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COST OF CAPITAL AND EFFECTIVE TAX RATE: A COMPARISON OF U.S. AND JAPANESE MANUFACTURING INDUSTRIES*

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I. *Introduction*

The purpose of this paper is to compare the effects of taxation on the cost of capital and the effective corporate tax rate between U.S. and Japanese munufacturing industries. Since the 1970s the U.S. has strengthened fiscal incentives to investment: in 1971 capital consumption allowances were accelerated and in 1981 still more liberal treatment of depreciable assets was introduced by Accelerated Cost Recovery System (ACRS); and the investment tax credit, which was first enacted in 1962, was reinitiated in 1971 after a short suspension since 1969 (Pechman (1987), and Jorgenson and Sullivan (1981)). Recent tax reform of 1986 repealed the investment tax credit, but reduced the rate of corporate income tax substantially to level off distortions in capital allocation.

Japan has been no exception in this regard and in both corporate and personal taxes various measures have been taken to foster capital accumulation. In corporate income tax, accelerated depreciation has been adopted since the beginning of the 1950s, though the degree of its acceleration has been moderated gradually. In addition to it, tax-free reserves, which postopone tax payments of certain types of income, have been extensively employed. And on the personal side capital income has been separated from income of other sources, and special (sometimes almost zero) tax rates have been applied to it (Tajika and Yui (1988)).

We would like to compress these differences in tax structures of the two countries into the cost of capital and the effective tax rate, and to examine how these indexes have been affected by tax policies. The derivation and estimation of them is hardly a new undertaking. However, it has been tackled extensively these days, motivated strongly by the recognition that the allocation of capital has been distorted by incomplete income tax policies. The contributions which we seek in the theoretical part of our paper are twofold. The first is to explicate the relation between personal capital income taxes and the cost of capital. This line of research has been pursued by Auerbach (1979, 1983), King and Fullerton (1984), and Boadway, Bruce and Mintz (1984). Methodologically we will adopt the wealth maximization approach of Auerbach, and present the optimization problem of equity owners explicitly. We will then solve the problem to get the desired formulas under the assumption that invest-

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able funds are financed in fixed proportions by retained earnings, borrowing and new share issues.

The second contribution we are after has to do with a characteristic of Japanese corporate tax policy. In postwar Japan such a straightforward policy as the investment tax credit has rarely been taken, but measures deferring tax liabilities have been more often been introduced. Tax-free reserves are a typical example of such measures. We would like to explore how this particular form of incentive policy makes its way toward the marginal cost firms incur when investing.

The plan of the rest of the paper is as follows. The second section will present a problem of investors and derive the formulas of the cost of capital and the effective tax rate. The third and fourth sections will report our empirical findings: in the former, the results under constant and in the latter under actual prices will be presented. Various interest rates will also be set constant in the third section. The reason which has compelled this classification of estimates is that the cost of capital and the effective tax rate are sensitive to price changes and it is useful to find out the intrinsic differences in tax structures by first ignoring these changes. The last section will summarize and conclude the paper.

II. *The model*

In the studies of the cost of capital and the effective tax rate in the 1960s and the early 1970s, only taxation on the corporate side was taken into account, and the effects of corporate finance and corporate income tax on the cost of capital was analyzed (Hall-Jorgenson (1967), Stiglitz (1973)). Recent studies on the issue, however, have tried to introduce personal tax on capital income (interest, dividends and capital gains) into the process of deriving the formulas of cost of capital.

Since the income raised by corporations is distributed to individuals in one way or another and corporations have to satisfy their share owners with paying at least a minimum rate of return they require, it is quite natural to investigate how the taxation on the personal side affects the cost of capital. And as we will see later, the postwar Japanese tax system has been characteristic in being engineered to enhance capital accumulation from the personal as much as from the corporate side. We will start with conceptualizing investors requring a certain minimum rate of return from their equity investment and pose their optimization problem explicitly. The problem will then be solved under the constraint that fixed fractions of investment are financed by borrowing, new share issuance and retained earnings.

The second characteristic of our formulas of cost of capital, as was alluded to in the introduction, has to do with tax-free reserves. Corporations can defer their tax liabilities on the amount of certain reserves until they are added back to their income. Although the reserves do not exempt tax liability as much as they are deducted from taxable income, they will certainly reduce corporate tax burden by putting off the day on which tax liabilities are due.

In postwar Japan various tax free reserves were introduced since the early 1950s and they seem to have reduced corporate tax burden more than accelerated depreciation, which is a more common measure adopted by almost every country to mitigate corporate tax liabilities. We would like to show how the cost of capital has been affected by tax-free reserves and to present a formulation which allows us to quantify the effects the reserves might have had on the cost of capital.

2.1 Cost of capital without tax-free reserves

We will first derive the formulas of cost of capital and effective tax rate which take into account taxes on personal capital income. The formula which will also take care of tax-free reserves will be discussed later.

Now, we assume that investors expect a minimum rate of return, ρ, to their investment. We will express the value of the firm by V. The investors receive from the firm the dividend income D, and the capital gains. Dividend and capital gains are assumed to be taxed at the rates θ and c respectively. It is also assumed that new shares amounting to v^N is issued and therefore that the capital gains received by the investors is equal to $\dot{V}-v^N$, where $\dot{V}$ designates the derivative of V with respect to time, t.

With the above set up, investors' portfolio choice will yield the following equation:

$$\rho V=(1-c)(\dot{V}-v^N)+(1-\theta)D . \qquad (1)$$

Solving this first-order differential equation of V, we will get

$$V=\frac{1-\theta}{1-c}\int_0^\infty e^{-\frac{\rho}{1-c}s}\left(D-\frac{1-c}{1-\theta}v^N\right)ds , \qquad (2)$$

where the V above is the value of the firm at time zero (which is regarded as the time the firm is established).

As for the mode of financing investment we will assume that fixed fractions of investment, α_1 and α_2, are financed respectively by issuing bonds and new shares. This, in turn, implies that $\alpha_3=1-\alpha_1-\alpha_2$ is the portion of investment financed by retained earnings. The economic value of capital stock, K, is to depreciate at the rate δ. Hence, net capital increase at time t is given by

$$\dot{K}=I-\delta K , \qquad (3)$$

whe I stands for the gross investment.

The dividend distributed by the firm at t, D, is expressed by

$$D=(1-\tau)\pi-(1-k)pI+\tau\int_{s=0}^{s=t}\hat{\delta}e^{-\hat{\delta}(t-s)}I_s ds+B_t-B_{t-l}-i(1-\tau)\int_{s=t-l}^{s=t}Bs\,ds+v^N , \qquad (4)$$

where the new notation employed are the following:

τ: the corporate tax rate,
$\pi(K)$: the corporate income before tax,
k: the rate of investment tax credit,
$\hat{\delta}$: the accounting rate of depreciation,[1]
p: the price of investable goods,
B: the funds raised by issuing bonds,

[1] To be precise the word "accounting" is used here to imply "tax-accounting". In the literature of corporate taxation this type of depreciation is referred to as depreciation for tax purposes.

l: the maturity of bond,
i: the rate of interest paid by the firm.

In deriving Equation (4) it has been assumed that the maturity of corporate bond is l and that the interest paid to investors is fully deductible from the taxable income. And the preceding assumptions on the mode of corporate finance dictate that

$$B=\alpha_1 pI$$

and

$$v^N=\alpha_2 pI\ .$$

Without loss of generality the time of investors' optimization may be set at zero, i.e., optimization at the time of corporate establishment, and their problem is presented formally as to maximize

$$V=\frac{1-\theta}{1-c}\int_0^\infty e^{-\hat{\rho}t}\left\{(1-\tau)\pi(K)-(1-k-\tau z)-S\alpha_1-\frac{\theta-c}{1-\theta}\alpha_2 pI\right\}dt$$

subject to

$$\dot{K}=I-\delta k,$$

where

$$\hat{\rho}=\frac{\rho}{1-c}\ ,$$

$$z=\int_0^\infty \hat{\delta}e^{-(\hat{\rho}+\hat{\delta})t}dt=\frac{\hat{\delta}}{\hat{\rho}+\hat{\delta}}\ ,$$

$$S=1-e^{-\hat{\rho}l}-i(1-\tau)\frac{1}{\hat{\rho}}(1-e^{-\hat{\rho}l})$$

and the maximization will be carried out with respect to the choice of investment, I.

The cost of capital, C, is defined as the marginal rate of return to capital when the optimal investment scheme is chosen, i.e.,

$$C=\partial\pi/\partial K\Big|_{K=\text{the optimal capital stock.}}$$

A straightforward application of the maximum principle will yield the formula of the cost of capital:

$$C=C^B\alpha_1+C^N\alpha_2+C^R\alpha_3\ , \qquad (5)$$

where

$$C^B=\frac{1-S-k-\tau z}{1-\tau}\left(\hat{\rho}+\delta-\frac{\dot{p}}{P}\right)\frac{p}{p^0},$$

$$C^N=\frac{1+\dfrac{\theta-c}{1-\theta}-k-\tau z}{1-\tau}\left(\hat{\rho}+\delta-\frac{\dot{p}}{p}\right)\frac{p}{p^0},$$

$$C^R=\frac{1-k-\tau z}{1-\tau}\left(\hat{\rho}+\delta-\frac{\dot{p}}{p}\right)\frac{\dot{p}}{p^0}$$

and p^0 is the producer's price of the output of the firm.

A glance at Equation (5) shows that the cost of capital for the firm is the weighted average of costs of capital under the three modes of finance with weights being the fractions of investment financed by the corresponding financial sources. If the maturity of bond is assumed to be a "period," the formula of cost of capital under the bond finance, c^B, is simplified to

$$C^B = \frac{\frac{1+i(1-\tau)}{1+\hat{\rho}} - k - \tau z}{1-\tau}\left(\hat{\rho}+\delta-\frac{\dot{p}}{p}\right)\frac{p}{p^0} .$$

This formula says that the cost of capital to the firm when marginal investment is financed by borrowing is lower than that under retained-earnings finance so long as the minimum rate of return required by investors, $\hat{\rho}$, is greater than the effective rate of interest at which firms borrow, $i(1-\tau)$.

The effects of taxation of personal capital income on the cost of capital are as follows. The capital gains tax, c, will raise the minimum rate of return required by investors from ρ to $\hat{\rho}=\rho/(1-c)$. This will increase the costs of capital under various financial sources across the board. The dividend income tax, θ, will affect the cost of capital when investment is financed by new shares marginally. Since in practice the rate of tax on dividend income may be considered to be higher than that of capital gains tax, the increase of the dividend income tax will raise also the cost of capital.

2.2 Cost of capital with tax-free reserves

We are now in a position to explore the relation between tax-free reserves and the cost of capital. Let us start our analysis by assuming that tax-free reserves amounting to R is deducted from the taxable income of a firm and that they are to be added back to the income only when a certain length of time, T, is passed. We have discussed elsewhere that tax-free reserves have been utilized by Japanese firms essentially as a device to mitigate their tax burden and therefore that they may be represented by a function of corporate income, although each tax-free reserve had been institutionalized judicially as a preparation for unexpected future expenses (Ikemoto, et al (1984)). This feature of tax-free reserves has led us to the following relationship:

$$R=R(\pi(K)) \quad \text{and} \quad dR/d\pi>0 .$$

When tax-free reserves, R, is deducted from the taxable income and the corporate tax on R is postponed to the T time later, the cash flow of the firm will be increased as much as

$$\tau\cdot R\cdot(1-e^{-\hat{\rho}T}) ,$$

when measured by the value at the time when the reserves are deducted from the taxable income. Adding this term to the corporate dividend D, which is expressed by Equation (4), and solving the problem of investors will yield the formula of the cost of capital with tax-free reserves.

The new formula we obtain is the same as the previous one but for a change in the denominators of the costs of capital under different financial modes. That is, in the new, the denominators of the costs of capital, C^B, C^N, and C^R, are altered to

$$1-\tau+\tau\cdot R'\cdot(1-e^{-\rho T}) ,$$

where R', is the derivative of R with respect to $\pi(K)$. The presence of the new denominator implies the following: the cost of capital gets smaller as tax-free reserves become more responsive to corporate income and as the period for which corporate tax on tax-free reserves is deferred is longer.

2.3 Effective tax rate

It would go without saying that the statutory rate of corporate income tax does not represent the real tax burden corporations pay, for various special treatments like the investment tax credit, accelerated depreciation and tax-free reserves reduce their tax liabilities. The idea of effective corporate tax, on the other hand, is essentially to seek such a rate of corporate income tax that would realize by itself the cost of capital which prevails under the existing tax system; in a sense, the effective tax rate is the "condensed" rate of corporate income tax.

To be more specific, we start by doing away with all the special measures like the ones mentioned above, and by letting the rate of depreciation be economic. The source of corporate finance is restricted to retained earnings. Under these assumptions we ask which rate of corporate income tax would bring about the cost of capital that emerges under the current tax system.

The effective tax rate, τ^E, thus conceptualized may be defined implicitly by:

$$\frac{(1-\tau^E z^E)(\rho+\delta-\dot{p}/p)}{1-\tau^E}p=C , \tag{6}$$

where z^E is the present value of the stream of economic depreciation of a unit-value worth of investment, C on the right hand side is the prevailing cost of capital (Equation (5)), and the price of output of the firm, p^0, is set at unity for the sake of simplicity.

Noticing that the rate of change of the price of investable goods is $\dot{p}/p$, z^E may be expressed as

$$z^E=\delta/(\rho+\delta-\dot{p}/p) .$$

The substitution of this z^E into Equation (6) and some rearrangements of terms will yield the following relationship:

$$(C/p-\delta)\,(1-\tau^E)=\rho-(\dot{p}/p) .$$

This equation says that the effective tax rate is no other thing but the wedge between the marginal net-of-depreciation rate of return of the firm and investors' real rate of return. This characteristic of our effective tax rate may appeal more straightforwardly to our notion of effective tax rates.

With the formulas of cost of capital and effective tax rate available, we would like to estimate them for U.S. and Japanese manufacturing industries. The rest of this paper will be devoted to this estimation, and the comparison of its outcomes between the two countries will be made.

III. *Results with Constant Prices*

3.1 Sources of data

The data necessary to estimate the formulas of the cost of capital and the effective tax rate are classified into the following three categories: tax, corporate and price statistics. We will describe our method of estimation first for the U.S., and next for Japanese manufacturing industries. And Tables 1(a) and (b) show the results of our estimates.

Using the notation of the preceding section, tax statistics consist of τ, k, m, θ, c and R'. As for the U.S. manufacturing industry, we have estimated τ by dividing the corporate income tax proceeds of both federal and local governments by taxable income. The rate of investment tax credit, k, has been obtained as a weighted average of its statutory rates applied to equipments and structure with weights being the shares of relevant types of investment. The rates of taxes on personal capital income, m, θ, and c, have been based on the estimates reported by King and Fullerton (1984). These estimates in turn are outcomes of the TAXSIM model for 1977, and employed as relevant statistics for 1980 in their study. Reflecting tax reforms since 1980, the tax rate on personal capital income should have been reduced. However, we could not incorporate these factors into our estimation due to the lack of statistics to update the estimation. The last tax statistic is the marginal increase of reserves when corporate income is increased mariginally, R'. For the U.S. manufacturing industry we have calculated the rate of increase of reserves for bad debts as R's, which is shown in Table 1(a) as R_2.[2]

Corporate statistics comprise i, l, α_1, α_2, δ, z^E, and z, again using the notation of the last section. The rate of interest of corporate borrowing, i, has been set equal to the rate of interest of corporate bonds rated Baa. The maturity of corporate borrowing (say, by means of issuing bonds), l, is a parameter which is difficult to estimate. One reason for this difficulty is that corporate borrowing is often rolled over or transformed to other forms of borrowing. The maturity of long run corporate bond in Japan is about ten years, and we have used this for l in common for both countries. The fractions of investment financed by borrowing and new share issues, α_1 and α_2 respectively, have been estimated annually by using the Flow of Funds Accounts (Non Financial Corporate Business), and their averages over the period 1970 to 1979 have been used for calculating the cost of capital and the effective tax rate. The rate of economic depreciation, δ, has come essentially from Hulten and Wykoff's (1981) estimates; their estimates of δ of thirty three assets have been given weights which are equal to the shares of investment of each type of assets. The accounting rate of depreciation has been estimated by using the useful live of assets reported by Jorgenson and Sullivan (1981) and the effects of further acceleration of capital consumption allowances have been taken into consideration. The present values of depreciation, z^E and z, have been calculated by discounting the streams of economic and accounting depreciation.[3]

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[2] R_1 deals with a special type of tax-free reserves which are applicable only to Japanese manufacturing industry.

[3] When we discount the stream of economic depreciation to get z^E, the appropriate rate of discount is the real rate of return required by investors. A problem which arises when using annual real rates of return is that they fluctuate widely from year to year, even negative in years of high inflation. And so will the z^E's when annual rates of return are used to estimate them. Unstable z^E will in turn yield the effective tax rates which may be biased heavily by the rate of inflation. In order to avoid this problem we have used average real rates of return for discounting the stream of depreciation, with the average calculated over 1970 to 1984.

TABLE 1(a). ESTIMATES OF PARAMETERS: U.S. MANUFACTURING INDUSTRY

Year	τ	k	m	θ	c	R_2	i	α_1	α_2	δ	z^E	z	ρ	p	p^0
1970	0.534	0.000	0.271	0.410	0.065	0.059	0.091	0.349	0.048	0.117	0.814	0.660	0.066	0.398	0.353
1971	0.523	0.052	0.271	0.410	0.065	0.057	0.086	0.349	0.048	0.119	0.817	0.713	0.062	0.424	0.365
1972	0.528	0.054	0.271	0.410	0.065	0.056	0.082	0.349	0.048	0.123	0.823	0.730	0.059	0.444	0.378
1973	0.528	0.054	0.271	0.410	0.065	0.057	0.095	0.349	0.048	0.124	0.824	0.730	0.060	0.460	0.403
1974	0.523	0.053	0.271	0.410	0.065	0.057	0.095	0.349	0.048	0.126	0.825	0.708	0.069	0.505	0.492
1975	0.527	0.079	0.271	0.410	0.065	0.050	0.106	0.349	0.048	0.131	0.833	0.702	0.077	0.579	0.549
1976	0.521	0.073	0.271	0.410	0.065	0.043	0.097	0.349	0.048	0.133	0.836	0.719	0.071	0.619	0.584
1977	0.524	0.074	0.271	0.410	0.065	0.052	0.090	0.349	0.048	0.138	0.842	0.743	0.065	0.661	0.625
1978	0.526	0.074	0.271	0.410	0.065	0.046	0.095	0.349	0.048	0.137	0.840	0.731	0.069	0.715	0.671
1979	0.505	0.071	0.271	0.410	0.065	0.043	0.107	0.349	0.048	0.134	0.834	0.702	0.078	0.778	0.757
1980	0.517	0.073	0.271	0.410	0.065	0.055	0.137	0.349	0.048	0.136	0.839	0.664	0.100	0.851	0.880
1981	0.522	0.077	0.271	0.410	0.065	0.057	0.160	0.349	0.048	0.135	0.837	0.707	0.117	0.934	0.974
1982	0.538	0.075	0.271	0.410	0.065	0.081	0.161	0.349	0.048	0.134	0.834	0.703	0.117	1.000	1.000
1983	0.529	0.077	0.271	0.410	0.065	0.065	0.135	0.349	0.048	0.135	0.837	0.732	0.099	0.988	1.011
1984	0.530	0.077	0.271	0.410	0.065	0.068	0.142	0.349	0.048	0.136	0.838	0.716	0.103	0.987	1.033

TABLE 1(b). ESTIMATE OF PARAMETERS: JAPANESE MANUFACTURING INDUSTRY

Year	τ	k	m	θ	c	R_1	R_2	i	α_1	α_2	δ	z^E	z	ρ	p	p^0
1970	0.487	0.000	0.150	0.150	0.000	0.039	0.157	0.086	0.449	0.036	0.102	0.831	0.659	0.077	0.545	0.508
1971	0.486	0.000	0.200	0.150	0.000	0.037	0.194	0.086	0.449	0.036	0.100	0.831	0.702	0.060	0.539	0.504
1972	0.486	0.000	0.200	0.150	0.000	0.047	0.196	0.081	0.449	0.036	0.098	0.830	0.717	0.054	0.568	0.523
1973	0.487	0.000	0.250	0.150	0.000	0.048	0.144	0.084	0.449	0.036	0.096	0.829	0.671	0.072	0.698	0.639
1974	0.531	0.000	0.250	0.150	0.000	0.062	0.143	0.103	0.449	0.036	0.095	0.828	0.635	0.085	0.810	0.763
1975	0.530	0.000	0.250	0.150	0.000	0.066	0.223	0.096	0.449	0.036	0.093	0.827	0.669	0.070	0.799	0.777
1976	0.529	0.000	0.300	0.150	0.000	0.053	0.185	0.094	0.449	0.036	0.096	0.833	0.695	0.062	0.830	0.822
1977	0.529	0.000	0.300	0.150	0.000	0.043	0.179	0.085	0.449	0.036	0.098	0.839	0.736	0.049	0.852	0.835
1978	0.528	0.000	0.350	0.200	0.000	0.043	0.165	0.073	0.449	0.036	0.101	0.845	0.755	0.043	0.877	0.828
1979	0.529	0.000	0.350	0.200	0.000	0.029	0.132	0.077	0.449	0.036	0.104	0.851	0.726	0.053	0.948	0.904
1980	0.529	0.000	0.350	0.200	0.000	0.011	0.116	0.096	0.449	0.036	0.107	0.857	0.713	0.058	1.003	1.011
1981	0.550	0.000	0.350	0.200	0.000	0.016	0.113	0.094	0.449	0.036	0.107	0.857	0.725	0.054	0.995	1.013
1982	0.550	0.000	0.350	0.200	0.000	0.000	0.100	0.084	0.449	0.036	0.107	0.857	0.732	0.052	0.999	1.015
1983	0.550	0.000	0.350	0.200	0.000	0.018	0.079	0.080	0.449	0.036	0.107	0.857	0.744	0.048	0.995	1.006
1984	0.563	0.000	0.350	0.200	0.000	0.024	0.069	0.075	0.449	0.036	0.107	0.857	0.750	0.046	1.001	1.008

Price statistics comprise ρ, p and p^0. It is difficult to define clearly the minimum rate of return required by investors. This difficulty stems from the uncertainty accompanied when investing in a stock market. Here we are simply content with using the rate of return obtained when investing in Baa rated corporate bonds as the minimum rate investors require before tax, and calculate ρ by subtracing from it the tax on interest income. As for the price indexes of investable goods and the output of the manufacturing industry, we have used an implicit price deflator of investable goods and the wholesale price index respectively.

We turn to the data sources of Japanese manufacturing industry. In Japan, corporate income has been taxed by both central and local governments. We have combined the two types of corporate taxes to arrive at our estimates of τ. The investment tax credit has never been institutionalized systematically in Japan, and has been granted only to a very restricted class of assets of small scale firms. We have, therefore, set the rate at zero.

Taxation of personal capital income has had special features which are distinct from a comprehensive income tax. That is, separate tax has been applied to some of capital income, and even if the law dictates comprehensive income tax return, special measures have allowed tax payers to choose separate tax for their capital inome. This makes estimation of tax parameters of personal capital income difficult. In fact, the most difficult parameter to estimate among them is the tax rate on personal interest income, m. Table 1(b) lists the separate tax rate on interest received when investing in corporate bonds.[4] Part of dividend income has also been allowed to be taxed separately from other sources of income. The estimation of θ in the table is the average of various marginal tax rates levied on it. Capital gains of equities have been very liberally treated in Japan, and except for the transaction tax charged when they are sold, the gains either accrued or realized in the stock market have been treated as tax exempt.

As for tax-free reserves in Japan we have chosen the following three: reserves for retirement allowances, price fluctuations of inventories, and bad debts. Among them, retirement reserves which are deducted from taxable income for employees' retirement payments may be accumulated until they retire. We have regarded the average duration of an employee's commitment to a firm, which is about twelve years, as the accumulation period of the reserves. The other reserves are allowed to be accumulated for a year and added back to taxable income. The R_1 and R_2 in Table 1(b) are respectively marginal increases of these two types of reserves divided by the marginal increase of before-tax corporate income.[5]

The estimates of the rest of parameters are more or less the same as in the U.S. manufacturing industry. We will, therefore, state our estimation method in short. In Japan we can estimate the rate of interest charged for corporate borrowing directly from corporate statistics. The "i" in Table 1(b) is the effective rate of interest of borrowing and not the

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[4] There were three methods of taxation on interest income until 1987. The first is the one employed in our estimation and the second is the separate tax on discounted bonds issued by long-term credit banks, with tax rates lower than the first one. And the third method of taxation is "tax exemption," i.e., special saving accounts were treated as tax free with certain ceilings of balances to be qualified as tax exempt.

It is therefore difficult to decide which m to choose. However, it turns out that after-tax rates of return obtained from investing in the three types of assets are almost the same. Hence, proper combinations of interest rates and tax rates give us the same ρ. We have chosen here corporate bonds, and used their tax rate and their rate of return for estimating ρ.

[5] More detailed explanation of tax incentives for investment, including tax-free reserves, can be found in Tajika and Yui (1988).

same as the rate of some representative corporate bond. Investors' before-tax required rate of return when investing in a stock market has been set ebual to the rate of interest received when purchasing the bond issued by the Nippon Telephone and Telegram Company, one of the most widely circulated bonds in Japan in its postwar era. This choice of investors' required return is compatible with the aforementioned choice of tax rate on interest income. Economic rates of depreciation of various types of assests in Japan are assumed to be the same as those of corresponding assets in the U.S. However, differences in the structure of assets in investment have given rise to differences in the rate of economic depreciation aggregated for the manufacturing industry.

3.2 Effective tax rate under constant prices

One of the problems we encounter when estimating the formulas of the cost of capital and the effective tax rate is the effects of price changes on them. A glance at the formulas shows that fluctuations in investors' discount rate and the price of investable goods affect them straightforwardly. Moreover, as we will see later, these price statistics have been so volatile in the estimation period that we cannot distinguish the differences in taxation between the two countries from those in price changes. It seems, therefore, constructive to concentrate our discussion first on the differences in taxation of the two countries. For this purpose, we will set all prices constant and compare the effective tax rates of U.S. and Japanese manufacturing industries.

To be more specific, the way we have set prices constant in a hypothetical situation is as follows: the minimum rate of return investors require as well as the rate of interest charged for corporate borrowing have been set equal to 4%; and the price indexes of investable goods and outputs of the industry are set unity throughout the estimation period. The effective tax rates of the two countries calculated under these assumptions are shown in Figure 1.[6]

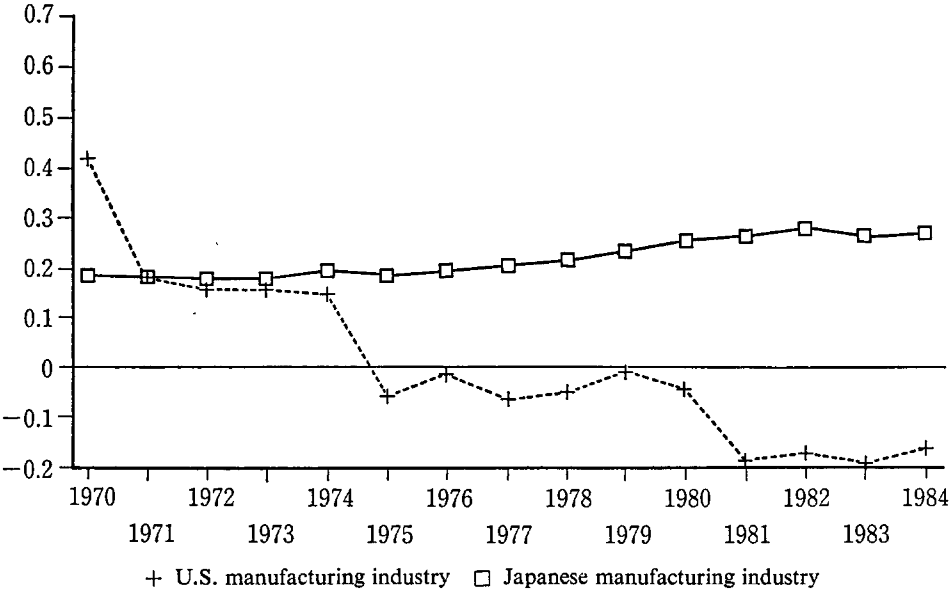
The figure reveals some interesting differences in the outcomes of tax policies of the two countries. First, the most decisive seems to be that the effective tax rate of U.S. manufacturing industry has had a downward, whereas that of the Japanese counterpart an upward trend. And the downward trend of the effective tax rate of U.S. manufacturing industry has been so steep that the rate became negative in 1975 and further declined after 1979. Second, the differential of the effective tax rate between the two nations has been widening, and in 1984 it reached as much as 0.435, i.e., the effective tax rates of the U.S. and Japanese manufacturing industries are -0.162 and 0.273 respectively. Third, a more careful examination of the downward trend of the U.S. manufacturing industry's effective tax rate shows that there were three somewhat distinct occasions that the rate was brought down, i.e., 1970–71, 1974–75 and 1980–81.

In order to detect the causes of these characteristics of the effective tax rate, it is convenient to derive the formulas of the rate under the current simplifying assumptions. The new formula we obtain is as follows:

$$\tau^E = 1 - \frac{\rho}{C-\delta} \quad .$$

[6] Main results of our estimation will be shown in figures to facilitate the comparison between the two countries. Their exact numbers are relegated to the Appendix.

FIG. 1. EFFECTIVE TAX RATE UNDER CONSTANT PRICES



Since ρ is set constant here and δ is a parameter exogenous to tax policies, the effective tax rate in the current situation has simply a positive relation with the cost of capital.

With this property of the effective tax rate in mind, we can explain two countries' declining and rising trends of the effective tax rate. The 1970–71 decline of the effective tax rate of the U.S. manufacturing industry may be ascribed to the reinstitution of the investment tax credit. In 1971 the rate of the credit jumpted to 5.2% from 0% in 1970 (see Table 1(a)). This caused the decline of the effective tax rate; effective tax rates in 1970 and 1971 were 0.421 and 0.179 respectively. If the same investment tax credit as in 1971 had been granted in 1970, the effective tax rate would have been 0.267. The 1974–75 decline may also be explained by the increase of the rate of the investment tax credit; it increased from 5.34% in 1974 to 7.93% in 1975. And this upswing in the credit rate was so significant that income from capital became effectively subsidized. The cause of 1980–81 decline is the acceleration of accounting depreciation by ACRS; the present value of depreciation, z, jumped from 0.809 in 1980 to 0.832 in 1981.

In contrast to the persistent decline of the effective tax rate in the U.S. manufacturing industry, that of Japanese one has had an almost monotonic rising trend. In Japan, as we pointed out in the data section, investment tax credit has never been a policy makers' favorite choice and the capital consumption allowances have stayed unaltered.[7] As for tax-free reserves, it was only until the middle of the 1970s that they were utilized actively. While tax incentive policies for investment have been rather modest in Japan in comparison with the U.S., the corporate income tax rate, τ, has been increased consistently. This, in turn, has raised the

[7] Actually the present value of accounting depreciation, z, has stayed around 0.76 to 0.77 during our entire estimation period.

effective tax rate of Japanese manufacturing industry; the effective tax rate of 18.4% in 1970 went up to 25.4% in 1980, and reached the highest 28% in 1982, and stayed around 27% since then.

IV. *Results with Actual Prices*

4.1 Cost of capital and effective tax rate

We now compare the cost of capital and the effective tax rates of U.S. and Japanese manufacturing industries with prices set at their actual values. Figures 2 and 3 show respectively our estimates of the variables under the present assumption.

Figure 2 gives us several interesting facts about the differences of the cost of capital between the two countries. One of the most important of them seems to be that the cost of capital of Japanese manufacturing industry has not necessarily been higher than that of the U.S. one. On the contrary, the latest years witnessed marked differentials; in 1983 and 1984, the cost of capital of Japanese manufacturing industry was lower than that of the corresponding industry in the U.S. by 22.6% and 26.3% respectively (see also Table 3 in Appendix). The main reason for this can be explained as follows: after 1980, the discount rate of investors in Japan went down, whereas it stayed at a historically high level in the U.S., as is clearly shown in Figure 4 which illustrates the two countries' time series of the discount rate. And the rates of inflation measured by the price index of investable goods became almost zero in 1983 and 1984 in the two countries (see Figure 5). Consequently, real rates of discount in Japan were far lower than those in the U.S. for the last two years of our estimation. This overwhelmed the effects of U.S. tax incentives for investment which potentially offset the rise of the cost of capital due to the increase of the real discount rate.

FIG. 2. COST OF CAPITAL UNDER ACTUAL PRICES

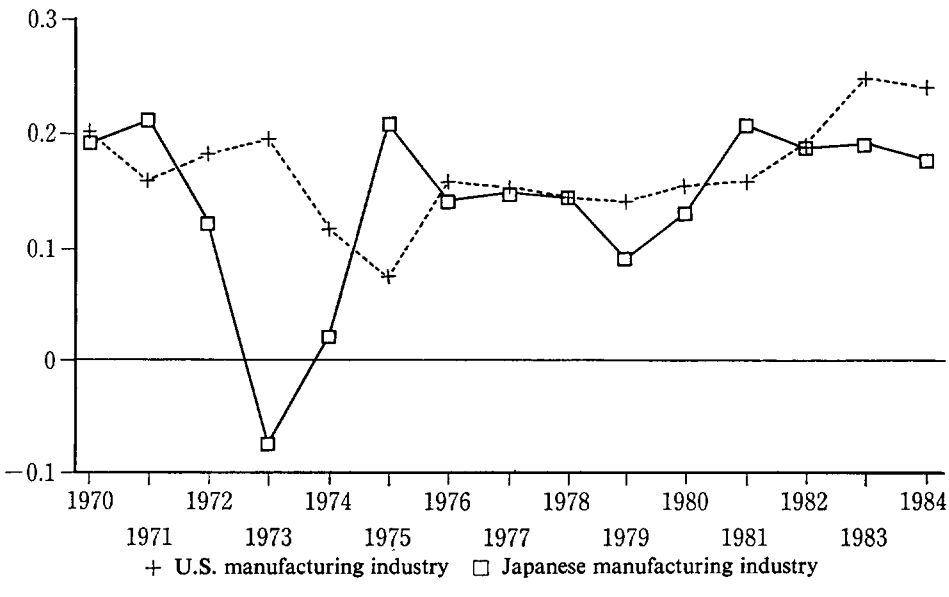


FIG. 3. EFFECTIVE TAX RATE UNDER ACTUAL PRICES

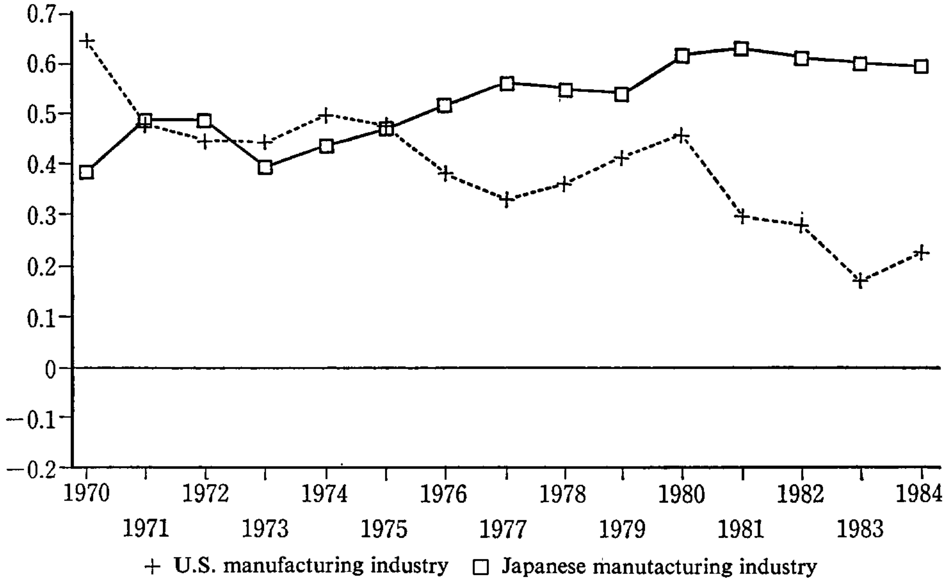
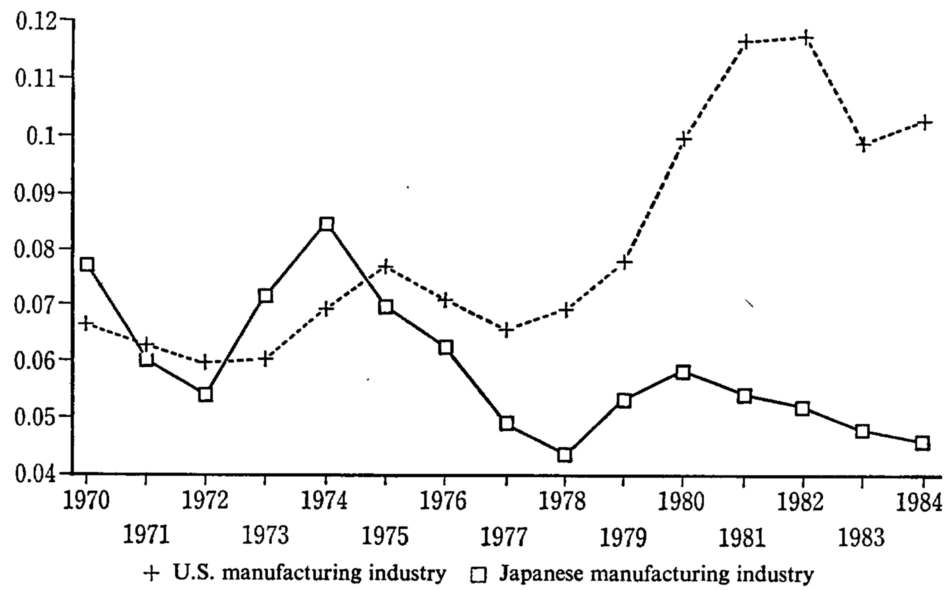
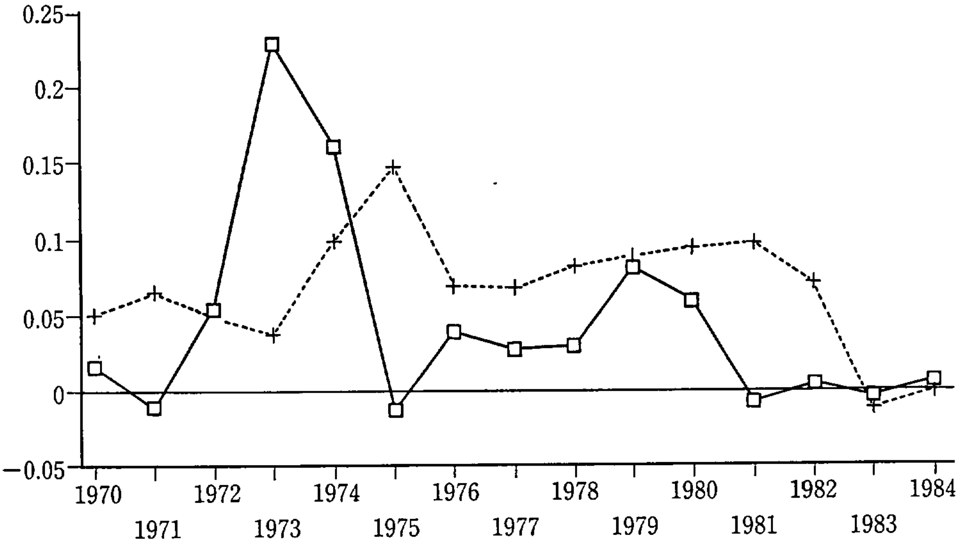


FIG. 4. THE RATE OF DISCOUNT, ρ



In relation to the differential of discount rates of the two countries, we would like to stress its effects on the effectiveness of capital consumption allowances. The allowances

Fig. 5. THE RATE OF INFLATION, $\dot{p}/p$



Note: The rate of inflation is measured as the rate of change of the price of investable good.

have been more conservative in Japan than in the U.S., and the introduction of ACRS in the U.S. made the accounting rate of depreciation of U.S. manufacturing industry much higher than that of Japanese one. However, the high nominal discount rate in the U.S. dwarfed the acceleration of depreciation. That is, when the effects of capital consumption allowances are measured in terms of the present value of depreciation of a unit-value worth of investment (z in our notation in Section 2), capital consumption allowances in the U.S. do not come out more accelerated than in Japan. To give some numbers since 1981, the z's in the U.S. are 0.724, 0.703, 0.732, 0.716 and the corresponding ones in Japan 0.724, 0.731, 0.743, 0.750. Thus, even after the introduction of ACRS, assets are eventually depreciated faster in Japan.

To find out more clearly the extent of the effects of differential of the dicount rate on the present value of depreciation, we further calculated the z's of the U.S. manufacturing industry by replacing the discount rate of the U.S. with that of Japan. Then, the modified z's in the U.S. since 1981 are 0.805, 0.811, 0.823, 0.830, which are much higher than the actual z's by 14%, 15.4%, 12.4%, and 10.7% respectively. And the modified z's are also larger than the z's of Japanese manufacturing industry, showing how potentially accelerated the consumption allowances are in the U.S.[8]

Another fact we notice in Figure 2 is that the cost of capital of Japanese manufacturing industry has been more volatile than its counterpart in the U.S. This seems to be a reflection of the differences of price changes of the two countries. According to Figure 5, which

[8] This, in fact, is supported by a simulation. Under the circumstance Japanese capital consumption allowances had been replaced with ACRS, the costs of capital of Japanese manufacturing industry would have been reduced about 8% after 1981, when ACRS became effective.

depicts the rate of change of the price of investable goods, the price in Japan seems to have fluctuated more and reacted to external shocks quicker than that in the U.S. For example, in 1973 the first oil shock was fully transmitted to the price index in Japan and the capital gains realized by it reduced the cost of capital drastically. And in 1975 while the price was stabilized in Japan, it reached the highest in the U.S., and the cost of capital of Japanese manufacturing industry surpassed that of U.S.

As in the first, the second oil shock pushed up the price of the investable goods in Japan faster, i.e., it peaked no later than in 1979 and declined until 1981. On the other hand, the price increase in the U.S. was rather chronic in the last half of the 1970s, and it plunged in 1981 and 1982. Thus, the second bottom of the cost of capital in Japan appeared in 1979 and it went up until 1981, whereas it never showed a marked decline in the U.S., but started to rise sharply after 1981.

We turn to the comparison of the effective tax rate. Figure 3 illustrates the results of our estimation. A fact which we notice immediately when we compare this figure with Figure 1, which shows the effective tax rate under constant prices, is that tax rates are now positive for both countries throughout the estimation period. This is due to the differences in the measurement of the present value of accounting and economic depreciation under the two assumptions on prices. That is, when actual discount rates are used, the present value of accounting depreciation of a unit-value worth of investment, z, becomes far smaller than the z calculated under the constant discount rate set at 4%. This makes the cost of capital under actual prices higher than the one under constant prices. On the other hand, the present value of economic depreciation of the same investment, z^E, turns out to be far higher under actual than under constant prices, for replacement costs of depreciable assets have been appreciated during our estimation period. The higher z^E, in turn, has the effects of pushing up the effective tax rate according to the definition of the effective tax rate. Thus, the differences in measurement of both z and z^E lead to the upward shift of the effective tax rate under actual prices, and as we have noticed, the tax rates of both countries became positive during the entire estimation period.

Although magnitudes of effective tax rates are significantly altered when the cost of capital is estimated under actual prices, their qualitative differences are not much changed; the effective tax rate of the U.S. manufacturing industry has a downward trend and that of Japanese one a clear upward trend. The declines of the rates in 1970–71, 74–75 and 80–81 in the U.S. are still observable under actual prices, but not as conspicuous as under constant prices. The differential of the tax rate between the two countries have been widening during the last few years of estimation, and it is somewhat striking for us to find that the wedges reached well over 30%.

4.2 Simulation of the cost of capital

We have so far tried to discover the main elements in our data base which have caused differences in the cost of capital and the effective tax rate between the two countries. In order to understand more precisely how various tax policies have affected these indexes, we have reestimated them under various alternative hypotheses. In what follows we would like to present some of the results of these exercises. Discussion here will be restricted to the simulation of the cost of capital, for its qualitative implication applies to that of the effective tax rate.

TABLE 2(a). SIMULATION OF COST OF CAPITAL: U.S. MANUFACTURING INDUSTRY (%)

Year	Case 1	Case 2	Case 3	Case 4
1970	0.4	6.9	−13.6	−4.6
1971	0.4	6.8	−10.1	−5.2
1972	0.4	6.7	−9.4	−5.3
1973	0.3	6.8	−9.4	−5.3
1974	0.4	7.7	−11.4	−5.2
1975	0.4	9.4	−13.8	−5.6
1976	0.3	8.2	−11.9	−5.6
1977	0.4	7.8	−10.5	−5.6
1978	0.4	8.3	−11.5	−5.6
1979	0.3	7.9	−12.5	−5.3
1980	0.6	10.7	−17.1	−5.3
1981	0.7	13.4	−13.9	−5.7
1982	1.1	14.8	−14.8	−5.9
1983	0.7	12.5	−11.7	−5.9
1984	0.8	12.9	−13.4	−5.8

TABLE 2(b). SIMULATION OF COST OF CAPITAL: JAPANESE MANUFACTURING INDUSTRY (%)

Year	Case 1	Case 2	Case 3	Case 4
1970	3.2	16.0	−14.4	−1.1
1971	2.8	7.8	−10.2	−1.0
1972	3.0	5.8	−8.9	−1.0
1973	3.5	14.1	−13.0	−1.1
1974	5.6	18.0	−18.2	−1.1
1975	5.8	12.4	−14.6	−1.1
1976	4.3	9.1	−12.7	−1.1
1977	3.0	4.2	−9.3	−1.1
1978	2.7	4.0	−8.2	−1.6
1979	2.3	8.7	−11.7	−1.6
1980	1.3	5.9	−12.9	−1.5
1981	1.6	5.5	−12.8	−1.6
1982	0.6	7.2	−12.4	−1.6
1983	1.4	6.0	−11.2	−1.6
1984	1.7	6.9	−11.1	−1.7

Notes: The underlying assumptions of each case are as follows:
Case 1 $R_1=R_2=0$, Case 3 $z=z^E$,
Case 2 $\alpha_1=\alpha_2=0$, i.e. $\alpha_3=1$, Case 4 $\theta=c=0$.

Tables 2(a) and (b) are the outcomes of this recalculation. Numbers in the tables are rates of changes in the cost of capital when new parameters are used. For example, 0.4% in Table 2(a) under Case 1 implies that the rate of increase of the cost of capital will be this much when the assumption under Case 1 replaced those under the original.

Case 1 seeks to detect the effects of tax-free reserves on the cost of capital. Here, they are completely repealed, and R_1 and R_2 are set equal to zero. The results confirm what we expect from our reading of the tax policies of the two countries; liberal treatment of reserves in Japan when compared with the U.S. suppressed the cost of capital more than in the U.S. Moreover, the effects of tax-free reserves in Japan have been declining, which also reflect its recent tax policy.

Case 2 explores the effects of corporate finance on the cost of capital. More specifically, finance by means of either borrowing or new share issues is ruled out and restricted only to retained earnings. The results are somewhat contradictory to our expectation; the abolition of finance through borrowing should have increased the cost of capital of Japanese manufacturing industry more than that of its U.S. counterpart, for the dependence on borrowing is heavier in Japanese one. This, however, is true only until about the middle of the 1970s, but not afterward, especially in the 1980s. The reason for this stems from the difference in the interest rate charged for borrowing (i, in the notation of Section 2). Very high rates of interest in the U.S. in the 1970s made corporate finance through borrowing more attractive in the U.S. than in Japan. In other words, the differences in nominal rate of interest overwhelmed the difference in the structure of corporate finance between the two countries.

Case 3 deals with the effects of capital consumption allowances on the cost of capital. Here, the accounting depreciation is replaced with the economic one and the stream of economic depreciation is discounted with an adjustment for inflation, i.e., z in the formula of the cost of capital is replaced with z^E. As is expected, the cost of capital is reduced significantly in both countries, implying that accounting depreciation has not been accelerated enough to recover the replacement cost of depreciable assets. And the culprits of this under-depreciation are the following two: chronic inflation during our estimation period, particularly during the late 1970s and the early 1980s; and the lack of indexation to adjust the basis of depreciation.

A somewhat unexpected aspect of the results of this simulation is that the rates of reduction of cost of capital of the U.S. manufacturing industry have been consistently higher than those of Japanese one since 1977. Our understanding of capital consumption allowances of the two countries is that they are more accelerated in the U.S., especially after the introduction of ACRS. Why, then, has this contradiction occurred? The answer lies in the differential of investors' discount rate. We have already pointed out that nominal discount rate started to soar in the U.S. since the late 1970s and the differential of this rate between the U.S. and Japan was widened. This made the z in the U.S. excessively low. Therefore, when it is replaced with z^E, the cost of capital drops sharply. Thus, under the circumstance in which indexation of depreciable assets is not introduced, accelarated depreciation is offset by the rising rate of interest, which ironically, too, is the outcome of inflation.

The last case is concerned with tax policies on personal capital income. A new set of assumptions we introduce is that personal taxes on dividend and capital gains are totally abolished, i.e., $\theta=c=0$. The cost of capital should go down under this hypothesis, and the numbers of Case 4 show it really does for both countries. Rates of reduction in the U.S. manufacturing industry are higher than in Japanese one, and this is a reflection of the difference of tax policies of the two countries; personal capital income has been taxed more heavily in the U.S. More specifically, in 1984 θ and c are 0.2 and zero in Japan, whereas corresponding numbers in the U.S. are 0.41 and 0.065.

V. *Conclusions*

This paper has attempted to show how tax policies have affected the cost of capital and the effective tax rate of U.S. and Japanese manufacturing industries. It has been composed of two parts. The first is theoretical and has developed the formulas of the above two indexes to be estimated. Here emphasis has been put on incorporating taxation on personal capital income and tax-free reserves into the formulas. The second is empirical and has sought to find out the causes which have triggered the differences in the cost of capital and the effective tax rate between the two countries.

The formula of cost of capital obtained proves to be the weighed average of three kinds of it, each of which corresponds to a specific sources of investment finance. Personal capital-gains tax has been shown to increase the cost of capital by raising the minimum rate of return required by investors. The dividend tax affects the cost of capital when marginal investment is financed by issuing new shares, and the cost of capital is shown to be increased when the dividend tax is raised in so far as the dividend tax rate is greater than the capital-gains tax rate. Tax-free reserves are found to reduce the cost of capital more, as the period over which taxes on reserves are deferred is longer and as the reserves are more sensitive to corporate income.

The empirical part of this paper has dealt with two regimes. In the first, prices are all set constant and the intrinsic differences of the two countries' tax policies toward investment have been examined. The results are that U.S. tax policies have been more active in promoting investment and that the gap of the effective tax rate between them has been widening, especially since the late 1970s.

Under the actual price regime both the cost of capital and the effective tax rate have been compared between the two nations. The finding under constant prices that the effective tax rate of U.S. manufacturing industry has been lower than its counterpart in Japan applies under fluctuating prices, though not as much straightforward as before. An even more interesting discovery is that tax policies for investment in the U.S. are still not promotive enough to draw down the cost of capital to the corresponding level of Japanese manufacturing industry. Main reasons behind this are the following two: first, the high interest rate in the U.S. pushed up the cost of capital when inflation started to subside after 1981; second, the high interest has also offset the acceleration of depreciation by making the present value of the stream of depreciation smaller, and this, too, has had the effects of raising the cost of capital.

This paper has provided us with a scope of further research. One of the most urgent and important topics to explore would be the effects of widening differential in the effective tax rate on investment behavior of Japanese manufacturing firms. They will certainly be more positive in investing abroad. Taxation and international capital movement, therefore, is now an issue we cannot avoid when studying the relation between tax policies and investment.

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APPENDIX: TABLE 3. COST OF CAPITAL AND EFFECTIVE TAX RATE OF U.S. AND JAPANESE MANUFACTURING INDUSTRIES

Year	U.S.			Japan		
	1	2	3	1	2	3
1970	0.421	0.201	0.646	0.184	0.192	0.385
1971	0.179	0.158	0.477	0.183	0.212	0.487
1972	0.157	0.182	0.447	0.177	0.124	0.488
1973	0.155	0.193	0.443	0.177	−0.074	0.395
1974	0.147	0.117	0.496	0.194	0.023	0.438
1975	−0.060	0.075	0.477	0.185	0.209	0.471
1976	−0.018	0.158	0.382	0.195	0.142	0.519
1977	−0.068	0.154	0.328	0.206	0.149	0.563
1978	−0.051	0.145	0.365	0.220	0.146	0.555
1979	−0.011	0.142	0.416	0.235	0.094	0.543
1980	−0.043	0.156	0.461	0.254	0.131	0.619
1981	−0.190	0.159	0.299	0.266	0.207	0.633
1982	−0.173	0.192	0.282	0.280	0.188	0.618
1983	−0.195	0.248	0.168	0.266	0.192	0.608
1984	−0.162	0.240	0.226	0.273	0.177	0.602

Notes: 1. Effective tax rate under constant prices.
2. Cost of capital under actual prices.
3. Effective tax rate under actual prices.

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