{it} equals the present value of depreciation allowances $D_i(s, t)$ and

$$(8)\qquad q'_{it} = (q_{it} - k_{it} - \tau_t z_{it})/(1 - k_{it} - \tau_t z_{it})$$

is a tax-adjusted price of new capital goods that we will interpret below.

Because of the assumption that production is governed by a Cobb-Douglas production function, the direct marginal product of capital of type i in period t is:

$$(9)\qquad F_{it} = a_t N_t^{(1-\alpha_1-\alpha_2)}\, \alpha_i K_{it}^{-(1-\alpha_i)}\, K_{jt}^{\alpha_j} \qquad j = 3 - i$$

where a_t is the production function constant. Thus, given the optimal choice of labor input, expressions (4) and (5) for i and j give us two equations in the capital stocks K_{1t} and K_{2t}. Without adjustment costs, this would permit a closed-form, backward solution for these capital stocks in each period.[3] However, since q_t depends on lagged capital stocks, this solution method is no longer possible, and we must resort to simulation analysis.

5.1.1 Parameterization

Three types of parameters appear in the model just described, relating to production (a, α_1, α_2, δ_1, δ_2, β_0, β_1, and β_2) taxation (τ, k_1, k_2, $D_1(\cdot)$ and $D_2(\cdot)$) and financial markets (r and π). For π, we use the realized values of the GNP deflator (year on year), while τ is set equal to the statutory corporate tax rate that prevailed for the majority of the year.[4] Firms' required rate of return, r, is set equal to after-tax real rate on 4- to 6-month commercial paper which prevailed in the year of investment, plus a risk premium that is taken to be constant. This series on adjusted interest rates was calculated by (10):

$$r_a = 0.06 + (1 - \tau)PR - INFL \tag{10}$$

where r_a is the adjusted rate, PR is the nominal (annualized) return on 4- to 6-month paper, and $INFL$ is the contemporaneous inflation rate. The after-tax risk premium in (10) is 6%, which roughly corresponds to the historical difference between after-tax risk-free interest rates and after-tax profit rates.

In order to calculate the production parameters α and δ and the tax terms k and $D(\cdot)$, it is necessary to aggregate data on 34 classes of assets for which we have data (20 equipment and 14 structures) into corresponding values for aggregate equipment and structures. This turns out to be a very complex problem. The method used is described in the appendix.

Once values of δ_1 and δ_2 are known, it is possible to estimate the capital share parameters α_1 and α_2 from production and capital stock data. We begin by calculating the net-of-depreciation, before-tax return to capital in the corporate sector in 1977 by dividing the difference between value added and labor compensation in the corporate sector, taken from the 1977 Census of Manufactures, by the total corporate capital stock, equal to equipment and structures plus inventories and land. We then assume that all forms of capital earned this before-tax rate of return, R_g.[5] Next, we assume that the Cobb-Douglas production function specified above refers to gross output net of returns to inventories and land,[6] calculated as follows:

$$G = Y + \delta_1 K_1 + \delta_2 K_2 - R_g(K_3 + K_4) \tag{11}$$

where Y is value added and K_3 and K_4 are stocks of inventories and land.

Once we have obtained this value of G, we note that, since output is observed net of adjustment costs, the production function $F(\cdot)$ must satisfy:

$$F(K_1,\ K_2, N) = G + A(I) \tag{12}$$

Finally, we define the net return to capital of type i ($i = 1, 2$) in the current period as being the derivative of G with respect to K_i, holding constant the capital stock *growth rates* (I_1/K_1), (I_2/K_2) and (I/K), less depreciation δ_i.[7] This yields (using (1) and (9)):

$$(13) \quad R_g = \alpha_i F/K_i - {}^1\!/_2\beta_0(I/K)^2 - {}^1\!/_2\beta_i(I_i/K_i)^2 - \delta_i \qquad i = 1, 2$$

which can immediately be solved for α_i.[8]

The resulting parameter values are:

$$\alpha_1 = .166$$

$$\alpha_2 = .181$$

$$\delta_1 = .137$$

$$\delta_2 = .033$$

with the estimated value of R_g equal to 10.4%. This estimate of the marginal product of capital (which is used only in the calculation of α_1 and α_2) is consistent with previous findings. In interpreting the sizes of the two share coefficients, it should be remembered that these are shares in *gross* output, *less* estimated returns to land and inventories. Relative to usual calculations of the capital share of net output, the first of these factors (the use of gross output) would lead to a larger total share (since depreciation is included in both numerator and denominator) while the second (excluding part of the capital stock) would lead to a smaller total share (since returns to excluded capital are subtracted from both numerator and denominator.)

The production function constant a is obtained for 1977 by dividing $F(\cdot)$ by the product of its component factors raised to the power of their respective factor shares. We then assume that the labor input, in efficiency units, grows at a constant rate of 3% over the entire sample period.[9] This imparts a trend rate of growth to the steady state of the model. That it is slightly below the historical capital stock growth rate of about 4% may be because part of that growth is attributable to the historical decline in effective tax rates on investment.

In order to obtain a historical series for a that would be consistent with observed fluctuations in the profitability of capital, we use data on after-tax corporate rates of return from Feldstein, Poterba, and Dicks-Mireaux (1983), updated to include 1984. We took the 1984 value to prevail for all subsequent years. Assuming capital market equilibrium and constant returns technology, this rate of return will be equal to the marginal gross return to capital, R_g in (13). Note that this methodology implicitly assumes that yearly variation in the return to capital is attributable to shocks to the production function and not to changes in the capital/labor ratio. Then, using (9) and (13), the technical and labor-related component of the production function can be computed:

$$a_t = \frac{(C + R_g^t)}{D}\left(\frac{K_t}{N_t}\right)^{(1-\alpha_1-\alpha_2)} \tag{14}$$

where the left side of (14) is the value to be calculated, and C and D are constants, with C equal to:

$$C = {}^1\!/_2(0.03)^2(\beta_0 + \beta_1 s_1 + \beta_2 s_2) + \delta_1 s_1 + \delta_2 s_2 \tag{15}$$

where s_i is the share of capital of type i in the capital stock ($s_1 + s_2 \equiv 1$).

Since (14) is a relationship which holds for all years, it must hold for 1977, the year from which values are calibrated. Marginal products of capital for all other years were calculated using α_1 and α_2 and the assumption that K_t/N_t is constant: to solve for a_t relative to its value in 1977,

$$\frac{a_t}{a_{77}} = \frac{C + R_g^t}{C + R_g^{77}} \tag{16}$$

The only parameters that remain to be chosen are the adjustment costs terms β_0, β_1, and β_2, which are quite crucial to our analysis. Previous studies have inferred these parameters from regressions of investment on "tax-adjusted q." The authors of these studies have derived "tax-adjusted q" by correcting the ratio of the market value of the firm to its capital stock (presumed to be average q) for tax factors such as the investment tax credit, accelerated depreciation, and the deductibility of adjustment costs that would cause marginal and average q to differ. In one case (Abel and Blanchard 1986), average q is explicitly estimated from projected future profits and interest rates. A regression of I on adjusted q can then be interpreted as estimating the inverted marginal cost function.

In a model with one capital stock, the coefficient on adjusted q would be an estimate of $1/\beta$, the inverted marginal adjustment cost. Although such regressions cannot be done if there is more than one capital stock, one can still interpret the coefficient as the inverse of the sum of marginal adjustment costs associated with investment of type i, or $[\beta_0 + \beta_i]^{-1}$ in the current model.

Empirical investigations have found this coefficient to be quite small. However, for many reasons usually pointed out by authors of the previous studies, these coefficients (which are not always even statistically significant) may be prone to serious downward bias because of an inexact measure of q being used.[10]

Given the uncertainty of what the "true" values of β_0, β_1, and β_2 should be, we choose values that, given the other parameters of the model, make the variances of the growth rates of investment in equipment, structures, and the two categories together that are generated by a historical simulation with perfect foresight roughly equal to their historical values for the period 1954–84. While this methodology is somewhat arbitrary, it derives from the observation that, in the simulations, fluctuations in investment are particularly sensitive to the configuration of adjustment costs.

Postwar investment history suggests that adjustment costs are substantial and not symmetric between equipment and structures. The net stock of equipment grew at a mean annual rate of 5.0% between 1954 and 1984, while structures grew 3.1% annually and total capital grew at a 3.9% rate. The historical variances of equipment, structures, and total net investment rates were .041%, .0070%, and .012% respectively. Adjustment cost parameters for the simulations were chosen to approximate as closely as possible these variances with those generated by the perfect foresight simulation when investors expect the 1985 tax law to stay unchanged forever. Choosing β_0, β_1, and β_2 to equal the common value of 6, as in Auerbach and Hines (1986), produces investment variability that does not conform well with the historical evidence: structures investment is too variable in these runs and equipment investment not variable enough. On the basis of experiments with several parameterizations, we found that the values $\beta_0 = 15$, $\beta_1 = 0$, $\beta_2 = 20$ produced results which most closely mirrored actual investment. This specification of adjustment costs yields equipment, structures, and total investment variances equal to .035%, .0067%, and .012% respectively.[11]

To compare these chosen values of β_0, β_1, and β_2 to those found in the previous literature on aggregate investment, note that the value of β corresponding to a dollar increase in net investment proportional to the weights of equipment and structures in the capital stock is $\beta = \beta_0 + k_1\beta_1 + k_2\beta_2$, where k_i is the fraction of the capital stock represented by capital of type i. Given typical values of k_1 and k_2, this yields a value of β approximately equal to 28, which is quite reasonable given previous research.[12]

5.1.2 Solution of the Model

In the presence of adjustment costs, the model as specified can only be solved numerically. There exist different techniques to obtain such solutions. The one used here is described in great detail in Auerbach and Hines (1986).

All simulations begin with the assumption that, prior to 1954, the economy was in a steady state: that economic conditions had been stable for sufficiently long that the stocks of both kinds of capital had completely adjusted, and no change in these conditions was anticipated. Though this is undoubtedly inaccurate, some such assumption is required to fix the initial values of capital stocks in a way that is consistent with the assumed production technology.

This solution for the steady state in 1953 does not depend on any future variables. Indeed, when expectations are assumed to be completely myopic throughout, the model can then be solved forward without iteration, with each year's solution beginning with K_{t-1} and solving for K_t. At the other extreme is the assumption of perfect foresight. By this we mean that all tax and inflation rates are correctly anticipated until the present. It is hard to implement this assumption for future dates, so we make assumptions about the values of these variables and suppose that firms' expectations match them. We then solve the model into the twenty-first century to guarantee convergence to a new steady state.

5.1.3 Measuring the Effects of Policies

In addition to the two capital stocks, we calculate three variables of interest. One is the *average* q of the representative firm, its value relative to the replacement cost of its capital stock. This starts with the marginal q obtained directly from the adjustment cost function, and then takes account of the variety of tax provisions that make old and new capital differ in value. The second is the *effective tax rate*, which summarizes the incentive to invest in a particular asset in a given year. The third is the *net investment flows* of equipment and structures which the simulation generates.

5.1.4 Estimating Average q

It is this variable that tells us what the overall impact of a tax change will be on market value. Generally, there will be two effects. To the extent that the incentive to invest increases,marginal q, defined to be the basic price of a unit of capital capital plus the derivative of the adjustment cost function with respect to investment, will rise. In the absence of taxes, the homogeneity of production and adjustment cost functions would imply that this would also be the firm's value per unit of capital.

But to the extent that the new incentive magnifies the distinction between new and old capital, the difference between marginal q and average q will also rise. The net effect on average q can be either positive or negative for expansionary or contractionary policies. Holding marginal q constant, an increase in average q may be viewed as a lump sum transfer to the owners of corporate capital.

The formula for average q is based on an arbitrage condition between old and new capital. Since new capital goods must generate after-tax cash flows equal to marginal q, it follows that

$$(17)\quad \bar{q}_{it} = \tau_t[\beta_0(I_t/K_{t-1}) + \beta_i(I_{it}/K_{it-1})] + PV_{it} + k_{it} + \sum_{s=t}^{\infty} \tau_s((1 + r)/(1 + r + \pi))^{(s-t)}D_i(s, t)$$

where $\bar{q}_{it}$ is marginal q and PV_{it} is the present value of the after-tax quasirents accruing to an new asset purchased for one dollar at date t. Since capital purchased at $t' < t$ has a present value of quasirents of $(1 - \delta_i)^{t-t'}PV_{it}$, it follows that its value at date t, per efficiency unit of capital, is

$$(18)\quad \bar{q}_{it,\, t'} = PV_{it} + [\sum_{s=t}^{\infty} \tau_s((1 + r)/(1 + r + \pi))^{(s-t)}D_i(s, t')]/(1 - \delta_i)^{t-t'}$$

Solution of (17) for PV_{it} and substitution of this expression into (18) gives a solution for the value of capital of type i and cohort t' at time t, in terms of $\bar{q}_{it}$. From (1) and the definition of marginal q, we also have:

$$(19)\quad \bar{q}_{it} = 1 + \beta_0(I_t/K_t) + \beta_i(I_{it}/K_{it})$$

Combining (18) and (19) to get each cohort's value, we then aggregate these values of average q over all vintages and both types of capital to obtain an overall value for the firm at date t.

Note that this expression for average q is consistent with the assumption of perfect foresight. When myopic expectations are assumed, we change (17) and (18) correspondingly.

5.1.5 Calculating Effective Tax Rates

In models based on myopic expectations, it is common to define the effective tax rate to be the percentage difference between the net (of depreciation) marginal products of capital before and after taxes. Given a fixed after-tax return, this calculation also tells us what the before-tax, or social return to capital must be for the firm to earn zero profits. Unless the economy actually is in a steady state, however, this will be correct only in the year the calculation is made. Hence, the effective tax rate as commonly used measures the required before-tax return to capital in the same year, assuming myopia.

When firms are not myopic, the formula for the user cost of capital is different, but we can still answer the same question, namely, What rate of return on capital must the firm earn in the current year, taking account of future changes in taxes, inflation, and the firm's marginal product of capital? As before, this will tell us what the firm's rate of return on investment must be, before taxes, in the current year. Dropping subscripts, the effective tax rate is defined to be:

$$\theta = [(\rho/q - \delta) - r]/(\rho/q - \delta) \tag{20}$$

where ρ is the marginal product of capital defined in (5).

It is not clear which value of q should be used in (20). The most obvious candidate is marginal q, as defined in expression (19). However, use of this value has the effect of incorporating the tax deduction for adjustment costs in the effective tax rate. This is perfectly acceptable; it reflects the fact that part of the cost of investment is expensed. However, it makes more difficult a comparison with previous results, since even when there is economic depreciation of direct capital costs, the effective tax rate will be less than τ. By using the tax adjusted value, q', defined in (8),[13] one "undoes" the differential tax treatment of adjustment costs, and obtains the usual results for expensing, economic depreciation, and other special cases. Hence, for the sake of comparability with other studies in which adjustment costs were ignored, we take this latter approach.

5.2 Simulation Results

This section presents the results of simulations, chosen to provide answers to some of the questions raised above. We begin by contrasting the historical patterns of net investment in equipment and structures with net investment series produced by simulation runs using myopic and perfect foresight assumptions about investor expectations of future tax laws and macroeconomic conditions.

Table 5.1 presents net corporate investment, expressed as a fraction of the capital stock, in equipment and structures for the period 1953–84. These investment rates are not derived from the published BEA net investment series; they are calculated by applying the BEA gross investment data and Hulten-Wykoff depreciation rates to form a perpetual inventory of corporate capital assuming the published 1925 net capital stock to be accurate. The investment series produced by this method are then measured consistently with net investment calculations from the simulation runs.

Table 5.1 illustrates several sharp features of the postwar investment experience. Equipment investment strongly accelerates in the mid-1960s, possibly in part in response to the introduction of the investment tax credit and repeal of the Long amendment. Both equipment and structures appear to be affected by business cycle downturns in 1970–71 and 1975–76. Structures never recover from the latter shock. Investment in every year of the post-1975 period fails to equal any of its previous values.

Table 5.1 **U.S. Corporate Net Investment, 1954–84**

Year	Equipment	Structures	Total
1953	5.1%	3.7%	4.2%
1954	3.6	3.5	3.5
1955	4.7	4.1	4.3
1956	5.0	4.3	4.5
1957	4.9	3.9	4.3
1958	0.5	3.1	2.1
1959	2.3	2.8	2.6
1960	3.0	3.2	3.1
1961	2.0	3.2	2.8
1962	3.5	3.3	3.4
1963	4.1	3.1	3.4
1964	6.0	3.4	4.3
1965	8.1	4.4	5.7
1966	9.6	4.5	6.4
1967	7.0	4.1	5.2
1968	7.0	4.1	5.2
1969	7.3	4.1	5.4
1970	5.2	3.6	4.2
1971	3.6	3.0	3.2
1972	5.3	3.1	4.0
1973	7.6	3.3	5.1
1974	6.6	3.0	4.5
1975	2.8	2.1	2.4
1976	3.4	2.0	2.6
1977	5.4	1.8	3.4
1978	6.2	2.2	4.0
1979	6.2	2.7	4.3
1980	5.4	2.4	3.8
1981	5.2	2.3	3.6
1982	2.9	2.1	2.4
1983	3.6	1.4	2.4
1984	6.7	2.7	4.6
Mean growth rate	5.0%	3.1%	3.9%
Variance of investment	0.041%	0.0070%	0.012%

Tables 5.2a–c and 5.3a–c present results from simulations in which investors have myopic expectations and perfect expectations respectively. The main point is to illustrate the effects of expectations on the smoothing of investment and the impact that movements in marginal q have on average q when adjustment costs are present. Both simulations are performed for the period 1953–90, under the assumption that Congress passes no post-1985 tax reform proposals and investors (in the perfect foresight simulation) correctly anticipate that there will be no changes.

Table 5.2a Effective Tax Rates: Myopic Expectations

Year	Equipment	Structures
1953	59%	48%
1954	53	46
1955	56	48
1956	59	50
1957	60	50
1958	54	47
1959	56	48
1960	54	47
1961	52	46
1962	38	43
1963	37	43
1964	28	40
1965	28	39
1966	31	41
1967	45	42
1968	41	48
1969	43	49
1970	53	48
1971	53	48
1972	10	42
1973	19	44
1974	33	53
1975	104	101
1976	11	42
1977	13	44
1978	22	47
1979	25	45
1980	27	44
1981	4	35
1982	−2	30
1983	2	28
1984	4	30
1985	4	31

Table 5.2a and 5.3a present effective tax rates for these two simulations. For each year there are two numbers: the effective tax rates for equipment and structures, respectively. These results are quite consistent with those of the previous literature. Since effective tax rates depend not only on the tax treatment of new investment but also on macroeconomic conditions and investment adjustment costs, a casual examination of effective tax rates does not reveal all the incentives built into the tax code. Effective tax rates may be useful for purposes of comparison, however.

Table 5.2b **Investment: Myopic Expectations**

Year	Equipment	Structures	Total
1953	3.0%	3.0%	3.0%
1954	3.6	3.2	3.3
1955	5.4	4.4	4.8
1956	3.3	4.6	4.1
1957	2.6	4.2	3.6
1958	1.9	2.7	2.4
1959	3.7	3.0	3.3
1960	2.7	2.3	2.4
1961	2.9	2.1	2.4
1962	6.8	2.9	4.4
1963	6.3	2.8	4.2
1964	6.9	3.0	4.5
1965	6.8	3.9	5.0
1966	5.8	4.4	5.0
1967	2.7	4.4	3.7
1968	4.4	5.3	4.9
1969	3.3	4.5	4.0
1970	0.4	4.2	2.7
1971	1.6	5.4	3.9
1972	6.5	4.0	4.9
1973	5.3	3.7	4.4
1974	1.7	6.7	4.7
1975	−3.3	15.3	8.2
1976	8.4	3.4	5.1
1977	7.1	4.5	5.4
1978	5.5	5.0	5.2
1979	4.4	3.9	4.1
1980	3.2	3.3	3.3
1981	4.6	2.6	3.3
1982	3.4	1.0	1.8
1983	3.6	1.1	2.0
1984	3.2	0.7	1.6
1985	3.0	0.7	1.6
Mean growth rate	4.0%	3.9%	4.0%
Variance of investment	0.055%	0.0062%	0.018%

Beginning from effective tax rates in 1953 well above the statutory rate of 52% for equipment, and somewhat lower for structures, effective tax rates for the myopic simulation in table 5.2a move lower with the tax changes introduced in 1954, and again in 1962 with the introduction of the investment tax credit. Tax rates on equipment go down again in 1972 with the reintroduction of the investment tax credit and the introduction of the Asset Depreciation Range (ADR) System. Effective tax rates for equipment and structures move strongly in 1975 for reasons

Table 5.2c **Average q: Myopic Expectations**

Year	Equipment	Structures	Total
1954	1.37	1.50	1.45
1955	1.48	1.73	1.65
1956	1.43	1.70	1.61
1957	1.38	1.63	1.55
1958	1.29	1.40	1.36
1959	1.35	1.49	1.44
1960	1.28	1.36	1.34
1961	1.27	1.34	1.32
1962	1.32	1.52	1.45
1963	1.29	1.49	1.42
1964	1.31	1.56	1.47
1965	1.35	1.72	1.58
1966	1.34	1.77	1.61
1967	1.30	1.68	1.53
1968	1.29	1.76	1.58
1969	1.22	1.63	1.47
1970	1.19	1.58	1.44
1971	1.29	1.81	1.62
1972	1.25	1.71	1.55
1973	1.21	1.65	1.49
1974	1.24	1.98	1.71
1975	1.49	3.15	2.56
1976	1.23	1.64	1.51
1977	1.25	1.77	1.60
1978	1.24	1.82	1.63
1979	1.17	1.65	1.49
1980	1.10	1.52	1.38
1981	1.07	1.39	1.28
1982	0.94	1.08	1.04
1983	0.96	1.11	1.06
1984	0.93	1.05	1.01
1985	0.92	1.06	1.01

to be discussed shortly. By 1980, higher rates of inflation have pushed effective tax rates back up to earlier levels, particularly on equipment. The introduction of ACRS in 1981 brought effective tax rates on equipment essentially to zero, also lowering tax rates on structures to a postwar low. Reduced inflation in 1982 brought tax rates down still further. Rates went up in 1983 on equipment and 1984 on structures because of the 1982 and 1984 tax acts, which introduced a 50% basis adjustment for the investment tax credit and an 18-year (instead of 15-year) tax life for structures, respectively.

The net investment rates for equipment, structures, and aggregate capital are displayed in table 5.2b, expressed as a percentage of the respective capital stocks. The substantial adjustment costs built into

Table 5.3a **Effective Tax Rates: Perfect Foresight**

Year	Equipment	Structures
1953	58%	49%
1954	54	48
1955	65	58
1956	65	59
1957	62	57
1958	49	44
1959	56	49
1960	48	40
1961	54	40
1962	47	46
1963	44	43
1964	38	42
1965	45	48
1966	41	51
1967	57	52
1968	57	61
1969	40	55
1970	45	52
1971	67	63
1972	42	57
1973	39	55
1974	54	74
1975	100	100
1976	42	63
1977	54	70
1978	59	73
1979	48	67
1980	46	64
1981	25	52
1982	−38	25
1983	−1	27
1984	−8	22
1985	−7	23

the model have the effect of raising marginal *q* when investment tax incentives are strong, thereby encouraging firms to smooth their investment. Despite this effect, the investment series in table 5.2b is highly erratic. The variance of structures investment is almost ten times its historical value, and episodes such as the introduction of the investment tax credit in 1962 and its removal at the end of the 1960s produce unrealistically sharp investment changes.

Years such as 1975 illustrate some of the hazards of modeling investment behavior under myopic expectations. Net structures investment in the model is 15% that year, and equipment investment is −3%. These incongruous results are produced by the economy's deep reces-

Table 5.3b **Investment: Perfect Foresight**

Year	Equipment	Structures	Total
1953	3.0%	3.0%	3.0%
1954	4.2	3.9	4.0
1955	4.2	3.9	4.0
1956	3.5	3.9	3.8
1957	3.2	3.9	3.6
1958	3.0	3.8	3.5
1959	3.6	3.8	3.7
1960	3.5	3.7	3.7
1961	3.9	3.8	3.8
1962	7.6	3.5	5.0
1963	6.9	3.6	4.9
1964	6.7	3.4	4.7
1965	5.7	3.4	4.3
1966	4.9	3.4	4.0
1967	2.0	3.8	3.1
1968	4.7	3.7	4.1
1969	4.0	3.7	3.8
1970	1.3	3.6	2.7
1971	1.5	3.4	2.6
1972	5.3	2.6	3.7
1973	4.6	2.6	3.4
1974	4.3	2.6	3.3
1975	3.9	2.4	3.0
1976	2.7	2.4	2.5
1977	2.2	2.2	2.2
1978	1.6	2.1	1.9
1979	0.9	1.9	1.5
1980	0.7	1.7	1.3
1981	1.5	1.8	1.7
1982	1.4	1.8	1.6
1983	1.0	1.8	1.5
1984	1.3	1.7	1.5
1985	1.6	1.6	1.6
Mean growth rate	3.4%	3.0%	3.2%
Variance of investment	0.035%	0.0067%	0.012%

sion that year and the accompanying low real interest rates and marginal products of capital. The enormous decline in real interest rates leads to a desired shift to longer-lived investment. Since myopic investors expect the cost of capital never to change in the future, they find themselves desperately short of structures when costs fall in 1975. Their one-period time horizon prevents them from delaying enough of their investment to minimize adjustment costs efficiently, and leads to unrealistically sensitive investment demands. That is, they are assumed not to anticipate a decline in marginal q from its current high level.

Values of average q, as reported in table 5.2c, reflect the pattern of investment as well as tax law changes. Average q has generally declined over the years as the distinction made by the tax system between old and new capital has widened. Under a system of economic depreciation, average q would equal marginal q net of the tax deduction of adjustment costs, as defined in (6) (averaged over the two types of capital). At a steady state growth rate of 3%, a corporate tax rate of about 50%, and with structures comprising about 60% of total capital, the steady state value of average q would be 1.14. In the short run, average q is determined both by the distinction between new and old capital (the difference between average q and marginal q) and by the value of marginal q itself. A change in the incentive to invest will typically affect both of these terms, sometimes in different directions.

Though the estimated time series given in table 5.2c suggest that average q for total capital was above one throughout the postwar period, it exceeded 1.14 only for the period before 1982. After the acceleration of depreciation allowances in 1954, and throughout the 1950s and until 1981, average q remained quite high. The mid-1960s investment boom in particular contributed to marginal q and therefore average q. Adverse macroeconomic conditions discourage investment in the 1980s, thereby lowering marginal q. Combined with the increased gap between new and old capital brought about by ERTA, this moves average q closer to one.

Table 5.3a presents effective tax rates for the perfect foresight simulation. The results are qualitatively similar to those in table 5.2a, with the exception that investment is steadier and so effective tax rates are jostled less by movements in marginal q.

Table 5.3b contains the perfect foresight investment series. Structures investment is very smooth over the whole time period, generally declining from 1954 until the late 1960s, rising then and declining thereafter. The presence of substantial joint adjustment costs raises the cost of structures investment when firms are investing heavily in equipment, and this effect is reflected in downward movements in structures investment rates for 1962 and 1972, years in which the investment tax credit was introduced. Similarly, structures investment recovers in 1967, when the investment tax credit was removed. Equipment investment follows the opposite pattern over these years, and is subject to much wider investment swings generally. The persistence of very high historical equipment investment over the period 1965–69 as reported in table 5.1 is not reproduced in the equipment investment series in table 5.3b; simulated investment responds quickly to incentives in 1962 and 1964, but dies out much more quickly in subsequent years.

Table 5.3c reports average q's for this perfect foresight simulation. As in the simulation with myopic expectations, average q follows a

Table 5.3c **Average q: Perfect Foresight**

Year	Equipment	Structures	Total
1954	1.42	1.63	1.56
1955	1.42	1.63	1.56
1956	1.40	1.62	1.54
1957	1.39	1.60	1.53
1958	1.37	1.59	1.51
1959	1.38	1.60	1.52
1960	1.37	1.60	1.52
1961	1.37	1.61	1.53
1962	1.37	1.62	1.53
1963	1.35	1.62	1.52
1964	1.32	1.62	1.51
1965	1.30	1.61	1.49
1966	1.27	1.60	1.47
1967	1.25	1.57	1.45
1968	1.23	1.57	1.44
1969	1.21	1.54	1.42
1970	1.19	1.52	1.40
1971	1.19	1.51	1.39
1972	1.16	1.48	1.36
1973	1.14	1.46	1.34
1974	1.12	1.44	1.32
1975	1.10	1.40	1.28
1976	1.05	1.33	1.22
1977	1.02	1.30	1.19
1978	0.99	1.26	1.16
1979	0.96	1.22	1.12
1980	0.94	1.18	1.09
1981	0.92	1.16	1.07
1982	0.91	1.14	1.05
1983	0.93	1.14	1.06
1984	0.92	1.15	1.06
1985	0.85	1.11	1.01

strong secular drift downward over the whole time period. Other than for the effects of strong investment and consequent high marginal q's in the mid-1960s, changes in the tax system have over time progressively increased the distinction between old and new capital in these runs.

The salient features of the historical investment pattern seem to be best captured by the perfect foresight simulation. Besides the generally less variable investment behavior it produces, its results for equipment in the mid-1970s and structures at the end of the 1970s are much closer to the actual investment pattern than is the case for the myopic simulation. Historical equipment and structures investment remained strong through 1974 and then declined in response to the recession. Investment in the myopic simulation responds too quickly to the macroeconomic and tax law changes, while the perfect foresight investors can see ahead to the next tax reform or phase in the business cycle and so their investments show the same kind of smooth transitions one finds in the historical series. Of course, the perfect foresight investment series do not always match historical investment: at the end of the 1970s, for example, perfect foresight investors would have known that ACRS was coming and would have reduced equipment investment much more than was the case in reality. And neither simulation run can explain the recent boom in equipment investment.[14]

5.3 Effects of Historical Investment Policies

One of the most important investment incentives of the period under consideration is the investment tax credit. While the investment tax credit reduces the partial-equilibrium user cost of equipment, some authors have suggested that the destabilizing effects of the credit over the business cycle mitigated its investment incentive for equipment and reduced incentives for structures investment.[15]

Table 5.4 presents investment series from a simulation in which it is assumed that the government never instituted an investment tax credit. The tax law is otherwise unchanged, and this run assumes that investors have perfect foresight. Some of the results are predictable: equipment investment rises much less quickly in 1962 and 1972 than it does in table 5.3b. In addition, equipment investment dies at the end of the 1970s when the investment tax credit is not present to mitigate the effects of adverse macroeconomic conditions.

The variance of equipment investment in this simulation is 0.024%, which is less than the 0.035% variance of investment reported in the perfect foresight run (table 5.3b) when the investment tax credit is present. While one might be tempted to conclude that the investment tax credit was destabilizing, such an interpretation depends on the sense in which stability is understood. Mean equipment growth for the simulation reported in table 5.4 is 2.86%, which is substantially less than the 3.4% growth rate reported in table 5.3b. The coefficient of variation for investment in the simulation with the tax credit removed is 0.54, which is very close to the 0.55 coefficient of variation for investment in the historical law perfect foresight (table 5.3b) simulation. It appears, then, that in raising both the mean and variance of investment the investment tax credit has not substantially changed its relative stability. Of course, it is hard to know in a model like this one whether absolute or relative stability is more appropriate in making welfare comparisons.

Table 5.4 **Investment: Perfect Foresight and No Investment Tax Credit**

Year	Equipment	Structures	Total
1953	3.0%	3.0%	3.0%
1954	4.2	3.8	4.0
1955	4.2	3.8	4.0
1956	3.5	3.8	3.7
1957	3.2	3.7	3.5
1958	3.0	3.7	3.4
1959	3.6	3.6	3.6
1960	3.6	3.6	3.6
1961	4.0	3.6	3.7
1962	6.2	3.5	4.5
1963	5.8	3.6	4.4
1964	5.1	3.5	4.1
1965	4.4	3.4	3.8
1966	3.8	3.4	3.6
1967	3.2	3.4	3.3
1968	3.5	3.7	3.6
1969	3.0	3.6	3.4
1970	2.6	3.2	3.0
1971	2.6	3.0	2.9
1972	3.1	2.8	2.9
1973	2.8	2.7	2.8
1974	2.8	2.6	2.7
1975	2.7	2.5	2.6
1976	1.8	2.5	2.0
1977	1.5	2.0	1.8
1978	0.9	1.9	1.5
1979	0.2	1.7	1.1
1980	0.1	1.5	1.0
1981	0.7	1.7	1.3
1982	0.6	1.6	1.2
1983	1.0	1.6	1.3
1984	1.3	1.4	1.4
1985	1.6	1.4	1.5
Mean growth rate	2.9%	2.9%	2.9%
Variance of investment	0.024%	0.0072%	0.012%

Table 5.5 presents investment series from simulations in which the investment tax credit was never introduced and firms have myopic expectations about future conditions. The mean growth rate of equipment is 3.54%, which is higher than in the perfect foresight simulation but still smaller than the 4.0% growth rate when investors receive the investment tax credit. The variance of equipment investment is 0.047%, and the coefficient of variation is 0.61. Thus the relative stability of equipment investment in the absence of an investment tax credit seems to be affected little by the nature of expectations of future tax policies.

Table 5.5 **Investment: Myopic Expectations and No Investment Tax Credit**

Year	Equipment	Structures	Total
1953	3.0%	3.0%	3.0%
1954	3.6	3.2	3.3
1955	5.4	4.4	4.8
1956	3.3	4.6	4.1
1957	2.6	4.2	3.6
1958	1.9	2.7	2.4
1959	3.7	3.0	3.3
1960	2.7	2.1	2.4
1961	2.8	2.1	2.4
1962	5.5	3.1	4.0
1963	5.4	2.9	3.9
1964	5.5	3.1	4.0
1965	5.9	3.9	4.7
1966	5.1	4.4	4.7
1967	3.9	4.1	4.0
1968	3.3	5.3	4.5
1969	2.4	4.5	3.7
1970	1.6	3.9	3.0
1971	2.7	5.2	4.2
1972	4.3	4.2	4.3
1973	3.7	3.9	3.8
1974	0.4	6.6	4.3
1975	−4.2	15.0	8.1
1976	8.0	3.1	4.7
1977	6.8	4.2	5.0
1978	5.1	4.7	4.9
1979	3.9	3.6	3.7
1980	2.5	3.1	2.9
1981	3.8	2.5	2.9
1982	2.3	0.9	1.4
1983	3.6	0.9	1.8
1984	3.1	0.4	1.4
1985	2.8	0.5	1.3
Mean growth rate	3.5%	3.8%	3.7%
Variance of investment	0.047%	0.0061%	0.017%

The introduction of ACRS in 1981 made new investment significantly more attractive than it would have been under the prevailing ADR system. Table 5.6 presents simulation results which illustrate the effects of this legislative change while holding the rest of the economic environment constant. In this simulation investors have perfect foresight and ACRS is never introduced.

Equipment investment in table 5.6 is significantly lower than corresponding perfect-foresight equipment investment in table 5.3b for the ACRS years, in particular 1981 and 1982. Because perfect-foresight

Table 5.6 **Investment: Perfect Foresight and ACRS Never Introduced**

Year	Equipment	Structures	Total
1953	3.0%	3.0%	3.0%
1954	4.2	3.9	4.0
1955	4.2	3.9	4.0
1956	3.5	3.9	3.7
1957	3.2	3.9	3.6
1958	3.0	3.8	3.5
1959	3.6	3.7	3.7
1960	3.5	3.7	3.7
1961	3.9	3.7	3.8
1962	7.6	3.5	5.0
1963	6.9	3.5	4.8
1964	6.7	3.4	4.7
1965	5.7	3.3	4.3
1966	4.8	3.4	4.0
1967	2.0	3.8	3.0
1968	4.6	3.7	4.1
1969	3.9	3.7	3.8
1970	1.2	3.6	2.6
1971	1.4	3.4	2.6
1972	5.3	2.6	3.7
1973	4.6	2.6	3.4
1974	4.2	2.6	3.2
1975	3.8	2.4	3.0
1976	2.6	2.3	2.5
1977	2.1	2.2	2.2
1978	1.5	2.1	1.8
1979	0.8	1.9	1.4
1980	0.5	1.7	1.2
1981	0.7	1.6	1.2
1982	0.6	1.5	1.1
1983	1.0	1.4	1.2
1984	1.1	1.4	1.3
1985	1.3	1.4	1.4
Mean growth rate	3.3%	3.0%	3.1%
Variance of investment	0.038%	0.0082%	0.014%

investors correctly anticipate and wish to smooth future adjustment costs, equipment investment in this run falls off slightly from investment in table 5.3b as early as 1966. In the absence of ACRS, average annual equipment investment is somewhat lower and its variance marginally higher (since ACRS was introduced at a time when macroeconomic conditions were unfavorable to investment). The coefficient of variation for equipment investment in this run is 0.59. Structures investment is less sharply affected by the absence of ACRS. Structures investment in table 5.6 is slightly lower than that in table 5.3b starting in 1959, and experiences a small drop in 1981.

High rates of inflation may discourage investment by lowering the present value of nominal depreciation allowances.[16] Table 5.7 illustrates the effects of rising inflation in the late 1960s and 1970s, by presenting results from a perfect-foresight simulation in which depreciation allowances are indexed to inflation starting in 1954. Equipment investment in table 5.7 is substantially higher over the period 1965–74 than it is in the perfect-foresight simulation without indexing (table 5.3b). Despite more generous depreciation allowances under indexing, equipment investment in table 5.7 is lower in the 1980s than is the investment series in table 5.3b. This feature of table 5.7 reflects the process of

Table 5.7 **Investment: Perfect Foresight and Indexing Introduced in 1954**

Year	Equipment	Structures	Total
1953	3.0%	3.0%	3.0%
1954	4.3	4.0	4.1
1955	4.3	3.9	4.1
1956	3.5	4.0	3.8
1957	3.1	3.9	3.6
1958	3.0	3.9	3.5
1959	3.6	3.8	3.7
1960	3.6	3.8	3.7
1961	4.2	3.8	4.0
1962	7.5	3.6	5.1
1963	7.0	3.7	5.0
1964	7.1	3.5	4.9
1965	6.1	3.5	4.5
1966	5.4	3.5	4.3
1967	2.7	3.9	3.4
1968	5.4	3.8	4.5
1969	4.6	3.8	4.1
1970	1.9	3.7	3.0
1971	2.1	3.5	2.9
1972	5.7	2.8	4.0
1973	5.2	2.7	3.7
1974	4.6	2.7	3.5
1975	3.8	2.6	3.1
1976	2.9	2.4	2.6
1977	2.4	2.3	2.4
1978	1.8	2.2	2.0
1979	1.0	1.9	1.5
1980	0.6	1.8	1.3
1981	0.9	2.0	1.5
1982	0.7	1.8	1.4
1983	0.3	1.9	1.2
1984	0.8	1.7	1.3
1985	1.1	1.6	1.4
Mean growth rate	3.5%	3.1%	3.3%
Variance of investment	0.041%	0.0068%	0.014%

adjustment from a higher capital stock, and is a further reminder of how misleading static cost-of-capital calculations can be in explaining investment. Equipment investment and its variance in table 5.7 are somewhat higher than those in table 5.3b, and have a coefficient of variation of 0.58. Structures investment in table 5.7 is slightly higher than investment in table 5.3b, but does not diverge from the other series very much over any ranges.

5.4 The Economic Effects of Tax Reform

In this section, we consider the impact on investment and firm value of three tax reform proposals that have been seriously considered by the Congress during the past year. The proposals share certain attributes but also have their differences.

All three plans would repeal the investment tax credit. The first plan, the Bradley-Gephardt "Fair Tax," would reduce the corporate tax rate to 30% and provide assets with 250% declining balance depreciation over lifetimes similar to those of the asset depreciation range of the 1970s. The second plan, proposed by President Reagan in May 1985 and generally referred to as Treasury II, would provide specified write-off patterns with comparable lifetimes, fully indexed for inflation, and reduce the corporate tax rate to 33%.[17] The third plan, passed by the House of Representatives and often called the Rostenkowski plan after the chairman of the House Ways and Means Committee, would reduce the corporate tax rate to 36% and provide 200% declining balance depreciation with a switchover to straight-line, indexed for half of all price level changes in excess of 5% per year.

Because all plans would remove the investment tax credit, one would expect a shift in the mix of investment toward structures. The statutory rate reductions should contribute to increases in the value of corporate equity, though the total impact on value of these plans will also depend on the as yet undetermined effects on the overall incentive to invest.

In order to compare the effects of the plans, we simulate each starting from the same initial conditions, and assuming that 1985 economic conditions (e.g., profitability and inflation) will prevail in each subsequent year. The particular assumptions made about previous behavior affect only the equipment and structures capital stocks with which we begin. We assume that investors behaved from 1954 through 1985 with perfect foresight, but expected the tax law and economic conditions of 1985 to last forever.

In considering the effects of the plans, we must also make an assumption about the behavior of interest rates. Since both corporate and personal tax rates would fall under each plan, it is reasonable to expect that some decline in before-tax interest rates would occur; how much is difficult to know without a more complete model of interest rate determination. Thus we consider two polar assumptions: that the real interest rate *after-tax* remains constant, and that the real interest rate *before-tax* remains constant.

Tables 5.8a and 5.8b show the effects on investment of the plans. For comparison, we present in the first column the investment figures predicted for the case in which no change in policy occurs. Tables 5.9a and 5.9b present the corresponding values for average q.

Table 5.8a, which presents results for the constant after-tax real interest rate assumption, shows that, without any change in the tax law, investment would be predicted to grow slowly over the next five years as a fraction of the capital stock but remain low. This is a continuation of the investment pattern that should have occurred in recent years in response to the very high prevailing real interest rates and low returns to capital. The growth simply reflects the gradual approach back to the steady state investment level of 3%.

A switch to Bradley-Gephardt would increase the tax burden on equipment and decrease that on structures. In the long run, the effective tax rate on equipment would be 23%, that on structures 26%, compared

Table 5.8a **Tax Reform and Investment (Constant After-Tax Real Interest Rate): Percentage Growth Rates of Capital under Different Plans**

	Tax Regime					
	Current Law			Rostenkowski		
	Equip.	Struc.	Total	Equip.	Struc.	Total
1985	1.6	1.6	1.6	1.6	1.6	1.6
1986	1.7	1.7	1.7	−0.8	2.0	0.8
1987	1.9	1.7	1.8	−0.3	1.9	1.0
1988	2.0	1.7	1.8	0.2	1.9	1.2
1989	2.1	1.8	1.9	0.6	1.8	1.4
1990	2.1	1.8	2.0	0.9	1.8	1.5
	Bradley-Gephardt			Treasury II		
	Equip.	Struc.	Total	Equip.	Struc.	Total
1985	1.6	1.6	1.6	1.6	1.6	1.6
1986	0.0	2.1	1.3	0.3	2.2	1.5
1987	0.4	2.1	1.4	0.7	2.2	1.6
1988	0.8	2.1	1.5	1.1	2.2	1.7
1989	1.1	2.0	1.7	1.3	2.2	1.8
1990	1.3	2.0	1.8	1.6	2.2	1.9

Table 5.8b **Tax Reform and Investment (Variable After-Tax Real Interest Rate): Percentage Growth Rates of Capital under Different Plans**

	Tax Regime					
	Current Law			Rostenkowski		
	Equip.	Struc.	Total	Equip.	Struc.	Total
1985	1.6	1.6	1.6	1.6	1.6	1.6
1986	1.7	1.7	1.7	−1.7	1.5	0.2
1987	1.9	1.7	1.8	−1.1	1.4	0.4
1988	2.0	1.7	1.8	−0.5	1.4	0.6
1989	2.1	1.8	1.9	0.0	1.3	0.8
1990	2.1	1.8	2.0	0.4	1.3	1.0
	Bradley-Gephardt			Treasury II		
	Equip.	Struc.	Total	Equip.	Struc.	Total
1985	1.6	1.6	1.6	1.6	1.6	1.6
1986	−1.3	1.4	0.3	−0.7	1.6	0.6
1987	−0.8	1.3	0.5	−0.2	1.5	0.8
1988	−0.3	1.3	0.7	0.2	1.5	1.0
1989	0.2	1.3	0.8	0.6	1.5	1.1
1990	0.5	1.3	1.0	0.9	1.5	1.3

Table 5.9a **Tax Reform and Market Replacement Cost (Constant After-Tax Real Interest Rates): Ratio of Market Value of Capital to Replacement Cost**

	Tax Regime					
	Current Law			Rostenkowski		
	Equip.	Struc.	Total	Equip.	Struc.	Total
1985	0.85	1.11	1.01	0.85	1.11	1.01
1986	0.85	1.12	1.02	1.00	1.28	1.17
1987	0.85	1.12	1.02	0.97	1.28	1.17
1988	0.85	1.13	1.02	0.96	1.28	1.16
1989	0.85	1.14	1.03	0.95	1.28	1.16
1990	0.86	1.14	1.03	0.95	1.29	1.17
	Bradley-Gephardt			Treasury II		
	Equip.	Struc.	Total	Equip.	Struc.	Total
1985	0.85	1.11	1.01	0.85	1.11	1.01
1986	1.07	1.39	1.27	1.05	1.36	1.24
1987	1.08	1.40	1.28	1.06	1.36	1.25
1988	1.08	1.41	1.29	1.06	1.36	1.25
1989	1.09	1.41	1.29	1.07	1.37	1.26
1990	1.10	1.42	1.30	1.08	1.38	1.27

Table 5.9b Tax Reform and Market Replacement Cost (Variable After-Tax Real Interest Rates): Ratio of Market Value of Capital to Replacement Cost

	Tax Regime					
	Current Law			Rostenkowski		
	Equip.	Struc.	Total	Equip.	Struc.	Total
1985	0.85	1.11	1.01	0.85	1.11	1.01
1986	0.85	1.12	1.02	0.94	1.16	1.08
1987	0.85	1.12	1.02	0.92	1.16	1.07
1988	0.85	1.13	1.02	0.91	1.17	1.07
1989	0.85	1.14	1.03	0.91	1.17	1.08
1990	0.86	1.14	1.03	0.91	1.18	1.08
	Bradley-Gephardt			Treasury II		
	Equip.	Struc.	Total	Equip.	Struc.	Total
1985	0.85	1.11	1.01	0.85	1.11	1.01
1986	0.98	1.19	1.11	1.00	1.18	1.11
1987	0.98	1.20	1.12	0.98	1.18	1.11
1988	0.99	1.21	1.13	0.97	1.19	1.11
1989	1.00	1.23	1.14	0.96	1.20	1.11
1990	1.02	1.24	1.16	0.96	1.20	1.11

to 4% and 31%, respectively, under present law. This results in a predicted drop in equipment investment of 1.6% of the equipment capital stock, and an increase of .5% in structures investment. By 1990, the aggregate capital stock is predicted to be about 1.5% lower because of the change. At the same time, the proposal is predicted to cause a jump in the stock market. The average q for both equipment and structures rises substantially, with an aggregate increase in market value of 26%! Over time, it continues to increase as the level of aggregate investment recovers.

Under Treasury II, investment in both equipment and structures would fare better than under the Bradley-Gephardt plan. Overall, investment would fall very little, with long-run effective tax rates of 18% on equipment and 23% on structures. Because of the higher corporate tax rate imposed, Treasury II would also result in lower windfalls than under Bradley-Gephardt, despite its more favorable impact on investment and marginal q.

The Rostenkowski plan would be less favorable for investment than either of the other two proposals, imposing, in the long run, an effective tax rate of 31% on both equipment and structures. The larger rise in the equipment tax burden, combined with the much lower adjustment costs associated with equipment, leads to a sharp decline in equipment investment in 1986, with structures investment behaving much as it did in the previous two simulations. Aggregate fixed investment is predicted to drop by .9 percentage points in 1986 because of adoption of the plan. Given the size of the fixed corporate capital stock relative to GNP, this translates into a drop in investment of just under six-tenths of a percent of GNP and about 5% of gross nonresidential fixed investment. By 1990, the capital stock would be about 3.3% lower than under current law.

Because it would lower the statutory tax rate the least, to 36%, and because it decreases marginal q the most through reduced investment, this plan would provide the smallest windfall to existing capital of the three plans. The aggregate value of average q would rise by 16%, compared to 26% under Bradley-Gephardt and 23% under Treasury II. Thus the Rostenkowski plan would raise more revenue from both new and old assets than would either of the other plans.

The simulations presented in tables 5.8b and 5.9b correspond to the assumption of a fixed before-tax interest rate. The associated increase in after-tax interest rates under the reform plans leads to further reductions in investment and windfalls to old capital. Nevertheless, in no simulation does the windfall fall below 7% of the market value of the capital stock, despite the quite large declines in investment and marginal q that are predicted.

5.5 Conclusion

The analysis in this chapter illustrates the importance of anticipated changes in taxes and other economic variables on investment behavior and firm valuation. Simulation results suggest that postwar U.S. corporate investment behavior can be understood as the outcome of a process in which investors anticipate the general direction of future tax changes. To be sure, our simple model of perfect foresight corporate investment does not explain all the major movements in investment over this period. Yet the simulation runs which explore the consequences of myopic investor expectations reveal how poorly this modeling approach, which is standard in static models, performs in a dynamic context.

The simulation experiments presented in this chapter describe the likely consequences of several alternatives to the historical pattern of corporate taxation. We examine the effects of the investment tax credit by simulating the last 25 years of firm behavior in its absence, and find that although the tax credit increased the variance of equipment investment, it increased mean equipment investment by even more. Of more pertinence to current policy discussions, we also simulate the effects of three of the proposed tax reform proposals. We find that the Treasury II, Bradley-Gephardt and Rostenkowski corporate tax plans all would discourage investment and reduce the size of the corporate capital stock relative to the effects of the current law. One of the advantages of the model described in this chapter is that we can use it to measure the extent of the windfall gains enjoyed by old capital upon introduction of these plans.

Several important aspects of the determinants of corporate investment and firm valuation remain poorly understood. The results in this chapter make us suspect that more attention needs to be devoted to the process by which investors form expectations about future tax policy and macroeconomic conditions.

Appendix

Aggregation of Depreciation Rates and Tax Parameters

What we seek are parameters for aggregate capital goods that, by some measure, accurately reflect those of their components. One criterion that seems reasonable is to require that, for a particular tax system, both net and gross rates of return to capital before tax be the same for the aggregate assets as for the sums of their components. A particular motivation for using this approach is that it results in the effective tax rate, as usually measured, being invariant to the aggregation procedure.

To see what weights this criterion dictates, consider first the special case in which adjustment costs are zero and expectations are myopic. Let Ω_{ij} be the fraction of capital stock j of the total in its class i (equipment or structures) at a particular date. (We suppress the time subscript but emphasize that these capital stock weights are not time invariant.) The gross before tax return to capital of type i is then

$$\rho_i = \sum_j \Omega_{ij}\rho_j = \sum_j \Omega_{ij}(r + \delta_j)(1 - k_j - \tau z_j)/(1 - \tau) \tag{A1}$$

where δ_j, k_j and z_j correspond to asset j. The net return is:

$$r_i^n = \rho_i - \sum_j \Omega_j\delta_j \tag{A2}$$

Thus, the criterion would be satisfied by weighting the individual values of δ by capital stock weights Ω and the tax parameters k and z by $\Omega(r + \delta)$; the tax parameters of short-lived assets should be more heavily weighted. This is an important choice, since the values of $k + \tau z$ generally increase monotonically with δ.[18]

Since capital stock weights change over time, this formula would require recomputation every year. However, this presents an index number problem, and it is unclear that we should prefer a measure with varying weights. Even after this issue is resolved, one must deal with the problem of adjustment costs and varying values of asset-specific q's, about which there is little information. Finally, there is the problem of expectations. When the marginal product of capital is dictated by expression (4), there are no simple weights (that we can think of!) that satisfy the criterion. One would generally have to determine the weights simultaneously with the solution for the marginal product itself, which would make the problem intractable.

In light of the situation, we choose to weight δ by Ω and tax parameters by $\Omega(r + \delta)$, using fixed values for r and the capital stock weights Ω over time. The capital stock weights used are for the year 1977, as described in Auerbach (1983). The rates of economic depreciation come from calculations by Hulten and Wykoff (1981). The fixed value used for r is .04.

Notes

1. For ease of notation, we write $A(\cdot)$ as a function of I_t alone rather than all its arguments.

2. The constancy of π is not assumed in our analysis, and is used here only for the sake of simplicity. Some of the later simulations examine the effect of allowing r to vary.

3. Note that net investment is simply the first difference of the capital stock.

4. This and other tax data used are described in appendix A of Auerbach (1983).

5. This would be true only if, among other things, the effective tax rates on all forms of capital were equal, which they were not.

6. This assumption is required if we are to consider the investment decisions separately for structures and equipment.

7. This marginal product definition is required for G to be homogeneous of degree one with respect to its inputs.

8. The internal consistency of this procedure can be verified by noting that, given this solution for α_1 and α_2, $R_g(K_1 + K_2)$ equals $[(\alpha_1 + \alpha_2)F - A(I) - \delta_1 K_1 - \delta_2 K_2]$ which, by (11) and (12), equals $[Y - R_g(K_3 + K_4) - (1 - \alpha_1 - \alpha_2)F]$. Thus the net returns to capital equal value added less the competitive return to labor.

9. Denison (1979, 92) finds all factors and productivity changes other than capital growth to contribute exactly 3.00% annually to the growth of U.S. nonresidential business output over the period 1948–73. While this figure includes noncorporate businesses and would presumably be lower over the period of the 1970s, it suggests that 3% is the most reasonable choice for the exogenous growth rate of noncapital inputs.

10. These include the presence of returns to other factors in the firm's market value, heterogeneity of the capital stock, and the standard use of a tax adjustments based on myopia of expectations about future changes in the tax law. Some evidence in support of this comes from the finding by Abel and Blanchard (1986) that the coefficient of investment on adjusted q rises substantially when the variable is purged of that part of its variation estimated to have come from fluctuations in the cost of capital (as opposed to profitability). In addition, there has been very little work done which estimates separate adjustment cost parameters for different types of capital; for an exploratory effort, see Chirinko (1984).

11. As Andrew Abel has pointed out, if actual investment series are measured with noise then our calibration method will in general lead to adjustment cost parameters which are smaller than the true parameters. However, our resulting estimates are similar to those obtained from q investment equations, which we believe to yield estimates that are biased upward.

12. See the discussion in Auerbach and Hines (1986).

13. When expectations are nonmyopic, q' is defined consistently, with future changes in π taken into account.

14. Nor is it easily explained by the assumption that investors know that one of the favorable tax reform proposals is imminent. In a perfect foresight run (not reported here) in which it was known all along that the House Ways and Means Committee proposal was to be adopted in 1986, equipment investment in 1985 would be only 1.3%. This conclusion could be reversed, however, if investors only recently learned of a forthcoming tax law change.

15. See, for example, Auerbach and Summers (1979).

16. Of course, inflation affects the incentive to invest through other channels as well. See, for example, the discussions in Auerbach (1979), Bradford (1981), and Hall (1981).

17. Also proposed as part of Treasury II was a recapture of "excess depreciation" attributable to investors being able to take into the tax base at a 33% rate income deferred through accelerated depreciation under the current 46% tax rate. The provision would have raised an estimated $56.1 billion between fiscal years 1986 and 1989, equal to about 2% of the value of the fixed corporate capital stock in present value. This provision is not included in our calculations. If truly unanticipated, however, its inclusion in our model would simply lead to a reduction in the 1986 value of average q under Treasury II of about 2%, with no other impact. As the results below suggest, this lump sum tax is quite small compared to the windfall gains that Treasury II would produce overall for owners of existing assets.

18. We note in passing that if the rate of growth of the capital stock, say g, equals the interest rate, then this latter set of weights corresponds to using investment *flow* weights rather than capital *stock* weights.

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Comment Andrew B. Abel

Alan Auerbach and James Hines have skillfully built, calibrated, and simulated a model to analyze the effects of tax policy on U.S. capital investment. Their simulation model produces time series for investment in equipment and structures, effective tax rates, and market valuations of firms. I will address three major issues in my comments: (1) the usefulness of a q-theoretic simulation model to examine the dynamic response of investment to tax policy changes; (2) calibration versus estimation as a method for choosing parameter values; and (3) the stabilizing or destabilizing effects of the investment tax credit.

1. The q theory of investment provides a simple and logically coherent framework for analyzing the dynamic response of investment to changes in tax policy. The theory depends quite heavily on the existence of convex adjustment costs—the notion that the marginal cost of investment is an increasing function of the rate of investment.

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Increasing marginal adjustment costs imply that investment will respond smoothly to changes in tax policies, and the q theory has proved to be extremely useful in analyzing the responses to temporary as well as permanent tax changes and the responses to anticipated as well as unanticipated tax changes. The phase diagrams used in the q model are simple and powerful tools which probably lead some of us to put more faith in the ability of q models to predict the short-run dynamic behavior of investment than is warranted.

Although there is some empirical support for the q model of investment, there are three major problems when the q theory is confronted with actual data. The theory predicts that investment will be a function only of the contemporaneous value of marginal q. In particular, neither contemporaneous output or profits nor lagged q should affect investment. However, empirical investment equations typically find that, on quarterly data, both lagged q and some measure of output or profits have significant effects on investment. Furthermore, these equations usually leave unexplained a large serially correlated portion of the variation in investment. Of these three departures from the simple theory, the most crucial for the issue of the *timing* of investment is the finding that lagged q and twice lagged q have significant effects on investment. If lagged q as well as contemporaneous q is a determinant of investment. then the dynamic structure of investment and, in particular, the short-run response of investment to tax policy is dramatically altered. Although the econometric evidence to date cannot definitively conclude that the significance of lagged q is due to delivery lags, it does at least remind us of the fact that it often takes several months for new equipment to be ordered, acquired, and installed. The delivery lag for structures is more appropriately measured in quarters or even in years.

The Auerbach-Hines model is based on annual data and one may argue that for equipment, at least, delivery lags are not important. However, the lags for new structures probably are quite substantial and, to the extent that the time paths of equipment and structures are linked (both through each component's effects on the marginal product of the other component and through interrelated adjustment costs), the lags in structures investment will spill over into equipment investment.

2. After specifying the structure of their simulation model, Auerbach and Hines had to choose values for the parameters of the model. I will focus on their method for choosing the parameters of the adjustment cost function β_0, β_1, and β_2. Previous authors have estimated these cost parameters from regressions of investment on q. In a model with only one type of capital good, the adjustment cost parameter β is equal to the inverse of the coefficient of investment on q. Auerbach and Hines decided against using available econometric estimates for the

adjustment cost parameters because, in their judgment as well as the judgment of some the people who produced these estimates, the estimated adjustment costs are too large; equivalently, the coefficient on q is considered to be too small. The reason for the alleged downward bias in the coefficient on q is that q is measured with error.

In order to avoid the downward bias in the response of investment to changes in q, Auerbach and Hines chose values of the adjustment cost parameters β_0, β_1, and β_2 which produced simulations in which the variance of investment is equal to the historical variance of investment. A complete analysis of the properties of the Auerbach-Hines procedure for choosing values for β is quite complex and certainly beyond the scope of this comment. To examine their procedure in a simple special case, suppose that y_t is investment and that we want to estimate θ in the regression

$$y_t = \theta q^*_t + \epsilon_t \tag{1}$$

where q^*_t is the true value of marginal q at time t. However, the true value of marginal q is unobservable but we can observe q_t which is a noisy measure of marginal q

$$q_t = q^*_t + \eta_t \tag{2}$$

For simplicity, we assume that ϵ_t and η_t are each serially uncorrelated and are uncorrelated with each other. Substituting (2) into (1) yields a relation between investment y_t and the observable variable q_t

$$y_t = \theta q_t + \epsilon_t - \theta\eta_t \tag{3}$$

The Auerbach-Hines procedure chooses an estimate θ_{AH} to equate the variance of the predicted series $\theta_{AH}^2 \text{var}(q_t)$ with the variance of y_t. Letting θ_{OLS} be the ordinary least-squares estimate of θ, we have

$$\text{plim } \theta_{OLS} = \text{cov}(y, q)/\text{var}(q) = \rho\sigma_y/\sigma_q \tag{4}$$

$$\text{plim } \theta_{AH} = [\text{var}(y)/\text{var}(q)]^{1/2} = \sigma_y/\sigma_q \tag{5}$$

where σ_x denotes the standard deviation of x and ρ is the contemporanoeus correlation between q_t and y_t. It is clear from (4) and (5) that θ_{AH} is greater than θ_{OLS} which is biased downward because of measurement error. However, θ_{AH} is not in general a consistent estimate of θ since

$$\text{plim } \theta_{AH}^2 = \theta^2 + [\sigma_\epsilon^2 - \theta^2\sigma_\eta^2]/\sigma_q^2 \tag{6}$$

As a measure of how well the simulated investment series tracks the expected value of the investment series over the historical sample, we can calculate the correlation of the predicted series, $\theta_{AH}q_t$, and the expected value of y_t, θq^*_t. It can be shown that asymptotically

$$\text{correlation } (\theta_{AH}q_t, \theta q^*_t) = [\sigma_{q^*}^2/(\sigma_{q^*}^2 + \sigma_\eta^2)]^{1/2} \tag{7}$$

Observe from (7) that the correlation of the simulated series and the expected value of y_t approaches one as σ_η^2 approaches zero. However, as σ_η^2 approaches zero, the estimate θ_{AH} becomes increasingly biased upward. The implication of this upward bias is that if the measurement error is unaffected by the simulated changes in policy, then the simulated effects of tax policy on investment will be overstated.

3. In order to address the question of whether the investment tax credit (ITC) is stabilizing or destabilizing, Auerbach and Hines present simulation results both with and without the ITC. They find that the presence of the ITC leads to a higher mean rate of investment and a higher variance of the rate of investment; the coefficient of variation of the rate of investment is hardly affected by the presence or absence of the ITC. In addressing the question of whether or not the ITC is stabilizing, Auerbach and Hines come to different conclusions depending on whether they measure stability by the variance or by the coefficient of variation of investment. The authors do not take a stand on which measure is more appropriate. It is worth noting that in the absence of population growth, the stochastic steady state of the economy would have an average growth rate near zero (the average value of I/K may not be literally zero), and in this case the coefficient of variation would be undefined.

If one is ultimately interested in social welfare, then the focus on the stability of investment is, of course, misplaced. Ideally, the model could be closed by including consumers who save and consume in order to maximize an intertemporal utility function. Specifying individual utility functions would then allow for a direct comparison of utility in the cases with and without the ITC.

In the absence of a general equilibrium model, it would appear that focusing on the stability of GNP would be more appropriate than focusing on the stability of the rate of investment. To get a handle on the question of the stability of GNP, note that under myopic expectations $q = F_K/[(1 - k - \tau z)r]$ where F_K is the marginal product of capital, r is the real rate of interest, k is the rate of the ITC, τ is the corporate tax rate, and z is the present value of depreciation deductions. Now consider a simple IS/LM model in which $Y = c(Y) + I(q) + G$ where Y is national income, $c(Y)$ is a Keynesian consumption function, $I(q)$ is the investment equation, and G is government purchases of goods and services. In comparing the cases with and without the ITC, note that the interest sensitivity of q is greater in the presence of the ITC. Therefore, the presence of the ITC causes the IS curve to be flatter than in the absence of the ITC. Finally we assume that the rate of inflation π is fixed and that there is a standard upward-sloping LM schedule $m = L(Y, r+\pi)$ where m is real money balances and $L(,)$ is the real demand for money.

Now consider the case in which the IS curve is fixed but the LM schedule is subject to random shocks. In this case, an outward shift of the LM schedule reduces the interest rate and increases both investment and output. In the presence of the ITC, the increases in both output and investment are greater than in the absence of ITC (see fig. 5.1). A symmetric argument for leftward shifts of the LM schedule suggests that the ITC destabilizes both output and investment.

Alternatively, suppose that the LM schedule is fixed but that *G* is stochastic. An increase in *G* shifts the IS curve to the right, leading to higher output, higher interest rate, and lower investment. In the presence of the ITC, the drop in investment is larger and increase in output is smaller than in the absence of the ITC (see fig. 5.2). A symmetric argument for a decrease in *G* suggests that under this stochastic specification the ITC again destabilizes investment. However, contrary to the case with a stochastic LM schedule, the ITC stabilizes output.

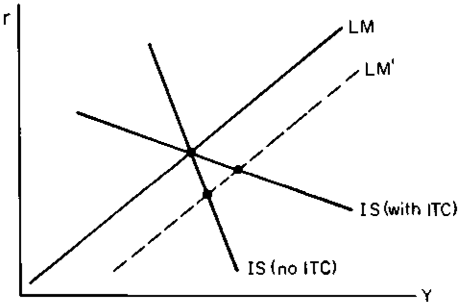

Fig. 5.1 Stochastic LM curve

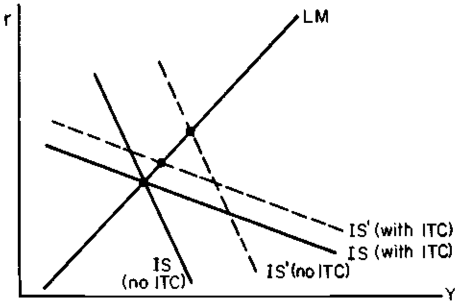

Fig. 5.2 Stochastic government spending