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TAXES AND CORPORATE INVESTMENT IN JAPANESE MANUFACTURING

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ABSTRACT

This paper examines the impact of taxes on the incentive to invest for the Japanese manufacturing sector in the postwar period. The idyosyncratic feature of the Japanese corporation tax system as compared to the U.S. is the prevelence of tax-free reserves and the tax deductibility of a part of taxes paid by corporations in the previous year. Our formula for the tax-adjusted Q and the cost of capital incorporates this. The main conclusions are as follows. While the postulated negative relation with the cost of capital cannot be found, investment in Japanese manufacturing shows until 1974 a strong association with the tax-adjusted Q. Since the change in stock prices, not taxes, is the primary source of changes in Q, the profitability of capital is the major determinant of investment.

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1. Introduction

The rapid output growth in postwar Japan is characterized by the high level of investment which has for almost all years been above 30% of the Gross National Product. Economic theory tells us that investment is governed by the cost and the benefit of incremental capital stock. Financial rate of return and taxes determine the cost of capital, while the benefit is the profitability of capital that depends on market opportunities and technology. The contribution of the neoclassical theory of Hall and Jorgenson (1971) is that it showed exactly how taxes influence the cost of capital, whereas the essential feature of the Q theory of investment is that the determinants of investment can be summarized by a single index called the tax-adjusted Q that combines the cost and the benefit of capital. In order to understand the high level of investment in Japan, it is necessary to analyze the relative importance of the cost and the profitability of capital and how taxes affect them. The purpose of this paper is to do precisely that by examining the relation between investment, the cost of capital, and Q.

The Japanese corporation tax system can potentially exercise profound impact on the incentive to invest. The Corporation Tax Law specifies the procedure for calculating taxable income and the applicable tax rates. The enterprise tax on corporations paid in the previous accounting year is tax deductible. The calculation of taxable income also includes accounting depreciation, inventory valuation, and allowances for accrued costs that can be credited to tax-free reserves. The Corporation Law lists a few tax-free reserves and specifies the maximum amount creditable to those reserves. Equally important in examining tax incentives is the Special Taxation Measures Law, which provides additional depreciation and a number of other tax-free reserves. If the Japanese corporation tax system played a major role in the high-speed output growth, it must be that investment was responsive to the cost of capital.

The plan of the paper is as follows. Section 2 incorporates the various aspects of Japanese tax law into a firm's optimization. Section 3 derives the formula for the cost of capital and the tax-adjusted Q, and identifies the channels through which taxes influence investment. In section 4 we calculate the cost of capital and the tax-adjusted Q for the Japanese manufacturing sector as a whole and examine their relationship to investment. Section 5 is a brief conclusion.

2. Taxes and the Valuation of a Firm

Our task in this section is to incorporate various aspects of the Japanese corporation tax system into a standard model of a firm's value maximization problem. The next section will derive a one-to-one relationship between the investment-capital ratio and "Q" adjusted for various tax parameters. For the most part, we will ignore personal taxes and the financial side of the firm. Modifications of the investment-Q relationship that are necessary if those factors are considered will be discussed at the end of the next section. Thus for the time being we will focus on a 100% equity financed firm whose investment finance comes from retained profits. Because we have to deal with many tax parameters, the notation will be rather complicated. A glossary of symbols is provided in Table 1.

Consider a firm in period 0 whose objective is to maximize its market value which is the present value of its net cash flow:

$$(2.1) \qquad V_0 = \sum_{t=0}^{\infty} C(0,t)(\Pi_t - T_t - a_t I_t),$$

where $C(0,t) = (1+r_0)^{-1}(1+r_1)^{-1}\cdots(1+r_{t-1})^{-1}$, r is the discounting rate that applies to future net cash flow. Π_t is pretax profits, T_t is corporate taxes, a_t is the price of investment goods, and I_t is the quantity of investment. Under Japanese tax law the following are the major items that are deductible from corporate income.[1]

(i) Depreciation Allowances. According to the financial statements compiled by corporations with the Ministry of Finance, virtually all corporations employ either the straight line method or the declining balance method.

(ii) Special Depreciation. In addition to the ordinary depreciation, the Special Taxation Measures Law lists asset types for which additional depreciation for the first year (and for some assets, several succeeding years) is permitted. Since the cumulative amount of depreciation is unchanged, special depreciation amounts to deferred tax payments.

(iii) Investment Tax Credits. Currently, corporations can choose for certain types of equipments between a special first-year depreciation of 30% and a tax credit of 7% of the acquisition cost. Since the amount of the investment tax credits is negligible relative to total investment expenditure, we will ignore it.

(iv) Enterprise Tax. The amount of enterprise tax paid in the previous accounting year can be deducted from this year's income. As seen below, the deductibility of the enterprise tax reduces the "effective" corporate rate significantly.

(v) Tax-Free Reserves. The Corporation Tax Law and the Special Taxation Measures Law list a host of tax-free reserves that can be deducted from income. For most reserves the amount deducted must be added back to the next year's income. In the formulation below we assume this is the case for all tax-free reserves.[2] Thus tax-free reserves, another veicle for corporations to defer tax payments, is essentially a one-year interest-free loan granted by the government. The variable that determines the maximum amount to be deducted from corporate income and credited to the reserve depends on the reserve. For example, for the Reserve for Retirement Allowance it is the wage bill, and for the Bad Debt Reserve it is the amount of receivables. We will divide various tax-free reserves into two groups. The first is employment-related reserves.[3] The second group consists of reserves whose maximum allowable deduction is a function of various other variables pertaining to the firm that, we assume, are a function of the "size" of the firm, which we take to be the reproduction cost of the firm.

The expression for the tax payment T_t that incorporates these features of Japanese tax law is:

(2.2a) $$T_t = (u_t + v_t)\times(\text{Taxable Income}).$$

(2.2b) $$\text{Taxable Income} = \Pi_t - DEP_t - S_{t-1} - (R_t - R_{t-1})$$

(2.2c) $$S_t = v_t\times(\text{Taxable Income}),$$

Here, S_t is the corporate enterprise tax and v_t is its tax rate. T_t is the total amount of corporation taxes including the national and local corporate tax and the enterprise tax. The overall tax rate is thus $u + v$. In the expression for the taxable income, R is the maximum amount to be deducted from income and credited to the tax-free reserves in period t.[4] DEP_t is the sum of ordinary depreciation and special depreciation. This can be written as

$$(2.3) \qquad DEP_t = \sum_{x=0}^{\infty} D(x,t-x)a_{t-x}I_{t-x},$$

where the depreciation formula as of t-x, D(x,t-x) includes special depreciation.

It is shown in the Appendix that the expression for the value of the firm under (2.1)-(2.3) can be written as

$$(2.4) \quad V_0 = \sum_{t=0}^{\infty} C(0,t)\{(1-\tau_t)\Pi_t - (1-z_t')a_tI_t + [\tau_t-\tau_{t+1}/(1+r_t)]R_t\}$$

$$+ A_0' - \tau_0R_{-1} + (1+r_{-1})y_{-1}S_{-1},$$

where

$$(2.5) \qquad y_t = \sum_{n=1}^{\infty} C(t,t+n)(u_{t+n}+v_{t+n})(-v_{t+1})(-v_{t+2})\cdots(-v_{t+n-1})$$

$$(2.6) \qquad \tau_t = u_t + v_t - y_tv_t,$$

$$(2.7) \qquad z_t' = \sum_{x=0}^{\infty} C(t,t+x)\tau_{t+x}D(x,t),$$

$$(2.8) \qquad A_0' = \sum_{t=0}^{\infty} \{C(0,t)\tau_t [\sum_{x=1}^{\infty} D(x,-x)a_{-x}I_{-x}]\}.$$

Some of these rather formidable expressions are standard. z_t' represents the present value of tax savings arising from depreciation allowances on a yen of new investment, while A_0' is the present value on all assets purchased in the past.

Other notations are novel. The "effective" tax rate τ is not simply the sum of u and v. A one-yen increase in the current enterprise tax means a tax saving of u+v yen in the next accounting year. But part of the tax saving, v, which is the amount of reduction in the next year's enterprise tax, gives rise to a tax increase of v(u+v) in the year after next. This, in turn, brings about a tax saving of $v^2(u+v)$ in the following year, and so forth. The term y in the expression for τ is the present value of tax changes on a yen of the current enterprise tax. This term is rather important: if u = 40%, v = 10% and r = 5%, its value is about 43%. That is, for every yen of the enterprise tax paid, the firm recovers in the present value sense 0.43 yen. The last term in the expression (2.4) for the value of the firm has a similar interpretation; it is the present value of tax changes arising from the enterprise tax already paid in the previous year. The third term in the braces in (2.4) represents a subsidy in the form of an implicit interest on a loan of τR yen.[5] Lastly, the term $\tau_0 R_{-1}$ is the additional current tax when the last year's reserves are added back to current income.

3. The Tax-Adjusted Q and the Cost of Capital

We now derive a one-to-one relationship between investment and "Q" adjusted for various tax parameters for the value-maximizing firm. Assuming that the firm is a price-taker, pretax profits can be written as

$$(3.1) \qquad \pi_t = p_t F(K_t, L_t, I_t) - w_t L_t,$$

where p is the output price, F is the production function, K is the capital stock, L is labor input, and w is the wage rate. Adjustment costs are incorporated here because output is assumed to be inversely related to investment, i.e., $\partial F/\partial I < 0$. "Bolting down" new machines is a resource-using activity; as the quantity of investment increases, a larger fraction of capital and labor has to be directed to the investment activity, which results in lower output.

As we indicated in the previous section, the tax-free reserves are divided into employment-related reserves (RL) and other reserves (RK). The former depends on the wage bill (wL) while the latter is a function of the reproduction cost of the firm (aK):

$$(3.2) \qquad R_t = RL_t(w_t L_t) + RK_t(a_t K_t).$$

As it will turn out, it does not matter in the final expressions for the tax-adjusted Q and the cost of capital how R is divided into the two components.

The firm is assumed to maximize its value in (2.4) subject to the capital accumulation constraint

$$(3.3) \qquad K_t = (1-\delta)K_{t-1} + I_t .$$

Since the last three terms in the expression (2.4) for the value of the firm is predetermined at time 0, the value maximization is equivalent to maximizing the first term subject to (3.3). That is, the firm is assumed to maximize

$$(3.4) \qquad \sum_{t=0}^{\infty} C(0,t)\{(1-\tau_t)\Pi_t - (1-z_t^{*})a_t I_t$$

$$+ [\tau_t - \tau_{t+1}/(1+r_t)][RL_t(w_t L_t)+RK_t(a_t K_t)]\}$$

subject to (3.3). Letting $C(0,t)\lambda_t$ be the Lagrange multiplier for (3.3), we obtain the following first-order conditions:

$$(3.5a) \qquad (1-\tau_t)p_t \partial F_t/\partial K_t + [\tau_t - \tau_{t+1}/(1+r_t)]\partial RK_t/\partial K_t$$

$$- \lambda_t + (1-\delta)\lambda_{t+1}/(1+r_t) = 0,$$

$$(3.5b) \qquad (1-\delta)p_t \partial F_t/\partial I_t - (1-z_t^{*})a_t = \lambda_t ,$$

$$(3.5c)\qquad (1-\tau)(p_t\partial F_t/\partial L_t - w_t) + [\tau_t - \tau_{t+1}/(1+r_t)]\partial RL_t/\partial L_t = 0.$$

The last condition yields

$$(3.6)\qquad \partial F_t/\partial L_t = w_t^*/p_t,$$

where

$$(3.7)\qquad w_t^* = w_t - \frac{[\tau_t - \tau_{t+1}/(1+r_t)]}{1-\tau_t}\,\partial RL_t/\partial L_t.$$

The second term is the reduction in wage rate induced by the employment-related tax-free reserves. Solving (3.6) for L_t and substituting it into (3.1), we see that pretax profits are a function of the real wage w^*/p adjusted for tax-free reserves. If pretax profits in real terms is denoted by $\pi_t = \Pi_t/p_t$, we obtain by the envelope theorem that

$$(3.8)\qquad \partial\pi_t(w_t^*/p_t)/\partial(w_t/p_t) = -L_t,$$

$$(3.9)\qquad \partial\pi_t(w_t^*/p_t)/\partial K_t = \partial F_t/\partial K_t.$$

If there were no adjustment costs, then $\partial F/\partial I = 0$, so we have from (3.5b) $\lambda_t = (1-z_t')a_t$. Thus from (3.5a) and (3.9) we obtain the following expression for the <u>cost of capital</u>:

$$(3.10)\qquad \partial\pi_t(w_t^*/w_t)/\partial K_t = c_t^*,$$

where

$$(3.11)\qquad c_t^* = \frac{(1-z_t')a_t - (1-\delta)(1-z_{t+1}')a_{t+1}/(1+r_t)}{(1-\tau_t)p_t}$$

$$- \frac{[\tau_t-\tau_{t+1}/(1+r_t)]\partial RK_t/\partial K_t}{(1-\tau_t)p_t}.$$

The second term represents the reduction in the cost of capital arising from the capital-related tax-free reserves. This expression, however, does not capture the effect of the reduced wage rate on the marginal profit $\partial\pi/\partial K$ brought about by the employment-related tax-free reserves. A more meaningful expression would add to c_t the effect of the employment-related reserves. Such an expression can be obtained as follows. Using (3.8), we obtain the following Taylor expansion:

$$(3.12)\qquad \partial\pi_t(w_t/p_t)/\partial K_t \simeq \partial\pi_t(w_t^*/p_t)/\partial K_t - (\partial L_t/\partial K_t)(w_t-w_t^*)/p_t.$$

Combining (3.7), (3.10) and (3.12) we get

$$(3.13)\qquad \partial\pi_t(w_t/p_t)/\partial K_t = c_t,$$

where

$$(3.14)\qquad c_t = \frac{(1-z_t')a_t - (1-\delta)(1-z_{t+1}')a_{t+1}/(1+r_t)}{(1-\tau_t)p_t}$$

$$- \frac{[\tau_t-\tau_{t+1}/(1+r_t)]}{(1-\tau_t)p_t}\left(\frac{\partial RK_t}{\partial K_t} + \frac{\partial RL_t}{\partial L_t}\,\frac{\partial L_t}{\partial K_t}\right).$$

This expression for the cost of capital is convenient for evaluating the overall impact of both types of tax-free reserves on the incentive to invest.

We now re-introduce adjustment costs. Noting that the optimal labor input is a function of w^*/p and solving (3.5b) for investment, we obtain the investment-Q relation:

$$(3.15) \qquad I_t = I_t(Q_t, K_t, w_t^*/p_t),$$

where

$$(3.16) \qquad Q_t = \frac{\lambda_t - (1-z_t')a_t}{(1 - \tau_t)p_t}.$$

This Q is referred to as the <u>tax-adjusted Q</u>. It is the real value of the gap between the shadow price of capital (λ) and the effective price of investment goods [$(1-z')a$], grossed up by the corporate tax rate. We note from (3.15) that optimal investment depends also on the adjusted real wage w^*/p. It is clear from the derivation of this optimal investment rule that if the production function F in (3.1) has the separable form $F(K,L,I) = G(K.L) - C(I,L)$, optimal investment rule does not involve the real wage rate.

There is a simple connection between the tax-adjusted Q and the cost of capital. By definition, the cost of capital c^* satisfies

$$(3.17)\qquad (1-\tau_t)p_t c_t^* + [\tau_t - \tau_{t+1}/(1+r_t)]\partial RK_t/\partial K_t$$

$$- (1-z_t^{\cdot})a_t + (1-\delta)(1-z_{t+1}^{\cdot})a_{t+1}/(1+r_t) = 0,$$

Subtracting (3.17) from (3.5a) we get

$$(3.18)\qquad (1-\tau_t)p_t(\partial F_t/\partial K_t - c_t^*) - [\lambda_t - (1-z_t^{\cdot})a_t]$$

$$+ (1-\delta)[\lambda_{t+1} - (1-z_{t+1}^{\cdot})a_{t+1}]/(1+r_t) = 0.$$

This can be solved for $\lambda_t - (1-z_t^{\cdot})a_t$ as

$$(3.19)\qquad \lambda_t - (1-z_t^{\cdot})a_t = \sum_{s=t}^{\infty} C(t,s)(1-\delta)^{s-t}(1-\tau_s)p_s(\partial F_s/\partial K_s - c_s^*).$$

That is, the tax-adjusted Q is essentially the present value of the gap between the marginal product of capital and the cost of capital. Thus, in the model with adjustment costs, the cost of capital continues to be an important channel through which taxes influence investment.

As shown in Hayashi (1982), the shadow price of capital λ in the expression (3.16) for the tax-adjusted Q can be made observable if we assume that (1) the firm is a price-taker and (2) the environment represented by the production function is linearly homogeneous. This latter homogeneity assumption in the present situation has to include the assumption that RL and RK in

(3.2), the maximum tax-free accumulation of reserves, are also linearly homogeneous in their respective variables, namely,

$$(3.20) \qquad \partial RL_t/\partial L_t = RL_t/L_t \quad \text{and} \quad \partial RK_t/\partial K_t = RK_t/K_t.$$

Under this set of assumptions it seems obvious that the maximized value of (3.4) is proportional to the initial capital stock $(1-\delta)K_{-1}$. So the <u>marginal</u> value of capital λ_0 is equal to the <u>average</u> value of capital:

$$(3.21) \qquad \lambda_0 = \frac{V_0 - A_0^{\cdot} + \tau_0(RL_{-1}+RK_{-1}) - (1+r_{-1})y_{-1}S_{-1}}{(1-\delta)K_{-1}}.$$

Thus the tax-adjusted Q as defined in (3.16) is connected to the value of the firm. Furthermore, under the homogeneity assumption the investment-Q relation becomes

$$(3.22) \qquad I_t/K_t = \Phi_t(Q_t, w_t^*/p_t)$$

This much is standard. A new result here is that the connection involves the tax-free reserves and the enterprise tax in the previous year. The same homogeneity assumption also permits a simplification of the expression (3.14) for the cost of capital. Noting that under the homogeneity assumption $\partial L/\partial K = L/K$ and using (3.20), we get, for $t = 0$,

$$(3.23)\qquad c_0 = \frac{(1-z_0')a_0 - (1-\delta)(1-z_1')a_0/(1+r_0)}{(1-\tau_0)p_0}$$

$$- \frac{[\tau_0-\tau_1/(1+r_0)]a_0}{(1-\tau_0)p_0}\left(\frac{R_0}{a_0K_0}\right).$$

For our purpose of empirical implementation, this expression is convenient because it does not involve the unobservable $\partial L/\partial K$.

So far we have assumed that there is only one kind of capital. The theoretical model can allow for other kinds of capital provided that there are no adjustment costs associated with investment in these other assets. It is fairly straightforward to show that the marginal value of the first asset (with adjustment costs) is given by (3.21) if the market value of other assets (which equals their reproduction cost because there are no adjustment costs for those assets) is already subtracted from V_0. In our empirical implementation in the next section, the first asset is depreciable assets (buildings, structures and equipments), while the other assets consist of land and inventories.

We close this section by discussing briefly the issue of investment finance. So far we have assumed an equity-financed firm that finances investment by retained profits. So the discount rate r is the expected equity return and the value of the firm is the total equity value. How should we modify the expressions for the tax-adjusted Q and the cost of capital? The following results on the investment-Q relation have been obtained in Hayashi (1985) for a model of a firm with adjustment costs under uncertainty and personal taxes: (i) the investment-Q relation can be derived when at least part of incremental investment is financed either by retained profits or by new equity; (ii) if new equity are used for investment finance, the value of the firm in the model is simply the sum of equity and debt outstanding; (iii) if retained profits are used, the equity value receives a higher weight than debt, provided that the capital gains tax rate is lower than the dividend tax rate; and (iv) when incremental investment is financed entirely by debt, the investment-Q relation cannot be derived. However, the model is incapable of explaining why corporations in the real world simultaneously issue new shares and pay dividends. There does not seem to be any work that derives the cost of capital as the determinant of investment for a firm without adjustment costs under uncertainty and personal taxes. More specifically, it remains unclear how the discount rate r_t is related to the corporate bond rate and the expected equity return.[6] With no completely satisfactory theory about how investment finance influence the tax-adjusted Q and the cost of capital, we will continue to use the expressions derived in this section, with V_0 (the value of the firm) being the value of equity and debt minus land and inventories.

4. Empirical Results

The impact of taxes on the incentive to invest can be evaluated by examining how taxes enter the expressions for the tax-adjusted Q and the cost of capital. Since they involve the present value of various forms of tax savings, we have to make assumptions about how future tax rates and discount rates are anticipated. For empirical implementation we assume static expectations about the tax rates (u, v, τ) and the discount rate. Thus z', A' and τ can now be written as

$$(4.1) \qquad z'_t = \tau_t z_t, \text{ where } z_t = \sum_{x=0}^{\infty} (1+r_t)^{-x} D(x,t),$$

$$(4.2) \qquad A'_0 = \tau_0 A_0, \text{ where } A_0 = \sum_{t=0}^{\infty} (1+r_0)^{-t} \sum_{x=1}^{\infty} D(x,-x) a_{-x} I_{-x},$$

$$(4.3) \qquad \tau_t = u_t + v_t - (u_t + v_t) v_t / (1 + r_t + v_t).$$

The z here coincides with Hall-Jorgenson's z. The expression for the tax-adjusted Q [(3.16) with (3.21)] becomes

$$(4.4) \qquad Q = \frac{\left[\dfrac{V - \tau A + \tau R_{-1} - \tau S}{a(1-\delta)K_{-1}} - (1-\tau z)\right] a}{(1 - \tau)p},$$

where the time subscript "0" is dropped for notational ease. Assuming $z_0 = z_1$ the expression (3.23) for the cost of capital becomes

$$(4.5) \qquad c = \frac{1-\tau z}{1-\tau}\frac{a}{p}\left[\rho + \delta - \frac{\tau r}{(1-\tau z)(1+r)}\frac{R}{aK}\right],$$

where

$$(4.6) \qquad \rho = (1+r)a/a_1 - 1$$

is the real discount rate adjusted for changes in the investment goods price.

The measurement of the tax-adjusted Q and the cost of capital for the Japanese manufacturing sector as a whole requires data on: V (market value of equity plus debt minus land and inventories), u (corporate tax rate), v (enterprise tax rate), r (discount rate), A (present value of depreciation allowances on past investment), R (tax-free reserves), S (enterprise tax), a (investment goods price), δ (physical depreciation rate), K (capital stock), aI (nominal investment), z (present value of depreciation allowances on new investment), p (output price) and ρ (real rate of return). Two principal data sources are the Ministry of Finance (various fiscal years) and the Tax Bureau (various fiscal years). The former has data on the financial statements aggregated over all corporations by industries. The aggregation is done by blowing up the sample aggregates by the sampling ratio. These data will be referred to as the Financial

Statements data. The latter has data on taxes paid by corporations and tax-free reserves allowed by the Tax Bureau. These data will be referred to as the Tax data. Since the time interval for those two primary data is a fiscal year (from April to the next March), all the calculations below are for fiscal years.

The data on V, A, z, aI and K are taken from a study by Homma, Hayashi, Atoda and Hata (1984), which calculated the tax-adjusted Q for various Japanese industries but which did not take tax-free reserves and the tax deductibility of the enterprise tax into account.[7] Their data are for the period of 1955 to 1981, and this determined our sample period. The following is a brief summary of how the data on V, A, z, aI and K are constructed in their study. (i) The data on nominal investment are taken from the Economic Planning Agency's Gross Capital Stock of Private Firms. Although the data includes the noncorporate sector, the numbers are very close to the nominal investment series calculated from the Financial Statements data except that the latter shows erratic movements for the first few years of the sample period. The data on the capital stock is from the National Wealth Survey. As this survey is done every five years, the Gross Capital Stock data are used for interpolation. Using the nominal investment series from the Financial Statements data and the investment goods price index (to be explained later), I generated a capital stock series by a perpetual inventory method with the rate of depreciation of about 9%. It turned out that this capital stock series is very close to the above capital stock series.

(ii) The market value of equity is calculated under the assumption that the ratio of the market value to the book value for all corporations in manufacturing is the same as that for all corporations in manufacturing traded on the Tokyo Stock Exchange. In calculating the market value of equity, the average of daily stock prices over the fiscal year is used. The market value of long-term debt is obtained by dividing the interest payments by a long-term interest rate. The market value of short-term debt is assumed to be the same as the book value. The value of the firm is the sum of the market value of equity and debt. However, the stock market valuation of a firm includes the value of land and inventories, which must be subtracted from the value of equity plus debt to arrive at the financial valuation of the capital stock. A perpetual inventory method is used to calculate the value of land. The price index for land is the Residential Land Price Index constructed by the Japan Research Institute of Real Estates (Nihon Fudosan Kenkyu-Jo). The change in the book value of land is assumed to be the market value of the change in land. The market value of land in the base year (1955) is assumed to be equal to the assesement given by the Ministry of Local Administration for the purpose of levying property taxes. The value of inventories is assumed to be equal to the book value because the majority of corporations employ the average method for inventory valuation.

(iii) To calculate A and z, the data on the depreciation formula D(x,t) are necessary. The asset life for tax purposes is assumed to be 34 years for buildings, 28 years for structures and 10 years for equipments in 1970. These numbers are taken from the National Wealth Survey. The calculation incorporates the major reductions in asset lifetimes for tax purposes that occurred in 1951, 1961, 1964 and 1969. The Special Depreciation permitted by the Special Taxation Measures Law is incorporated into the depreciation formula as follows. The fraction of special depreciation in fiscal year t, SP(t) is defined as the ratio of the amount of special depreciation in the Financial Statements data to nominal investment. If d(x,t) is the depreciation formula implied by a given asset lifetime for a given depreciation method, the depreciation formula D(x,t) adjusted for special depreciation is: $D(x,t) = [1-SP(t)]d(x,t) + SP(t)$ for $t = 0$ and $D(x,t) = [1-SP(t)]d(x,t)$ for $t > 0$. The implicit assumption here is that the ratio of special depreciation, SP, is the same for all asset types. The yield on the Japan Telegraph and Telephone Company's bond is used for the discount rate. Other information necessary for calculating A and z are: (1) the share of respective depreciation methods and (2) the breakdown of nominal investment into the three asset types (buildings, structures and equipments). The data on (1) is taken from the financial statements of corporations traded on the Tokyo Stock Exchange. Since virtually all corporations employ either the straight line method (about 20%) or the declining balance method (80%), only the two depreciation methods are considered. This share is assumed to be the same for all asset types. The data on (2) are not available on yearly basis. The breakdown for 1975 (calendar year) is obtained from the capital formation matrix in the 1975 Input-Output Table. The breakdown is assumed to be the same as that in 1975 for all years.

Our construction of the investment goods price index (a) is as follows. From the capital formation matrix in the 1975 Input-Output Table, we can obtain the breakdown of nominal investment by industry source. We use this breakdown as weights to calculate the price index as a weighted average of the relevant components of the Wholesale Price Index. The same weight is used to calculate the overall depreciation rate (δ). The depreciation rate for individual assets is taken from Hulten and Wykoff (1981). Our estimate of δ turns out to be 8.99%. We use the overall Wholesale Price Index for the output price index (p).

Our estimate of u, v, S and R comes from the Tax data. The corporate tax rate u is the ratio of the national and local corporation taxes to the taxable income. The enterprise tax rate v is the ratio of the enterprise tax to the taxable income. The figure for S is directly available from the Tax data. The measurement of R (tax-free reserves) is more problematical. There are as of 1981 twenty-eight tax-free reserves listed in the Corporation Tax Law and the Special Taxation Measures Law. Since corporations may accumulate the reserves above the maximum amount specified by the tax law without any further tax benefits, the data on reserves available from the Financial Statements data cannot be used. Furthermore, the Financial Statements data do not report tax-free reserves separately; some of the tax-free reserves are merged with the amount of special depreciation and other reserves that are not tax-free. On the other hand, the data on only six major tax-free reserves from 1963 are available from the Tax data. They are: Reserve for Bad Debts, Bonus Reserve, Reserve for Retirement Allowances, Reserve for Price Fluctuations, Overseas Market Development Reserve for Small- and Medium-Sized Enterprises, and Reserve for Overseas Investment Losses. The amount credited to these reserves (except for the last two, which are minor relative to the rest) must be added back in full in the following accounting year, as assumed in our theoretical model. For lack of alternative data sources, we use the total of these six tax-free reserves for R.

The data thus obtained that are necessary for calculating the tax-adjusted Q and the cost of capital are gathered in Tables 1 and 2. The data for 1955 (fiscal year) are not available because the calculation of Q requires data for the preceding year. Table 3 contains the tax-adjusted Q and the cost of capital along with a couple of variables that summarize the impact of taxes on the cost of capital. Since no data are available for R (tax-free reserves) before 1962, our calculation assumes that the ratio of R to aK (the reproduction cost of capital) prior to 1963 is the same as that for 1963. As we can see by comparing the Q series in Table 3 with the data on the market value of equity in Table 1, stock prices are the main source of variations in Q. An expected rate of return of 4% is used for ρ in calculating the cost of capital by the formula (4.5). We see from this formula that the direct impact of taxes on the cost of capital is captured by two terms, $(1-\tau z)/(1-\tau)$ and $(R/aK)\tau r/[(1-\tau z)(1+r)]$. We call the former the tax factor, which influences the cost of capital multiplicatively. The latter measures the equivalent reduction in the rate of return caused by the tax-free reserves. These two terms are shown in the last two columns of Table 3. The rate of return equivalence of the impact of tax-free reserves is tiny (at most 0.6%). Our calculation should, however, be taken as providing a lower bound, since our data on R includes only six reserves.

A basic assumption behind the formulas (4.4) and (4.5) is that R, the amount deductible from corporate income, is proportional to the capital stock. In order to check the validity of this assumption, we looked at the financial statements of individual firms in manufacturing publicly traded. The source of the data is the NEEDS Company Data compiled by the Nihon Keizai Shimbun. From data on accounting depreciation and the book value of depreciable assets, the market value of the reproduction cost of capital (aK) is constructed by a perpetual inventory method for about 620 firms for the fiscal years 1965 to 1981. Although this data set consists mainly of individual financial statements, there is an item that reports since 1976 the maximum amount to be credited to the Reserve for Retirement

Allowances. This amount is regressed on the capital stock for each year. Table 4 reports the regression results. Although the intercept term is significant, the capital stock coefficient is very close to that in the regression without the intercept.

The data in Table 3 are graphed in Figures 1-6. The investment-capital ratio, the tax-adjusted Q, the cost of capital and the tax factor are plotted against time in Figures 1 to 4. The declining trend in the cost of capital is mainly due to the decline in the price of investment goods relative to the output price. The tax rate τ is the major reason for changes in the tax factor. The investment-capital ratio is plotted against the tax-adjusted Q in Figure 5. Until 1974 there is a fairly strong positive relationship between I/K and Q, but since then the correlation turns into negative. By historical standards, Q in recent years is too high in relation to investment. Two explanations come into mind for the puzzling behavior of Q after 1974, both of which rely on the sharp rise in energy prices. The first is to note that the relationship between I/K and Q as given in (3.22) involves real factor prices whose component includes energy prices. Energy inputs are needed to install new machines within the firm. As energy prices go up, the installation activity gets depressed. This explanation seems a little far-fetched. The second explanation relies on the heterogeneity of capital. There is no ex-post substitutability between energy and capital. Our calculation of the capital stock gives equal weights to gas guzzlers and gas misers. while in the financial markets gas guzzlers are heavily discounted when energy gets expensive. However, if this explanation is correct, Q should be undervalued, which it is not. The behavior of Q in recent years remains a puzzle.

However, Q looks good if compared with the cost of capital. The plot of I/K against the cost of capital in Figure 6 shows a positive correlation.

5. Conclusion

While the postulated negative relationship with the cost of capital does not exist, investment in Japan shows, at least until 1974, a strong positive association with the tax-adjusted Q. However, most of the action in Q comes not from taxes but from stock prices. As stock prices are a good summary of future profitability, we may conclude that market opportunities and technological change have been the major driving force behind the high invstment level in postwar Japan.

Appendix: Derivation of the Valuation Formula

In this appendix we derive the formula (2.4) in the text.

Combining (2.1), (2.2a) and (2.2b), the value of the firm is written as

$$(A.1)\quad V_0 = \sum_{t=0}^{\infty} C(0,t)[(1-u_t-v_t)\Pi_t + (u_t+v_t)X_t + (u_t+v_t)S_{t-1} - a_t I_t],$$

where

$$(A.2)\qquad C(0,t) = (1+r_0)^{-1}\cdots(1+r_{t-1})^{-1} \text{ if } s < t, \quad = 1 \text{ if } s = t,$$

$$(A.3)\qquad X_t = DEP_t + (R_t - R_{t-1}).$$

With this notation (2.2b) becomes

$$(A.4)\qquad S_t = v_t(\Pi_t - X_t) - v_t S_{t-1},$$

which can be solved for S_{t-1} as

$$(A.5)\qquad S_{t-1} = v_{t-1}\sum_{i=0}^{t-1} V(i,t-2)Y_i - v_{t-1}V(0,t-2)S_{-1},$$

where

$$(A.6)\qquad Y_t = \Pi_t - X_t,$$

$$\text{(A.7)} \qquad V(i,j) = (-v_i)(-v_{i+1})\cdots(-v_j) \text{ if } i \leq j, \quad = 1 \text{ if } i > j.$$

Substituting (A.5) into (A.1) we obtain

$$\text{(A.8)} \qquad V_0 = \sum_{t=0}^{\infty} C(0,t)[\pi_t - (u_t+v_t)Y_t - a_t I_t$$

$$+ \sum_{t=0}^{\infty} C(0,t)[(u_t+v_t)v_{t-1}\sum_{i=0}^{t-1} V(i,t-2)Y_i]$$

$$- \sum_{t=0}^{\infty} C(0,t)[(u_t+v_t)v_{t-1}V(0,t-2)]S_{-1}.$$

The summation in the second line can be rewritten as:

$$\sum_{t=0}^{\infty}\sum_{i=0}^{t-1} [C(0,t)(u_t+v_t)v_{t-1}V(i,t-2)Y_i]$$

$$= \sum_{t=0}^{\infty}\sum_{n=1}^{\infty} [C(0,t+n)(u_{t+n}+v_{t+n})v_{t+n-1}V(t,t+n-2)Y_t]$$

$$= \sum_{t=0}^{\infty} C(0,t)[\sum_{n=1}^{\infty} C(t,t+n)(u_{t+n}+v_{t+n})v_t V(t+1,t+n-1)]Y_t$$

$$= \sum_{t=0}^{\infty} C(0,t)y_t v_t Y_t,$$

where

$$\text{(A.9)} \qquad y_t = \sum_{n=1}^{\infty} C(t,t+n)(u_{t+n}+v_{t+n})V(t+1,t+n-1).$$

Using this y_t, the summation in the third line can be rewritten as

$$\sum_{t=0}^{\infty} C(0,t)[(u_t+v_t)v_{t-1}V(0,t-2)]S_{-1}$$

$$= -[\sum_{n=1}^{\infty} C(-1,n-1)(u_{n-1}+v_{n-1})V(0,n-2)](1+r_{-1})S_{-1}$$

$$= -(1+r_{-1})y_{-1}S_{-1}.$$

Thus (A.8) becomes

$$\text{(A.10)} \qquad V_0 = \sum_{t=0}^{\infty} [C(0,t)(\Pi_t - \tau_t Y_t) - a_t I_t] + (1+r_{-1})y_{-1}S_{-1}$$

$$= \sum_{t=0}^{\infty} C(0,t)[(1-\tau_t)\Pi_t - a_t I_t] + (1+r_{-1})y_{-1}S_{-1},$$

$$+ \sum_{t=0}^{\infty} C(0,t)\tau_t DEP_t + \sum_{t=0}^{\infty} C(0,t)\tau_t(R_t-R_{t-1}),$$

where

$$\text{(A.11)} \qquad \tau_t = u_t + v_t - y_t v_t .$$

Now, it is shown in Hayashi (1982) that the second summation in (A.10), the present value of $\tau_t DEP_t$, where DEP_t is defined in (2.3) in the text, can be decomposed as:

$$\text{(A.12)} \qquad \sum_{t=0}^{\infty} C(0,t)(1-z_t')a_t I_t \;+\; A_0',$$

where z' and A' are defined in the text [see (2.7) and (2.8)]. Furthermore, it is easy to show that the third summation in (A.10) becomes

$$\text{(A.13)} \quad \sum_{t=0}^{\infty} C(0,t)\tau_t(R_t-R_{t-1}) = \sum_{t=0}^{\infty} C(0,t)[\tau_t-\tau_{t+1}/(1+r_t)]R_t \; -\tau_0 R_{-1}.$$

Substituting (A.12) and (A.13) into (A.10) we obtain the formula (2.4) in the text.

Footnotes

1. For a good description of the Japanese corporation tax system, see An Outline of Japanese Taxes published by the Printing Bureau under authorization of the Tax Bureau of the Ministry of Finance.

2. For a few tax-free reserves, the law permits corporations to spread the amount to be added back to income over several years. The tax-free reserves for which the data are available to us are the types described in the text.

3. The Reserve for Retirement Allowances and the Bonus Reserve are examples. In the theoretical model we will assume for such reserves that the amount creditable to the reserve is a fraction of the current wage bill and that the amount credited must be added back in full to the next year's income. However, the Reserve for Retirement Allowances does not exactly satisfy this assumption. According to the law, the amount creditable to this reserve during the current year is either (i) the difference over the year in a hypothetical total severance pay that the firm must pay if all the employees retire now, or (ii) a fraction of the current total wage bill. Furthermore the amount to be added back to income is the actual severance pay during the current year. So if the firm hires a worker, it can deduct from income either the hypothetical severance pay accruing to the worker or the fraction of the worker's current salary, and the corresponding increase in income occurs when the worker actually retires, which may be several decades from now. Let R be the amount accumulated in the reserve. If the firm chooses (i) above, R is the hypothetical total severance pay. If the firm chooses (ii), the change in R is the fraction of the current wage bill. Provided that the present value of the future corresponding increase in income is negligible, the tax benefit arising from this reserve comes only from the decrease in current income, which equals the change in R. This is equivalent to the assumption in the text that the firm can deduct from current income the entire amount R but that the previous year's R must be added back in full to current income.

4. For the Reserve for Retirement Allowances, R is the amount that has been accumulated. See footnote 3.

5. That the tax-free reserves influence the cost of capital through this term was noted in Ikemoto, Tajika and Yui (1984).

6. Auerbach (1979) shows that the discount rate is a weighted average of the corporate bond rate and the expected equity rate of return for a case where there are no uncertainties but where the corporate bond rate is an exogenously given function of the debt-equity ratio.

7. Mr. Kuniaki Hata of the Tax Bureau was in charge of all the calculations in this study.

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TABLE 1

OBS	YEAR	EQUITY	DEBT	VALUE	NOMK	NOMI	RESERVE
1	1956	1041	1423	332	2198	535	.
2	1957	1553	2125	602	2784	867	.
3	1958	1912	2532	1189	3370	912	.
4	1959	2692	2502	1536	3956	1158	.
5	1960	5019	3132	3379	4542	1942	.
6	1961	6603	3886	4431	5754	2338	.
7	1962	7263	4220	4554	6967	2486	.
8	1963	6459	5651	3705	8179	2641	462
9	1964	6348	6654	3309	9392	2842	561
10	1965	6350	7899	3630	10605	2453	629
11	1966	8591	9503	6130	12615	2870	738
12	1967	10099	10969	6625	14625	4210	914
13	1968	13149	13007	8811	16635	5372	1118
14	1969	24022	15622	17948	18645	6948	1602
15	1970	21408	18781	13853	20655	7923	2062
16	1971	21783	23562	15570	26649	6823	2223
17	1972	21126	29373	15950	32642	7315	2540
18	1973	27238	31780	13136	38636	8754	3090
19	1974	28133	33858	6265	44630	9739	4058
20	1975	38763	46364	27562	50624	8890	4458
21	1976	48535	48433	35830	55502	9055	4834
22	1977	45151	53055	34115	60379	8916	5811
23	1978	50800	58059	42809	65257	8276	5680
24	1979	54740	57103	36869	70135	10827	6098
25	1980	60394	53820	28405	75013	13316	6593
26	1981	83012	63191	51437	79891	14321	6780

Note: OBS = observation number; EQUITY = market value of equity; DEBT = market value of debt, VALUE = the numerator in (3.21) of the text, namely the value of the firm that is attributable to the existing capital stock; NOMK = reproduction cost of capital; NOMI = nominal investment; RESERVE = tax-free reserves. In trillions of yen.

TABLE 2

OBS	YEAR	R	PINVEST	POUTPUT	U	V	TAU	Z
1	1956	0.077	0.631	0.581	0.401	0.120	0.469	0.530
2	1957	0.098	0.651	0.579	0.400	0.121	0.469	0.477
3	1958	0.090	0.613	0.546	0.372	0.118	0.442	0.495
4	1959	0.089	0.625	0.559	0.392	0.114	0.458	0.498
5	1960	0.101	0.626	0.560	0.400	0.115	0.466	0.495
6	1961	0.116	0.638	0.567	0.386	0.113	0.453	0.483
7	1962	0.125	0.625	0.557	0.368	0.113	0.437	0.465
8	1963	0.088	0.622	0.569	0.368	0.111	0.435	0.543
9	1964	0.092	0.622	0.569	0.363	0.112	0.430	0.543
10	1965	0.082	0.623	0.575	0.349	0.108	0.415	0.569
11	1966	0.077	0.648	0.591	0.344	0.111	0.413	0.604
12	1967	0.080	0.659	0.599	0.342	0.112	0.411	0.593
13	1968	0.085	0.664	0.603	0.340	0.113	0.410	0.579
14	1969	0.089	0.683	0.623	0.344	0.113	0.414	0.574
15	1970	0.092	0.696	0.637	0.356	0.113	0.425	0.565
16	1971	0.079	0.686	0.632	0.349	0.109	0.416	0.593
17	1972	0.066	0.720	0.652	0.362	0.109	0.427	0.620
18	1973	0.085	0.877	0.800	0.379	0.113	0.445	0.576
19	1974	0.117	1.018	0.988	0.396	0.120	0.466	0.507
20	1975	0.096	0.997	1.007	0.379	0.111	0.445	0.542
21	1976	0.090	1.032	1.062	0.411	0.117	0.477	0.556
22	1977	0.074	1.048	1.066	0.413	0.120	0.480	0.591
23	1978	0.067	1.063	1.041	0.413	0.116	0.477	0.611
24	1979	0.077	1.150	1.175	0.414	0.116	0.478	0.582
25	1980	0.090	1.210	1.331	0.422	0.116	0.486	0.549
26	1981	0.083	1.195	1.350	0.429	0.115	0.492	0.563

Note: R = nominal interest rate; PINVEST = price index of investment goods (normalized to unity for the 1975 calender year); POUTPUT = price index of outputs, U = national and local corporation tax rate; V = corporate enterprise tax rate; TAU = T defined by (4.3) of the text; Z = present value of depreciation allowances on one yen of new investment, defined by (4.1) of the text.

TABLE 3

OBS	YEAR	IOVERK	Q	C	TAXFTR	REQRES
1	1956	0.244	-1.129	0.196	1.415	0.0022
2	1957	0.311	-0.980	0.209	1.462	0.0027
3	1958	0.271	-0.598	0.200	1.399	0.0023
4	1959	0.293	-0.460	0.203	1.424	0.0024
5	1960	0.427	1.110	0.205	1.440	0.0027
6	1961	0.406	1.061	0.204	1.429	0.0030
7	1962	0.357	0.437	0.202	1.415	0.0030
8	1963	0.323	-0.184	0.188	1.351	0.0026
9	1964	0.303	-0.501	0.187	1.345	0.0028
10	1965	0.231	-0.590	0.180	1.306	0.0024
11	1966	0.227	-0.228	0.179	1.279	0.0023
12	1967	0.288	-0.224	0.180	1.284	0.0025
13	1968	0.323	0.037	0.181	1.293	0.0028
14	1969	0.373	1.445	0.180	1.302	0.0038
15	1970	0.384	0.623	0.181	1.321	0.0047
16	1971	0.256	0.060	0.177	1.290	0.0034
17	1972	0.224	-0.204	0.180	1.284	0.0028
18	1973	0.227	-0.600	0.185	1.340	0.0038
19	1974	0.218	-1.128	0.183	1.431	0.0058
20	1975	0.176	-0.176	0.170	1.366	0.0045
21	1976	0.163	0.068	0.171	1.405	0.0047
22	1977	0.148	-0.101	0.170	1.377	0.0045
23	1978	0.127	0.084	0.175	1.355	0.0037
24	1979	0.154	-0.188	0.170	1.383	0.0041
25	1980	0.178	-0.483	0.162	1.427	0.0048
26	1981	0.179	0.108	0.158	1.423	0.0044

Note: IOVERK = investment-capital ratio; Q = tax-adjusted Q; c = cost of capital; TACFTR = the tax factor defined on page 24 of the text; REQRES = the equivalent reduction in the rate of return caused by the tax-free reserves, also defined on page 24 of the text.

TABLE 4

Fiscal Year	Sample Size	Mean of Capital Stock	With Intercept			Without Intercept
			Constant	Capital Stock	R^2	Capital Stock
1976	626	20826	759 (5.5)	0.062 (37.8)	0.69	0.064 (39.6)
1977	626	21892	1062 (5.9)	0.055 (29.8)	0.59	0.057 (31.2)
1978	620	22362	1146 (5.9)	0.058 (30.1)	0.60	0.061 (31.5)
1979	618	23688	1165 (6.0)	0.058 (31.5)	0.62	0.061 (32.9)
1980	616	25096	1181 (5.9)	0.062 (33.1)	0.64	0.065 (34.6)
1981	613	25247	998 (5.2)	0.067 (35.3)	0.67	0.070 (37.0)

Note: The dependent variable is the maximum allowable limit on the amount deductible from corporate income as credits to the Reserve for Retirement Allowances. Numbers in parentheses are the t values. The reserve and the capital stock are measured in millions of yen.

FIGURE 1

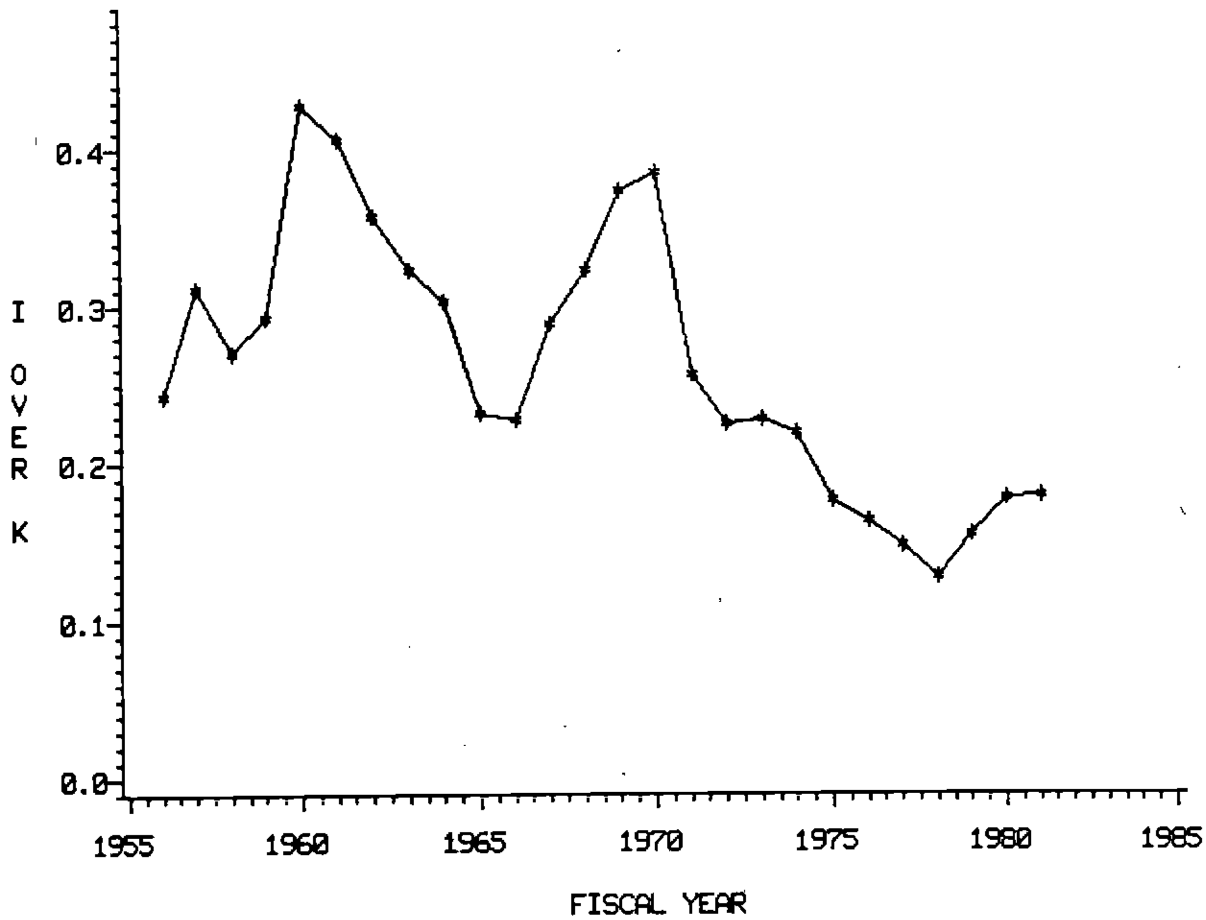
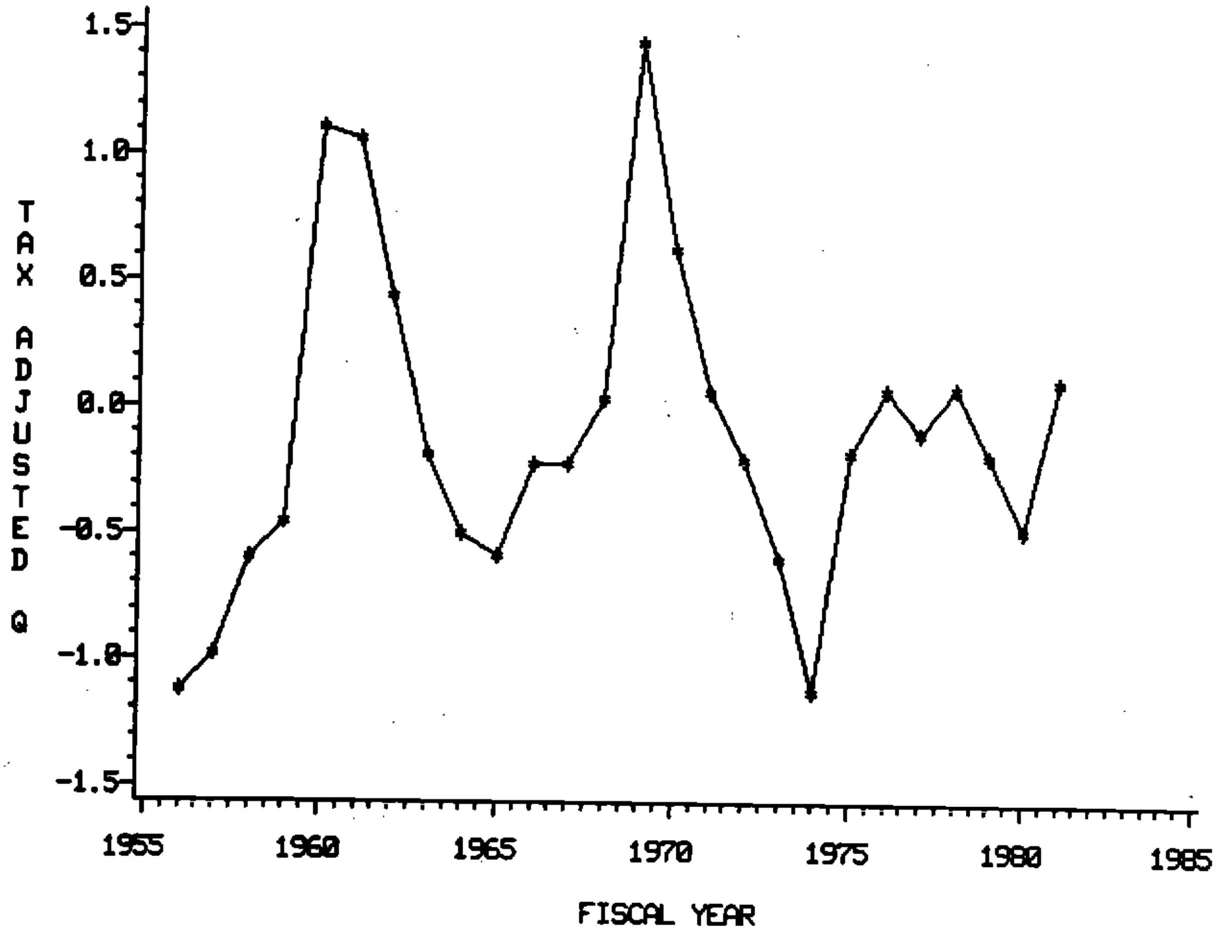
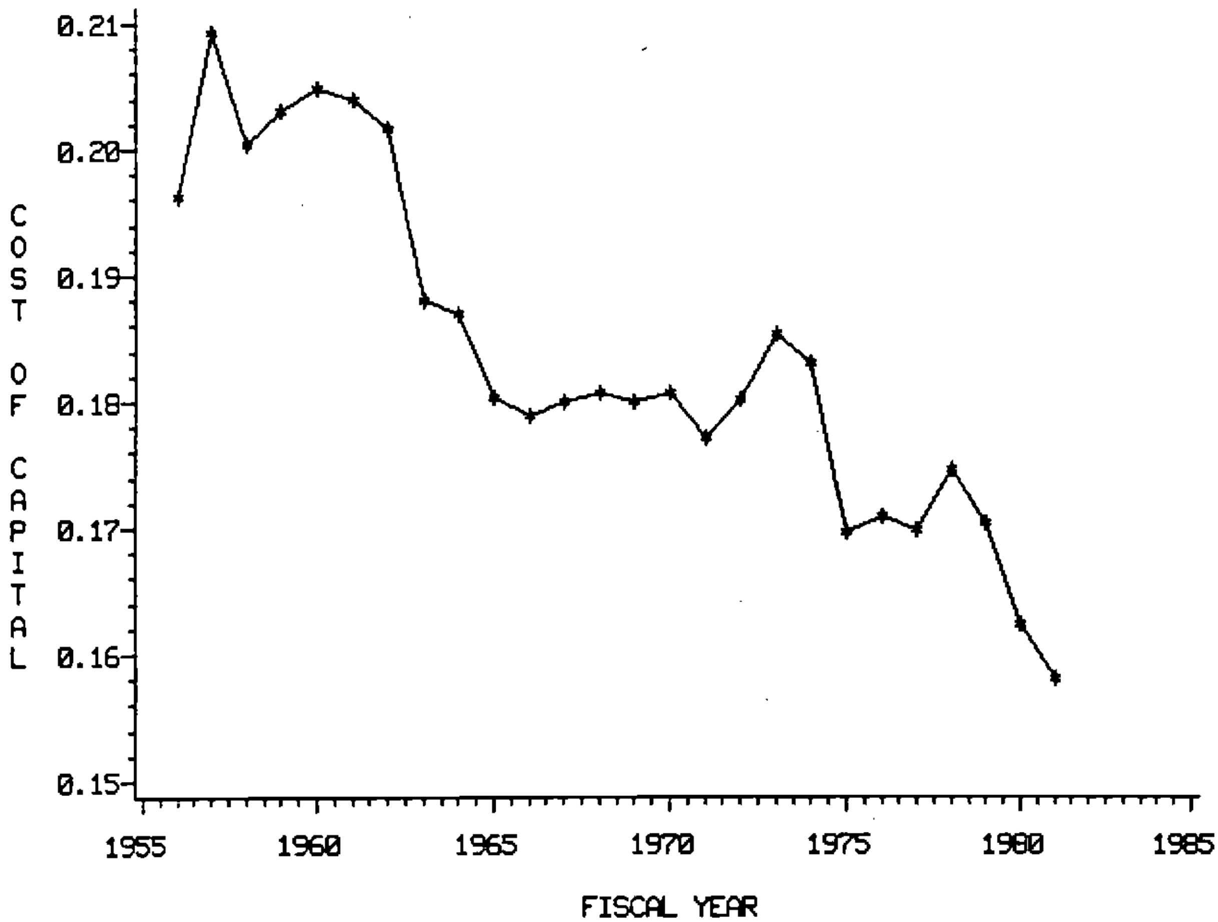

I OVER K
0.4
0.3
0.2
0.1
0.0
1955
1960
1965
1970
1975
1980
1985
FISCAL YEAR

FIGURE 2



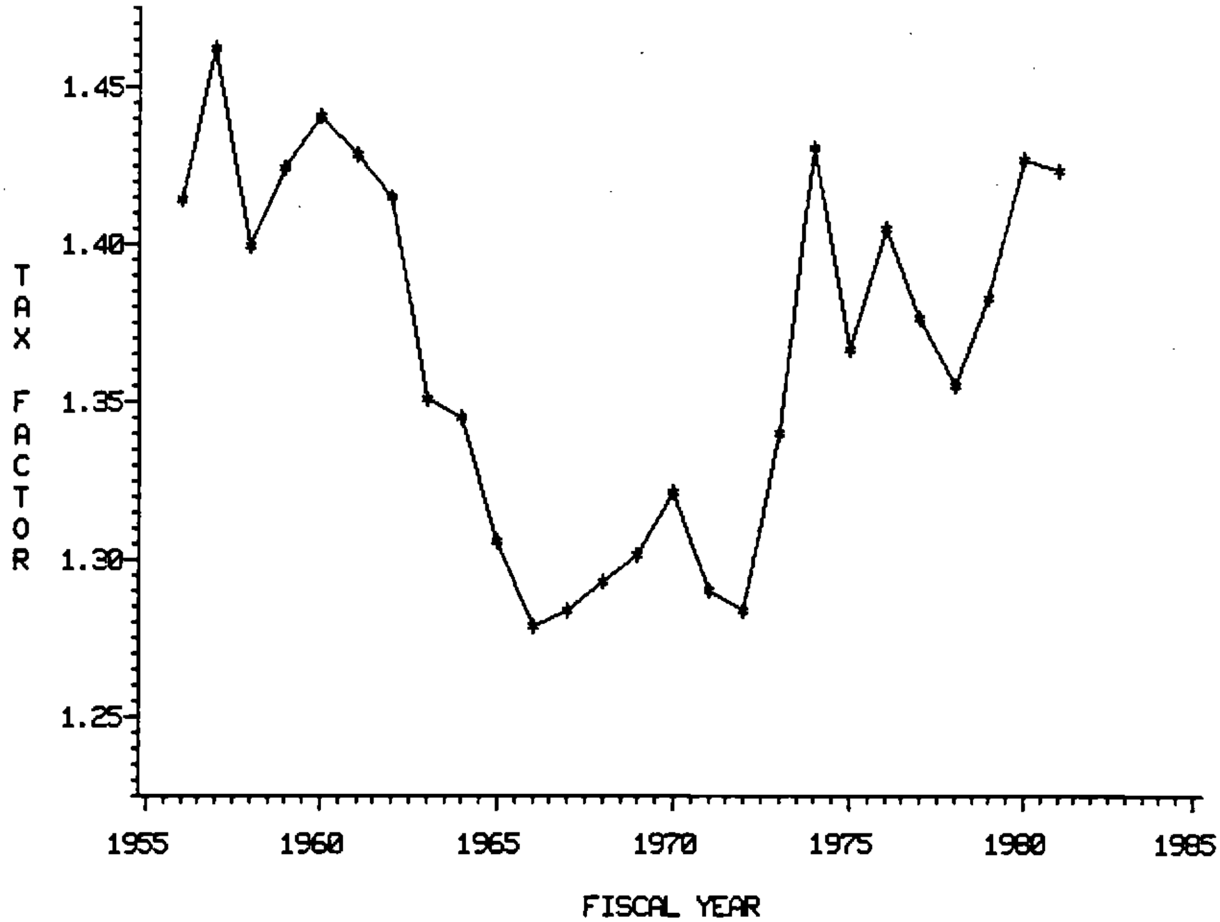
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
TAX ADJUSTED Q
1955
1960
1965
1970
1975
1980
1985
FISCAL YEAR

FIGURE 3



0.21
0.20
0.19
0.18
0.17
0.16
0.15
COST OF CAPITAL
1955
1960
1965
1970
1975
1980
1985
FISCAL YEAR

FIGURE 4



1.45
1.40
1.35
1.30
1.25
TAX FACTOR
1955
1960
1965
1970
1975
1980
1985
FISCAL YEAR

FIGURE 5

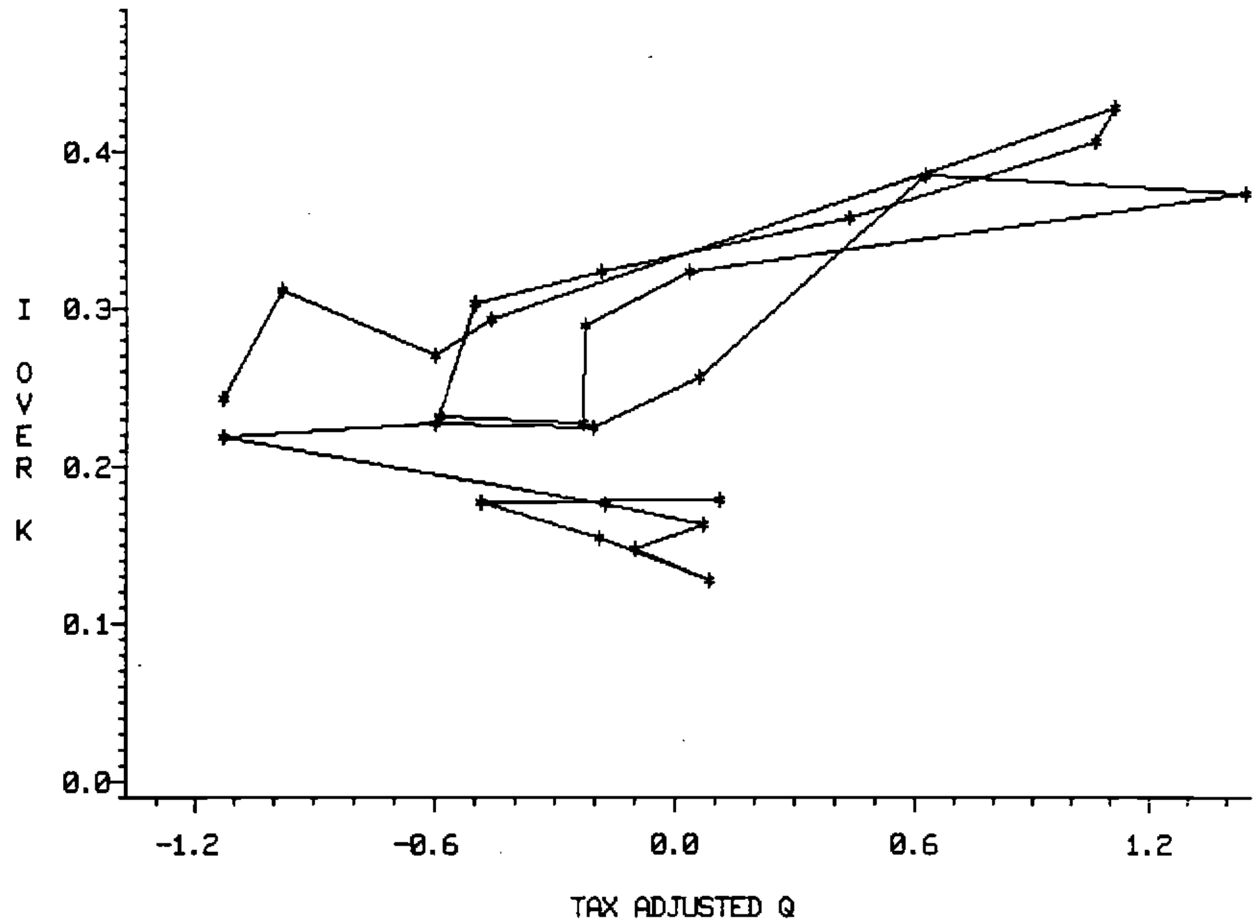
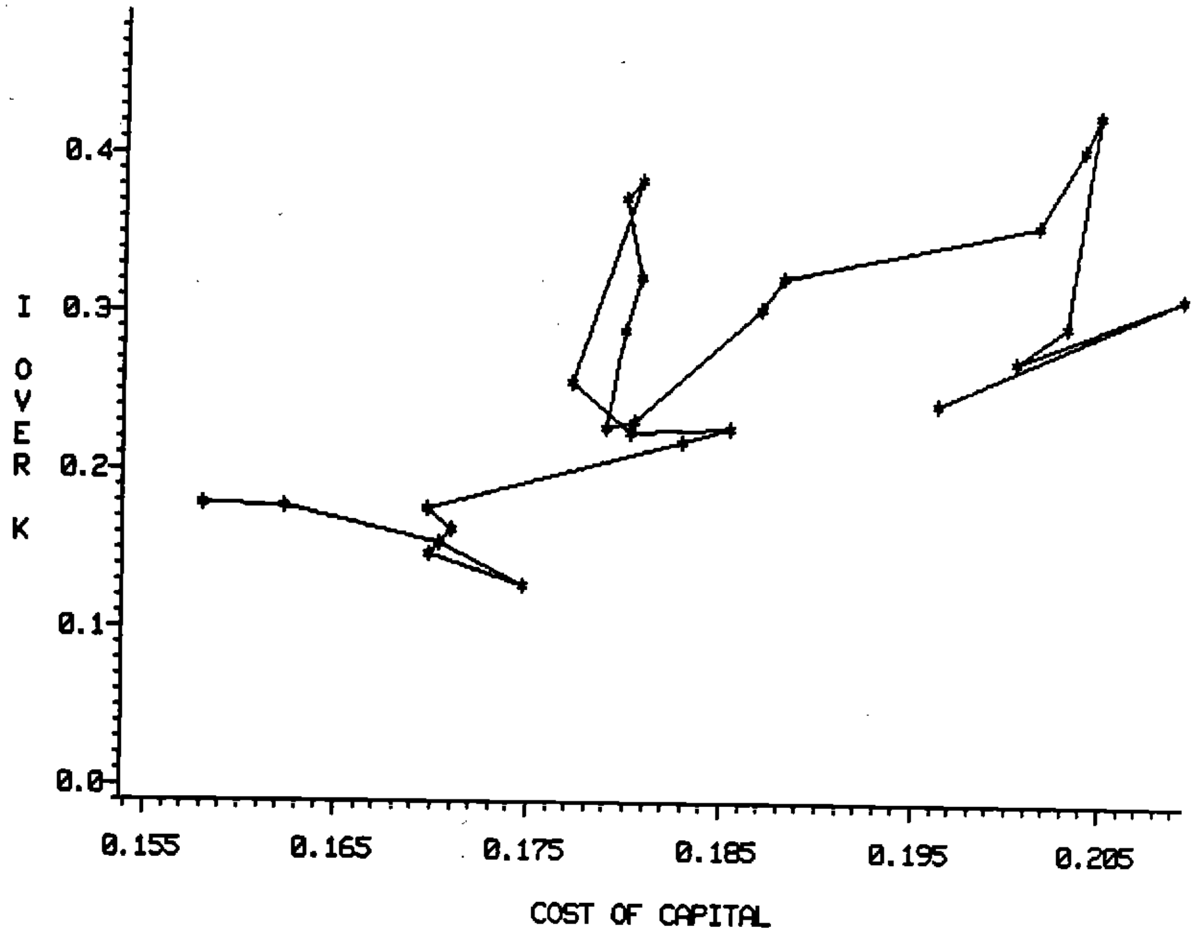


FIGURE 6



I OVER K
0.0
0.1
0.2
0.3
0.4
0.155
0.165
0.175
0.185
0.195
0.205
COST OF CAPITAL