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Costs of Inflation in Japan: Tax and Resource Allocation

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Costs of Inflation in Japan:
Tax and resource allocation[♦]

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Abstract

This paper tries to shed light on the optimal inflation rate by investigating the effects of changes in inflation on resource allocation via changes in the effective tax rates. Given that some taxes are not lump-sum but subject to the proportional/progressive tax schedule, and that taxes are levied on nominal income instead of real income, an increase in the inflation rate has a distortional effect because it raises the effective tax rates. This paper tries to estimate that effect by taking Japan's institutional background fully into account and by applying the general equilibrium framework of Abel [1997]. The current costs of the higher inflation are found to be larger in Japan compared with those in other industrial countries, because of the lower rate of corporate capital return.

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I. INTRODUCTION

What inflation rate should the central bank aim at? Researchers have looked into the various costs associated with particular aspects of inflation in attempts to shed light on this question. They include inflation uncertainty (Kimura and Tanemura [2000]); relative price variability (Ueda and Osawa [2000], Shiratsuka [2000]); and inflation inertia (Kasuya and Oshima [2000]). This paper is another attempt to answer the above question by investigating the long-run costs of inflation in view of tax and resource allocation.

Inflation affects resource allocation because the government levies taxes proportionally or progressively. It also levies taxes on nominal income. Lump-sum taxes are desirable for the efficiency of resource allocation because they are neutral to the optimum behavior of economic agents[1]. However, in reality, proportional or progressive taxes on income and consumption are often used as a means of income redistribution, and as a built-in stabilizer, at the expense of their distortional effects on resource allocation. Furthermore, because income subject to tax is not real but nominal, an increase in the inflation rate raises the effective tax rate in spite of the unchanged pre-tax real income. As a result, the shift of the inflation rate induces some changes in distortional effects on resource allocation through changes in the effective tax rates.

A wealth of studies have tried to estimate the distortional effects of inflation through taxes—see, for example, contributions in Feldstein [1999], which covers the United States (Feldstein), the United Kingdom (Bakhshi, Haldane and Hatch), Germany (Tödter and Ziebarth) and Spain (Dolado, González-Páramo and Viñals). In Japan, the Economic Planning Agency (EPA, currently, the Cabinet Office) [1999] estimates such distortional effects. However, all of these studies use data that contains relatively high rates of inflation and corporate profits. For instance, the EPA uses data from 1975 to 1997, which spans the periods that were affected by two oil crises[2]. It is interesting to see whether these estimates have been, in the current Japanese situation, quite accurate; the average inflation rate has been almost zero (or negative depending on the periods) and the return on capital has been low.

This paper estimates the effects of inflation on resource allocation by taking the following two steps:

- The first step is to calculate the changes in the effective tax rates caused by inflation. This paper estimates changes in the effective tax rates on (i) corporate capital return, (ii) housing investment, and (iii) labor income, as consistently as possible within Japan's institutional background. The estimated results show that an increase in the inflation rate raises the effective tax rate on corporate capital return by a larger amount than those on housing investment and labor income.
- The second step is, in a general equilibrium framework of Abel [1997], to calculate the impacts on consumption stemming from the above estimated changes in the effective tax rates. Abel provides the setup to measure the distortional effects on resource allocation as a decrease in levels of household consumption, which leads to a decline in household utility. Mainly due to the low corporate capital return, which implies larger changes in its effective tax, the current costs of inflation in Japan are

[1] Lump-sum tax can affect the resource allocation in the long-run model where the population is endogenous.

[2] Furthermore, the EPA might overestimate the rate of capital return because its calculation of corporate capital is based on book values.

found to be relatively high compared with those in the existing studies.

This paper is organized as follows: Sections II, III, and IV focus on the first step. The impacts of inflation on corporate capital return, housing investment, and labor income are discussed, in turn, in each section. Section V proceeds to the second step by introducing Abel's model, which leads to the numerical calculations of the costs of inflation in Section VI. Finally, Section VII summarizes the results and provides several caveats.

II. Impact of the Shift of Inflation on Corporate Capital Return

This section analyzes changes in the effective tax rate on corporate capital return. In doing so, it takes into account more detailed information of corporate finance than Feldstein [1999] and the EPA [1999].

A. Corporate finance and tax on capital return

Households receive returns from firms who issue debt and/or equities for their investments, but these returns are subject to various taxes (Chart 1). In Japan, the following taxes are levied: (i) **interest income tax** must be paid when households receive interest; (ii) **corporate income tax** is levied on corporate profits after deducting the above interest payments; (iii) **dividend income tax** must be paid when households receive dividends as a portion of corporate return after corporate tax payments; and (iv) **capital gains tax** must be paid when households realize capital gains by selling equities—this can be thought as the tax on the retained profits which increase stock prices.

The above relationship can be expressed as follows. Suppose that households invest in firms whose pretax return is equal to R. The post-tax return, r, which the households receive (white areas in Chart 1) becomes

$$r = R\,[B(1-t_b)+(1-B)(1-t_{corp})\{(1-D)(1-t_{cg})+D(1-t_d)\}], \qquad (2\text{-}1)$$

where B is the share of interest payments to capital return; t_{corp} is the tax rate on corporate income; t_b is the tax rate on interest income; t_d is the tax rate on dividend income; t_{cg} is the tax rate on capital gains; and D is the dividend payout ratio.

The effective tax rate on capital return, t_1, is then defined as the difference between the pretax and the post-tax rates of return:

$$t_1 = 1 - r/R. \qquad (2\text{-}2)$$

B. Effects of the change in the inflation rate on tax

Because income subject to tax is not real but nominal, its effective tax rate changes depending on the inflation rate. That is, the shift of the inflation rate affects the effective tax rate through changes in the following nominal values: (i) corporate depreciation allowances; (ii) corporate interest payments; (iii) household interest receipts; and (iv) household holding stock. These effects will be examined below in line with Feldstein [1999].

(i) Corporate depreciation allowances

In calculating corporate tax, firms can deduct depreciation allowances from their taxable income. Because a rise (fall) in the inflation rate does not affect the nominal values of depreciation allowances, their real values become smaller (larger) and taxable income increases (decreases). When the inflation rate rises (falls), the effective tax rate rises (falls) and the post-tax real rate of return falls (rises).

Auerbach [1978] derives the change in the post-tax real rate of return (which households receive) resulting from the shift of the inflation rate (*Dp)* as follows:

$$\Delta r = -t_{corp} \frac{d}{N + p + d} \Delta p \{1 - (D t_d + (1 - D) t_{cg})\},$$

where *N* is capital cost, and *d* is the rate of depreciation. The part in braces corresponds to the share of the net household receipts after deducting capital gains tax and dividend income tax.

(ii) Corporate interest payments

On the assumptions that (a) the future inflation rate is perfectly foreseeable and (b) both the nominal rate of return and the nominal interest rate change by the same amount as changes in the inflation rate (the Fisher effect), corporate interest payments increase (decrease) and taxable income decreases (increases), reflecting a rise (fall) in the inflation rate. That is, the effective tax rate falls (rises) and the post-tax real rate of return rises (falls). The change in the post-tax real rate of return that households receive becomes

$$Dr = t_{corp}\, b\, Dp\, \{1 - (Dt_d + (1-D)t_{cg})\},$$

where *b* is the ratio of debts to assets.

(iii) Household interest receipts

As the other side of the coin, the rise (fall) in the inflation rate causes the nominal values of household interest receipts to increase (decrease). The effective tax rate on interest income rises (falls) and the post-tax real rate of return falls (rises). The assumption that household portfolio (debt share) is equal to the corporate debt share yields the change in the post-tax real rate of return by

$$Dr = -t_b\, b\, Dp,$$

where t_b is tax rate on interest income.

(iv) Household holding stock

The rise (fall) in the inflation rate raises (reduces) stock prices. Even if the real values of households holding stock do not change, the nominal capital gains increase (decrease). The effective tax rate on capital gains rises (falls) and the post-tax real rate of return falls (rises).

Suppose that the rise (fall) in the inflation rate, *Dp,* raises (reduces) corporate assets (capital stock) by the same amount, but does not affect corporate debt. This causes the nominal values of corporate equity, whose ratio to assets is *(1-b)*, to increase (decrease) by *Dp/(1-b)*, and the post-tax real rate of return to fall (rise) by t_{cg} *Dp/(1-b)*. Assuming that the household investment ratio of stock is *(1-b)* as in (iii), the change in the post-tax real rate of return amounts to

$$\Delta r = -\ t_{cg} \frac{1}{1-b}(1-b)\,\Delta p\ .$$

Summation of the above four factors yields the change in the post-tax real rate of return (*Dr*) and the change in the effective tax rate (*Dt₁*), caused by the shift of the inflation rate (*Dp*), as

$$\Delta r = \left(-t_{corp} \frac{d}{N+p+d} \Delta p + t_{corp} b \Delta p \right) \{1-(Dt_d + (1-D)t_{cg})\} - t_b b \Delta p - t_{cg} \Delta p \quad (2\text{-}3)$$

$$\Delta t_1 = -\frac{\Delta r}{R}\ . \qquad (2\text{-}4)$$

C. Estimations of the returns on corporate capital and the effective tax rates

This paper introduces two quantitative methods to estimate the rates of returns and the effective tax rates[3]. The first method (Method 1) obtains them as the average pretax rate from 1985 to 1998. The other (Method 2) calculates them from the average post-tax interest rate for the same periods with an assumption on the risk premium.

Method 1

As a baseline, it is necessary to have the rate of return, which is neutral to cyclical movements and largely consistent with the zero inflation rate. The sample period from 1985 to 1998 is chosen on these grounds, since the period covers several business cycles and observes reasonably stable inflation rates—the average inflation rate in terms of the consumer price index (CPI) during the period was 1.08 percent, which can be regarded as almost zero inflation rate given the similar size of inflation bias (0.9 percent in Shiratsuka [1999]).[4]

Based on the data of the non-financial sector in the SNA[5] (System of National Accounts), the pretax rate of return is calculated as[6]**:**

R = (receipts[7] – dividend incomes) / (assets – corporate shares) . (2-5)

This paper uses the tax rates in fiscal year 2000 (see Chart 2 for further details) to calculate the post-tax rate of return and the effective tax rate. From equations (2-5), (2-1) and (2-2) respectively, the following values can be obtained:

pretax rate of return	R: 4.51%,
post-tax rate of return	r: 2.83%,
effective tax rate	t_1: 37.17%.

[3] This paper assumes that a change in inflation does not affect corporate finance behavior such as the ratio of debt to equity.
[4] As mentioned above, the sample period of the EPA [1999] is 1975 to 1997, which yields the higher average inflation rate.
[5] Based on the SNA68 instead of the more recent SNA93.
[6] Since the receipts in the numerator do not include capital gains from stock, dividend incomes and corporate shares (stock which corporations hold) are subtracted.
[7] The sum of operating surpluses and property income.

Equations (2-3) and (2-4) then yield the following impacts of the changes in the inflation rate.

	Rise in the inflation rate (from 0 to 2%)		Fall in the inflation rate (from 0 to –2%)	
Post-tax rate of return	2.24%	(-0.60%)	3.43%	(+0.60%)
Effective tax rate	50.36%	(+13.19%)	23.98%	(-13.19%)

Figures in parentheses indicate the level changes (% points).

If the inflation rate rises by two percentage points, the effective tax rate on return rises by around 13 percentage points and the post-tax rate of return falls by 0.60 percentage points. The decomposition of the rate of return shows that the effects are (i) –0.56 percentage points by the decrease in corporate depreciation allowances, (ii) +0.36 percentage points by the increase in corporate interest payments, (iii) –0.20 percentage points by the increase in household interest receipts and (iv) –0.20 percentage points by the rise in household holding stock.

Method 2

Method 2 goes the other way round—it first calculates the post-tax rate of return from the average interest rate from 1985 to 1998 with an assumption on the risk premium, and then derives the pretax rate of return (Chart 3).

The post-tax rate of return, which households receive, can be expressed as:

$$r = b\, i_b + (1-b)(i_b + r),$$

where i_b is the post-tax interest rate, and r is the risk premium.

Method 2 obtains the pretax rate of return in the following ways.

(1) debt: the pretax return to debts is equal to $b\, i_b(1+t_b)$

(2) equity: the pretax return to equity is equal to X which satisfies

$$X(1-t_{corp})\{D(1-t_d) + (1-D)(1-t_{cg})\} = (1-b)(i_b + r).$$

Summation of (1) and (2) yields:

$$R = b\, i_b(1+t_b) + (1-b)(i_b + r)/\{(1-t_{corp})\{ D(1-t_d) + (1-D)(1-t_{cg})\}\}.$$

Assuming the risk premium is one percent, the average post-tax interest rate of 4.4 percent gives (see Chart 3 for more details)

pretax rate of return	R: 8.17%,
post-tax rate of return	r: 4.90%,
effective tax rate on return	t_1: 40.06%.

From equations (2-3) and (2-4), the post-tax rate of return and the effective tax rate after the shifts of inflation become as follows:

	Rise in the inflation rate (from 0 to 2%)		Fall in the inflation rate (from 0 to -2%)	
Post-tax rate of return	4.38%	(-0.52%)	5.42%	(0.52%)
Effective tax rate	46.39%	(+6.33%)	33.73%	(-6.33%)

Figures in parentheses indicate the level changes (% points).

The change in the effective tax rate, Dt_1, in Method 1 (about 13 percent) is more than double compared with that in Method 2 (a little more than six percent). This is because the rates of returns are estimated lower in Method 1 than Method 2.

The same size shift in the inflation rate (i.e., two percentage points) brings roughly same size shifts in the post-tax rate of return, *Dr*. However, Dt_1 in Method 1 becomes larger owing to the lower level of *R* in equation (2-4).

Although it is very difficult to judge which of the above two methods is more plausible, this paper takes Method 1 as more reasonable. This is mainly because there seems to be no reason to assume that the risk premium is one percent. In addition, the calculated interest rate of 5½ percent (pretax basis) might be overestimated because the rate of return might not have fully reflected the recent trend of disinflation and low growth.

D. International comparison

The rate of corporate capital return in Japan (4½ percent, Method 1) is much lower than those in other industrial countries (Chart 4). For example, Feldstein [1999] estimates about 9 percent for the United States, which is more or less in line with those in the United Kingdom, Spain, and Germany. This implies that the same amount of change in the inflation rates (say, from zero to two percent) lead to a larger change in the effective tax rate in Japan than those in other countries.

The wide gaps of the rates of returns between Japan and other industrial countries are thought to be due to the combination of several factors: Japan has suffered from the long-lasting recessions of the 1990s and the rate of return has been progressively lowered. However, the household sector has been insensitive to such changes in the return and has kept its high savings ratio. Furthermore, even after financial liberalization—including that on capital outflows—Japan’s massive savings has not flowed out from the country (stemming, perhaps, from the so-called home bias regarding global investment). This has prevented the international arbitrage of real interest rates among those countries. As a result, Japan has a lower rate of corporate capital return.

III. Impact of the Shift of Inflation on the Cost of Housing Investment

As seen above, inflation reduces the corporate capital return (i.e., return on non-housing investment), and then makes housing investment relatively favorable. Consequently, inflation may lead to excessive demand for housing.

A. Cost of housing investment

The cost of housing investment consists of (i) the corporate capital return, which households could earn unless they invested in housing stock (opportunity cost), (ii) the cost of maintenance, and (iii) depreciation of housing stock. The costs with/without taxes then become:

- the cost of housing investment without taxes: *RH*,

$$RH = R + m + d,$$

- the cost of housing investment with taxes: *rh*,

$$rh = m(i\text{-}q) + (1\text{-}m)(r+p) + t + m + d - p, \qquad (3\text{-}1)$$

where m is the maintenance cost of housing stock; d is the rate of depreciation of housing stock; m is the ratio of the mortgage to housing stock; i is the interest rate on the mortgage; q is the ratio of tax credit to the mortgage; and t the rate of property tax (see Chart 5 for further details).

The government adopts tax incentive (such as tax credit to the mortgage) to promote owner-occupied housing investment, which may end up excessive investment. Tax incentive for housing differs across countries. In Japan, the government allows to deduct a certain portion of the mortgage balances from income tax of households (tax credit).

B. Change in the cost of housing investment due to the shift of inflation

The rise in the inflation rate affects the cost of housing investment through two channels in equation (3-1). One is a rise in the interest rate of the mortgage. The other is a change in revenues from corporate capital investment that households could earn if they did not invest in housing stock. The tax incentive remains constant under the Japanese tax credit system.

The effect of the shift of inflation is

$$d(rh)/dp = m\ di/dp + (1\text{-}m)\ d(r+p)/dp - 1,$$

where $di/dp=1$ (the Fisher effect). Denote the rates of the corporate capital return before and after the shift of inflation (say, from zero to two percent), r and r',

$$dr/dp = (r'\text{-}r)/Dp.$$

The cost of housing investment after the shift of inflation, rh', is calculated as

$$rh' = rh + \{(d(rh)/dp\}\ Dp$$
$$= rh + (1\text{-}m)(r'\text{-}r).$$

The rise in the inflation rate decreases corporate capital return ($r' < r$), and then makes housing investment more favorable ($rh' < rh$).

Based on the parameters in Chart 5, the cost of housing investment becomes 14.98 percent under the zero inflation rate in Method 1. Compared with the cost of 15.31 percent under no taxes, this implies that the tax incentive rate amounts to 2.16 percent (=(15.31-14.98)/15.31). When the rate of inflation rises (falls), the cost of housing investment and the tax incentive rate change as described in the following table.

	Rise in inflation (from 0 to 2%)		Fall in inflation (from 0 to –2%)	
Cost of housing capital investment	14.71%	(-0.27%)	15.25%	(+0.27%)
Tax incentive rate[8]	-3.95%	(-1.79%)	-0.37%	(+1.79%)

Figures in parentheses indicate the level changes (% points).

The rise (fall) in the inflation rate makes housing investment more (less) favorable. However, the size of the changes in the tax incentive rate of housing investment is small compared with that in the tax rate on corporate capital return.

C. International comparison

Compared with other industrial countries, the tax incentive rate of housing investment in Japan is relatively small (Chart 6). The tax incentive rate under the zero inflation rate amounts to only a little more that two percent in Japan, in comparison with about 20 percent in the U.S. and about 25 to 40 percent in European countries. The change in the tax incentive rate resulting from the shift of inflation (from zero to two percent) is about 1¾ percentage points, smaller than those in other countries: more than three percentage points in the U.S. and two to three percentage points in European countries except for Germany.

These differences are attributable to two reasons. First, the scale of tax credit (tax incentive) is smaller in Japan. Second, the tax incentive in Japan is neutral to a change in inflation rate[9]. The reason for the latter: in Japan, the tax credit is applied to a certain portion of the mortgage balance, which is not altered by a change in the current inflation. Meanwhile, in the U.S., for example, tax deduction depends on nominal interest payments for the mortgage—a rise in inflation increases both nominal interest payments and the amount of tax deduction, and then reduces both real interest payments and the cost of housing investment.

IV. Impact of the Shift of Inflation on Labor Income Tax

A change in nominal labor income (due to inflation) alters the effective tax rate on labor income because of the following two reasons: First, its tax schedule is progressive (i.e., the higher the nominal income becomes, the higher tax rate is applied). Second, there exist several tax deductions (e.g. basic allowance, allowance for spouse, allowance for dependants and deduction for employment income). This section estimates the effect of inflation on labor income tax in accordance with Mishan and Dicks-Mireaux [1958] and Hayashi [1995].

A. Model of the progressive structure of income tax and the effect of inflation

To estimate the effect of inflation on labor income tax, the following exponential form is assumed to approximate the progressive structure of income tax:

$$t = a\, y^b,$$

8 Negative tax rates mean incentive to housing investment in view of the tax system.

9 In Japan, the interest rate paid on the mortgage is not much lower than corporate capital return. Therefore, housing investment becomes less advantageous. This could be another reason, in addition to the above two mentioned in the text.

where y is labor income and $t(y)$ is the amount of tax payments. Labor income, y is ordered so that it becomes a continuous function of n, where the nth individual is arranged from the lowest income to the highest:

$$y = f(n).$$

The aggregate income, Y, and the aggregate income tax payments, T, are

$$Y = \int_0^N f(n)dn,$$

$$T = \int_0^N a[f(n)]^b dn,$$

where N is the population in the country.

Because the shift of the inflation rate changes labor income to $(1+Dp)y$, the aggregate income, Y', and the aggregate tax payments, T', become

$$Y' = \int_0^N (1+\Delta p) f(n)dn = (1+\Delta p)Y,$$

$$T' = \int_0^N a[(1+\Delta p) f(n)]^b dn = (1+\Delta p)^b T.$$

The following equation shows the average tax rate after the shift of the inflation rate:

$$T'/Y' = (1+Dp)^{b-1}\ T/Y \text{ » } T/Y + (b-1)\ Dp\ T/Y. \qquad (4\text{-}1)$$

Because the marginal tax rate t_{mar} can be expressed as:

$$t_{mar} = \int_0^N \frac{\partial t}{\partial y} dn = \int_0^N ab(f(n))^{b-1} dn,$$

the marginal tax rate after the shift of inflation becomes

$$t'_{mar} = \int_0^N \frac{\partial t'}{\partial y} dn = \int_0^N ab\{(1+\Delta p) f(n)\}^{b-1} dn$$
$$= (1+\Delta p)^{b-1} t_{mar} \approx t_{mar} + (b-1)\Delta p\, t_{mar}. \qquad (4\text{–}2)$$

B. Estimation of a factor of the exponential form

Following Nishizaki and Nakagawa [2000], this section estimates the relationship between tax payments[10] and labor income, taking account of the progressive tax schedule and the tax deductions. Tax payments are based on the statutory tax rates in FY2000. The estimation is based on a family consisting of two parents with two children. Chart 7(1) shows the relationship between pretax labor income and the average/marginal tax rates.

Estimation based on the tax schedule in Chart 7(1) yields the following results (Chart 7(2)).

log(payments of labor income tax) = -11.16 + 2.24 log(pretax labor income) ,

(-72.68) (112.6)

where adj.R^2=0.93 and the figures in parentheses are t-values.

Thus, the factor of the exponential form, b, becomes 2.24.

[10] Sum of national and local taxes.

C. Estimation of the effect of inflation on the labor income tax rate

The change in the average/marginal tax rates resulting from the shift of inflation by *Dp* is *(b-1) Dp t*, from equations (4-1) and (4-2), where *t* is either the average or marginal tax rate. The shift of the inflation rate from zero to two percent bring an increase in the labor income tax rate by

$$Dt = (2.24-1)*0.02*0.1$$

$$=0.00248\ (0.2\%)$$ [11],

which is much smaller than the change in the tax rate on corporate capital return (about 13 percent). Thus, the effect of inflation on the labor income tax is almost negligible.

V. ESTIMATION OF THE COST OF INFLATION BY A GENERAL EQUILIBRIUM MODEL

This section discusses the distortional effects of an increase in the inflation rate through a rise in the effective tax rate by applying a general equilibrium model of Abel [1997] [12], which is an extension of Sidrauski's [1967] model. By means of a "general" framework, Abel models the behaviors of households, firms, and the government.

The main idea of Abel's model is summarized in Chart 8. Consider the case where the inflation rate rises. Because the rise in the inflation rate increases the tax rate on corporate capital return, household investment decreases, and both capital stock and production decline. This in turn decreases household income and consumption in the long run. Furthermore, an increase in the cost of holding money balances reduces household utility. Meanwhile, an increase in the government revenue is supposed to partially offset the above negative impacts on the household utility.

The first part in this section introduces Abel's model to describe the behaviors of households, firms, and government. The next part discusses how household behavior changes by the shift of the effective tax rate (resulting from the shift of the inflation rate).

A. Setup of a general equilibrium model

As mentioned above, Abel's model consists of the three sectors: households, firms and the government. Each sector is modeled as follows:

Household sector

The household sector is assumed to have the following utility, which comprises consumption, money balances, and labor supply:

$$\sum_{t=0}^{\infty} b^{t} u(c_t, m_t, l_t) = \sum_{t=0}^{\infty} b^{t} \left(\frac{c_t^{\;1-r}}{1-r} + f\,\frac{m_t^{\;1-d}}{1-d} - y\,\frac{l_t^{\;1+h}}{1+h} \right), \qquad (5\text{-}1)$$

[11] The 10 percent labor income tax rate is consistent with both the weighted average of the marginal tax rates by persons and the weighted average of the average tax rates by tax payments in Chart 7(3). See footnote 21 for further discussion.
[12] In fact, a partial equilibrium model of Feldstein [1999] appears more popular than Abel's model among empirical economist. However, this paper uses Abel's model because of its clarity. See Appendix B for the estimated results of Feldstein's model and the comparison with those of Abel's model.

where b: discount rate; r, d, h: coefficients of relative risk aversion on consumption, money, and labor (reciprocals of the elasticity of intertemporal substitution); f, y: positive constants; c, m, l: consumption, real money balances, and labor supply (per capita); and subscript t denotes the time period t.

The household sector faces the following budget constraint, where household income consists of labor income, capital income, and interest income from holding government bonds:

$$\begin{aligned} & c_t(1+t_c)+(1+n)(k_{1,t+1}+k_{2,t+1})+(1+n)\mathrm{p}_{t+1}m_{t+1}+(1+n)\mathrm{p}_{t+1}b_{t+1} \\ & \quad = (1\text{-}t_w)w_t l_t + R_{1,t}k_{1,t} + R_{2,t}k_{2,t} + \{1+i_{b,t}(1-t_b)\}b_t + m_t\,, \end{aligned} \qquad (5\text{-}2)$$

where n: population growth rate; k_1, k_2, b: corporate capital stock, housing stock, and real stock of government bonds (per capita); w, t_c,, t_w: real wage, consumption tax rate, labor income tax rate; R_1: post-tax rate of corporate capital return; R_2: post-tax rate of return to housing investment; $i_{b,t}$: pretax interest rate of bonds; t_b: interest income tax rate; and p_{t+1}: inflation rate ($=p_{t+1}/p_t$).

The following equations represent a solution that maximizes the utility of equation (5-1) subject to (5-2) with the Lagrange multiplier of $b^t l_t$:

$$\begin{cases} (c_t):\ c_t^{-r} = (1+t_c)\,l_t \\ (k_{i,t}):\ b\,l_t R_{i,t} = l_{t-1}(1+n) \\ (m_t):\ bf\,m_t^{-d} + b\,l_t = l_{t-1}(1+n)p_t \\ (b_t):\ b\,l_t\{1+i_{b,t}(1-t_b)\} = l_{t-1}(1+n)p_t \\ (l_t):\ -y\,l_t^{h} + l_t(1-t_w)w_t = 0 \end{cases} \qquad (5\text{-}3)$$

In a steady state, equations (5-3) become as follows[13,14,15]:

$$\begin{cases} R_i = \dfrac{1+n}{b}, \quad where\ i = 1, 2 \\ 1+i_b(1-t_b) = \dfrac{1+n}{b}p \\ \dfrac{f\,m^{-d}}{c^{-r}}(1+t_c) = i_b(1-t_b) \\ \dfrac{y\,l^h}{c^{-r}}(1+t_c) = (1-t_w)w \end{cases} \qquad (5\text{-}4)$$

Corporate sector

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[13] It is necessary to satisfy $p > b/(1+n)$ from the zero interest rate constraint of the nominal interest rate.

[14] The second equation in (5-4) represents the Fisher effect regarding the post-tax interest rate. Assuming the tax rate on interest income is equal to 20 percent, the rise in the inflation rate by two percentage points raises the post-tax nominal interest rate by the same amount and the pretax nominal interest rate by two and a half percentage points. However, because debtors borrow their funds by the payments of the pretax interest rate, it may not be realistic that the pretax nominal interest rate makes greater changes than the inflation rate by the effects of tax.

[15] In this model, tax on interest income does not affect estimated results since the tax is assumed to be lump-sum.

A Cobb-Douglas type production function of labor, corporate capital and housing stock is assumed, where y is per capita production[16].

$$y = Ak_1^{a_1} k_2^{a_2} l^{1-a_1-a_2}, \tag{5-5}$$

where a_1 and a_2 are shares of corporate capital and housing stock respectively.

In a competitive market, maximization of corporate profits yields:

$$w = (1-a_1-a_2)y/l \tag{5-6}$$

$$R_i = (1-t_i)a_i y/k_i + 1, \quad \text{where } i=1, 2. \tag{5-7}$$

Government

Suppose a central back is a part of unified government[17]. The government finances its expenditures by taxes (on corporate capital return, labor income, and consumption) and seigniorage. The government levies a negative tax (transfer) to households for housing investment. This model does not take progressive tax on labor income into account. Given almost negligible impact on the effective tax rate (Section IV), the simplification must not alter the estimated results below much.

Budget constraint of the government is

$$\begin{aligned} t_c c + t_w(1-a_1-a_2)y + t_1 a_1 y + t_2 a_2 y + \{(1+n)p - 1\}m \\ = g + \{1 + i_b(1-t_b) - (1+n)p\}b, \end{aligned} \tag{5-8}$$

where g is per capita government expenditure. Eliminating i_b from equation (5-4), equation (5-8) becomes

$$\begin{aligned} t_c c/y + t_w(1-a_1-a_2) + t_1 a_1 + t_2 a_2 + \{(1+n)p - 1\}m/y \\ = g/y + (b^{-1} - 1)(1+n)p\, b/y. \end{aligned} \tag{5-9}$$

B. Steady state equilibrium

From equations (5-4) to (5-7) and (5-9), the following equations can be derived:

$$c + n(k_1 + k_2) = (1 - g/y)y \tag{5-10}$$

$$\left\{ \begin{aligned} & k_1 = \left[\left(\frac{1+n}{b} - 1 \right)^{-1} (1-t_1)a_1 AB^{a_2} \right]^{\frac{1}{1-a_1-a_2}} l, \quad \textit{where } B \equiv \frac{(1-t_2)a_2}{(1-t_1)a_1}, \\ & k_2 = Bk_1, \\ & c = (1-g/y)AB^{a_2} k_1^{a_1+a_2} l^{1-a_1-a_2} - nk_1(1+B), \\ & m = \left[\frac{1}{f} \left(\frac{1+n}{b} p - 1 \right) \frac{c^{-r}}{1+t_c} \right]^{\frac{-1}{d}}, \\ & l = \left[\frac{1}{y}(1-t_w)(1-a_1-a_2) \frac{y}{l} \frac{c^{-r}}{1+t_c} \right]^{\frac{1}{h}}. \end{aligned} \right. \tag{5-11}$$

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[16] It might be better to include housing stock not in the production function but in the utility function. However, this does not make difference in this model, as an increase in housing stock raises production and enhances household consumption as a consequence.

[17] In this model, the inflation rate is determined exogenously.

Substitution of the initial exogenous values of m^0, y^0, and l^0 gives the tax rate on labor income, t_w, and parameters f, A, y. This analysis assumes l^0=1 without loss of generality.

C. Change in the household consumption level due to the shift of inflation

Suppose each effective tax rate changes by Dt when the inflation rate changes. The effective tax rates on corporate capital return and on housing investment are those obtained in Sections II and III. The government needs to increase or decrease taxes to satisfy its budget constraint. If the government multiplies all the tax rates by the same factor, q, then the effective tax rates after the shift of the inflation rate become as follows:

$$\begin{cases} t_c = t_c q \\ t_w = (t_w + Dt_w)q \\ t_1 = (t_1 + Dt_1)q \\ t_2 = (t_2 + Dt_2)q \end{cases} \tag{5-12}$$

Substitution of equation (5-12) to equations (5-7) to (5-11) gives the value of q and the values after the shift of the inflation rate such *as* c^{new}, m^{new}, l^{new} and k_1^{new}.

Denote the consumption level $c*$ which yields the same level of utility as that in the new steady state.

$$u(c*, m^0, l^0) = u(c^{new}, m^{new}, l^{new}) \tag{5-13}$$

From equation (5-1), $c*$ can be expressed as

$$c* = \left((1-r)\left[u(c^{new}, m^{new}, l^{new}) - f\,\frac{(m^0)^{1-d}}{1-d} + y\,\frac{(l^0)^{1+h}}{1+h} \right] \right)^{\frac{1}{1-r}}. \tag{5-14}$$

Then, $(c*-c^0)/c^0$ can be used as a measure of the cost of inflation, where c^0 is the initial consumption level.

VI. ESTIMATED RESULTS

A. Estimated results of the cost of inflation

Substitution of the parameters[18,19,20,21] in Chart 9 to the previous equations provides

[18] This estimation assumes b (the discount rate) is 0.97, almost the same as the reciprocal of the post-tax rate of return. The inflation rate must be above minus three percent to satisfy the zero interest rate constraint of the nominal interest rate (because n, the population growth rate, is set to be zero). h (the reciprocal of the elasticity of labor) is assumed to be 10, although there is little consensus in academia regarding how much it is. For instance, Shimada [1986] obtains nearly zero elasticity of labor to wages for housewives, while Higuchi [1991] obtains 1.9 elasticity of labor to wages, which appears higher than that in the U.S. d (the reciprocal of the elasticity of money) is supposed to be 10, in accordance with Shiratsuka [2000] who estimates the elasticity of money to interest rates around 0.1. r (the reciprocal of the elasticity of consumption) is set to be 4, as Abel [1997].

[19] Note that per capita production, y, is net national product because this estimation uses net capital stocks.

[20] This paper calculates a_1 and a_2 to satisfy $k_2/k_1=\{(1-t_2)\, a_2/(1-t_1)\, a_1\}$ under the condition of a_1+a_2=0.3 and k_2/k_1=0.528 (FY1998, "National Accounts").

[21] The theoretical meaning is different between the tax rates in equation (5-2) and equations (5-8) and (5-9). However, the actual values are almost identical. The labor income tax rate in equation (5-2) corresponds to the weighted average of the marginal tax rate by persons and amounts to 10.7 percent

the estimated effects of the shift of inflation, which is summarized in Chart 10. The columns from (1) to (3) indicate individual effects of changes in seigniorage (money demand), the tax rate on corporate capital return, and the cost of housing investment. Column (4) combines all three effects.

Column (4) in Chart 10 shows that the rise in the inflation rate from zero to two percent reduces the consumption level by 3½ percentage points and the fall in the inflation rate from zero to minus two percent raises the consumption level by 4¼ percentage points. Changes in the tax rate on corporate capital return have much larger impacts than the other two effects (seigniorage (money demand) and housing investment)[22]. This estimation supposes no change in the labor income tax rate due to inflation, as the rise in the labor income tax rate by 0.25 percentage points (Section IV) does not have large effects (Chart 12-2(3a)).

The rise in the effective tax rate on corporate capital return reduces corporate capital stocks and production. Household income and consumption decrease. In the meantime, the increase in government revenue from corporate capital return allows government to reduce the tax rate. In this model, the fall in the labor income tax rate induces the labor supply to increase.

Dominance of the impacts from changes in the tax rate on corporate capital return leads to a much larger cost of inflation (i.e., the fall in the consumption level caused by the rise in the inflation rate) in Japan than those in other countries (Chart 11). As seen above (Section II.D), a change in the effective tax rate on corporate capital return is larger in Japan reflecting the low rate of corporate capital return.

B. Robustness of the estimated results

Overall, Charts 12-1 and 12-2 show that the above obtained results are reasonably robust against different assumptions on the parameters. In particular, the changes in the corporate debt ratio, the coefficients of relative risk aversion (on consumption, labor and money) and the level of government debt have little effect on the previous results (Chart 12-1 and 12-2(2)).

However, the estimated results are sensitive to the following factors: (i) the pretax rate of corporate capital return, *R*; (ii) the change in the government expenditure after the shift of inflation; and (iii) the choice regarding which tax to cut. These factors are explained a little more fully below[23,24].

(Chart 7). On the other hand, the labor tax rate in equations (5-8) and (5-9) corresponds to the weighted average of the average tax rate by tax payments and amounts to 11.2 percent (Chart 7). The difference between the tax rate (14.2 percent) obtained endogenously from Abel’s model and the above tax rates (10.7 and 11.2 percent) can be attributed to several tax items (e.g. tax on oil, revenue-stamp duty, and so on) other than labor income tax.

[22] Column (1) in Chart 10 is consistent with Mankiw [1987] who points out the merit of inflation. However, the effect is small compared with the adverse effect of the tax on corporate capital return.

[23] Though the effect due to change in the capital gains tax rate (from 0.1 to 0.26) is also large, this case should be considered as extreme—in a sense, the 0.26 tax rate may look unrealistic because taxpayers can select the option to pay the taxes of 1.05 percent on total proceeds instead of the tax of 26 percent on capital gains, and the government levies tax only when households sell the stock.

[24] Chart 12-2 (3d) is the case in which a negative relationship is assumed between the labor share of income and the rate of inflation as in Chart 13, instead of the constant share of labor. In that case, the rise in the effective tax rate caused by inflation heightens the pretax share of capital, which moderates the decrease in capital stock due to the higher inflation. Thus, the consumption level falls by smaller amount—depending on the parameter values, it might increase. As indicated in Chart 12-2 (3d) if the share of the non-housing capital, a_1, increases by 0.002 or 0.004 with the rise in inflation by two

(i) Pretax rate of corporate capital return

Method 1 obtains the rate of corporate capital return as 4½ percent from the data of 1985 to 1998. However, the rate might be underestimated because of cross-share holdings in Japan. Furthermore, once Japan undergoes structural reforms, including changing management styles to aim at higher profitability, the rate might rise in the future. If the long-run rate of return rose to seven percent[25] or 10 percent, the fall in consumption level would be little more than two percentage points or around 1½ percentage points, which is smaller in absolute value than the previous result of 3½ percentage points (Chart 12-1).

(ii) Change in the government expenditure

Suppose the government does not reduce taxes but increases its expenditure after government revenue increases due to inflation. If the government increases the ratio of its expenditure to GDP by one percentage point due to the two-percentage-point rise in the inflation rate, the cost of inflation jumps to 5.63 percent (Chart 12-2(3b)). This is because this model assumes that government expenditure does not increase the household utility in itself. On the contrary, the tax cut, as seen above, somewhat offsets the rise in the effective tax rates and hence contributes toward an increase in its utility.

(iii) Choice of tax cuts

This model supposes that the government reduces all tax rates uniformly when the government revenue increases due to inflation. If the government reduces only the tax on consumption and labor income, with the exception of the tax on corporate capital return, the costs of inflation become larger (Chart 12-2(3c)). On the other hand, if the government can cancel the rise in the tax rate on capital return by means of accelerated depreciation or cuts of tax rates, the cost of inflation becomes almost zero.

VII. CONCLUSION

This paper shows that a rise in the inflation rate increases the effective tax rate and distorts resource allocation. Conversely, the fall in the inflation rate provides benefits to the society. The costs and benefits in Japan are found to be larger than those in other industrial countries, because of Japan’s low rate of corporate capital return. Consequently, if the other conditions are identical across countries, Japan’s optimum inflation rate may be lower.

However, the actual benefits of deflation (disinflation) may well be much smaller than the above estimated results. Several important caveats seem worthwhile to mention here.

First, all the effects due to the shift of the inflation rate and the tax rates are attributed to only household behavior (consumption and investment) in Abel’s model. A firm is supposed to be just a mediator in the capital and the labor markets and be entirely controlled by households. In other words, a firm is something like a veil. The fall in the inflation rate causes the rate of return (which is fully distributed to households) to rise and then corporate investment to increase.

percentage points, then change in the consumption level becomes –1.25 percent or +1.08 percent.

[25] The rate of corporate capital return amounts to 6.3 percent when it is defined as “corporate operating surplus” divided by “net fixed assets + inventories + land” (average from 1985 to 1998, real, “National Accounts”).

However, the decision of corporate behavior may depend on firms themselves rather than on households. Managers are often observed to make their decisions on investment so as to maximize their nominal accounting profits. When the inflation rate declines deeply below zero, their profits plunge. In that case, corporate investment shrinks. Thus, the actual increase in investment caused by disinflation might be much smaller than the previous estimated results.

Second, it is important to recognize the comparative static nature of the analysis. Abel's model compares two long-run equilibrium states before and after the shift of inflation. It is beyond the scope of this model to analyze a question regarding dynamic adjustments; a question like whether there is a single and stable path toward a new equilibrium state or how much short-run costs are incurred in a transitional stage. Although it is true that deflation entails a temporary decline in production and employment, as shown in the Phillips curve, those sorts of short-run costs are ignored in this analysis.

Third, the assumption of the Fisher effect might not hold. The paper assumes the perfect foresight and the Fisher effect (that is, when the inflation rate changes, both the nominal rate of return and the nominal interest rate change by the same amount). These assumptions seem appropriate in the long run, but may be improper in the short run. Moreover, given the zero bound of the nominal interest rate, a case may arise in which the interest rate cannot be lowered as much as the Fisher effect proclaims. In that case, the cost of deflation might be larger.

Indeed, the optimum inflation rate depends not only on tax but also on other factors, including the rigidity of nominal wages and prices, the uncertainty of inflation, the relative price variability, and the zero interest rate constraint of the nominal interest rate. The cost/benefits of **deflation** aside, however, this paper reveals that, from the viewpoint of tax and resource allocation, there is a considerable cost associated with **inflation**. Furthermore, the paper highlights the importance of the rate of corporate capital return and the tax system with respect to the corporate tax. These are policy implications of this paper.

(APPENDIX A) Tax Rate on Dividend Income

Calculation of the national and local tax rates on dividend income based on the FY2000 tax schedule, taking the dividend tax credit into account. There are four types of dividend income taxes depending on the amount of dividend income: (i) comprehensive tax; (ii) optional withholding tax; (iii) withholding tax; and (iv) tax on investment trust etc. In the case of comprehensive taxation, the tax withheld on distribution is credited against personal income tax liability.

(1) Marginal tax rate in comprehensive taxation

total income	people	dividend income	tax credit	tax rate	tax levied on dividend income
thousand yen per capita	persons	million yen	million yen	%	million yen
below 700	42	6	1	10.00	0
1,000	224	25	3	10.00	0
1,500	2,333	167	17	10.00	0
2,000	8,042	573	57	10.00	0
2,500	11,878	1,098	110	10.00	0
3,000	14,959	1,556	156	10.00	0
4,000	30,716	3,844	384	10.00	0
5,000	27,903	4,391	439	10.00	0
6,000	24,776	4,899	490	17.97	390
7,000	22,194	5,406	541	20.00	540
8,000	19,471	5,723	572	20.00	573
10,000	31,023	11,694	1,169	20.00	1,170
12,000	22,424	11,827	640	24.47	2,254
15,000	29,319	22,389	1,219	30.00	5,498
20,000	33,487	37,762	2,047	30.00	9,282
30,000	32,312	56,978	2,849	36.62	18,019
50,000	22,650	71,108	3,555	37.00	22,755
above 50,000	12,976	145,699	7,285	37.00	46,624
total	346,729	385,144	21,534	27.81	107,104

Notes: 1. Tax levied on dividend income = (dividend income)*(tax rate) - tax credit
2. The tax rate is weighted average of the marginal tax rate by taxable income.

A similar calculation of the local tax rates on dividend income gives an average effective tax rate of 11.07%.

(2) Dividend income taxes

	weight	tax rate national	tax rate local	total tax rate
comprehensive tax	0.15	27.81	11.07	38.88
withholding tax, optional	0.03	35.00	11.07	46.07
withholding tax	0.74	20.00	0.00	20.00
on investment trust	0.09	15.00	5.00	20.00
				23.44 %

Note: Weights are calculated from Statistics of National Tax Administration.

(APPENDIX B) FELDSTEIN'S MODEL

This Appendix calculates the costs of inflation by a model developed by Feldstein [1999].

In comparison with Abel's model, Feldstein's model can be characterized as follows:

- The costs of inflation are represented by **deadweight losses**, whereas in Abel's model they are measured by a change in the household consumption.
- Since Feldstein's model is based on a **partial equilibrium** framework, four effects of changes in inflation (i.e., consumption, housing investment, money demand and debt service) are separately estimated and added together without investigating the consistency among them. On the other hand, Abel's model assesses all these effects in a consistent manner by a general equilibrium framework.
- The model contains both "young" and "old" periods. In contrast, Abel's model is based on the Ramsey economy, in which the household lives for an infinite time horizon. The time frame of Feldstein's model is thought to be shorter than that of Abel's model.
- It takes account neither production nor labor into account, and hence accumulation of capital does not increase production.
- Pretax return is predetermined. Post-tax return varies, depending on the inflation rate and the tax rate. In Abel's model, post-tax return is predetermined by deep parameters such as the discount rate of the household sector.

Chart 14 summarizes the estimated results of Feldstein's model. A rise in the inflation rate by two percentage points leads to a cost of 1.40 percent of GDP. On the other hand, a decrease in the inflation rate by the same amount yields the benefit of 0.13 percent of GDP. The estimated costs of inflation in Feldstein's model are smaller than those in Abel's model. Moreover, deflation can be costly depending on a parameter of tax policy (a parameter of the deadweight loss coefficient), l.

These differences of the estimated results are rooted in the characteristics of these two models. Abel's model takes the effects of corporate production into account, whereas Feldstein's model does not. Because a decrease in the effective tax rate due to disinflation increases capital stock and production, the estimated results of the benefits of deflation in Abel's model are much larger than those in Feldstein's model. Moreover, the results of Feldstein's model hinge upon a rather ad hoc assumption on l, whose equivalence cannot be found in Abel's model.

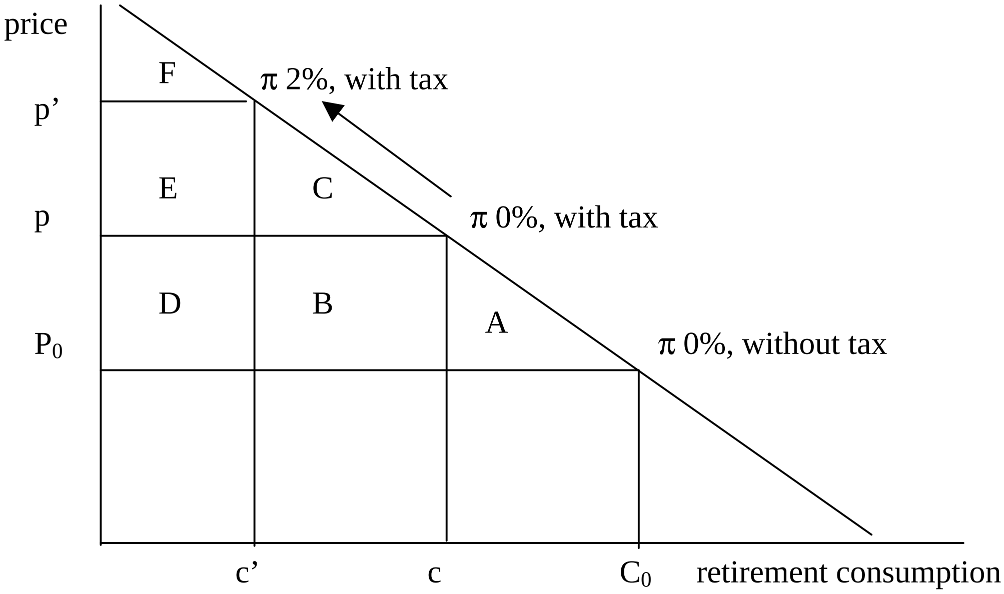
A. Setup of Feldstein's model

Intertemporal substitution of consumption

An individual is supposed to live for two periods (young and old). When he is young, he receives income and saves part of it, *s*. He retires after *T* years, and consumes $c=(1+r)^T s$ from the interest income of his saving. In this framework, saving at the young period can be regarded as the expenditure on the future goods/services at a price of $p=(1+r)^{-T}$.

The individual's consumption level after retirement is a function of the price, *p*. The figure below shows a compensated demand curve. Tax and inflation reduce the post-tax rate of return and increase the price. Thus, consumption after retirement decreases.

(Fig. B- 1) Retirement consumption when the inflation rate rises



Case	Consumer surplus	Tax revenue	Deadweight loss
No tax, No inflation	A+B+C+D+E+F	0	0
Tax, No inflation	C+E+F	B+D	A
Tax, Inflation	F	D+E	A+B+C

Denote the price as P_0 and retirement consumption as C_0 under no inflation and no tax. In this case, consumer surplus is equal to the area from A to F in the above figure. Under no inflation but with tax, the price increases to *p* and retirement consumption decreases to *c*. Consumer surplus declines to the area, C+E+F, and the government receives tax revenue of B+D. If the government distributes the increased revenue to consumers in the form of income transfer without distortion (say, by negative lump-sum tax), then total deadweight loss becomes the area of A. An increase in the inflation rate raises the price to *p’* and reduces retirement consumption to *c’*. Consumer surplus decreases to the area of F and tax revenue increases to the area of D+E. As a whole, the deadweight loss amounts to the area of A+B+C. Consequently, the costs of inflation correspond to the trapezoidal area, -(B+C):

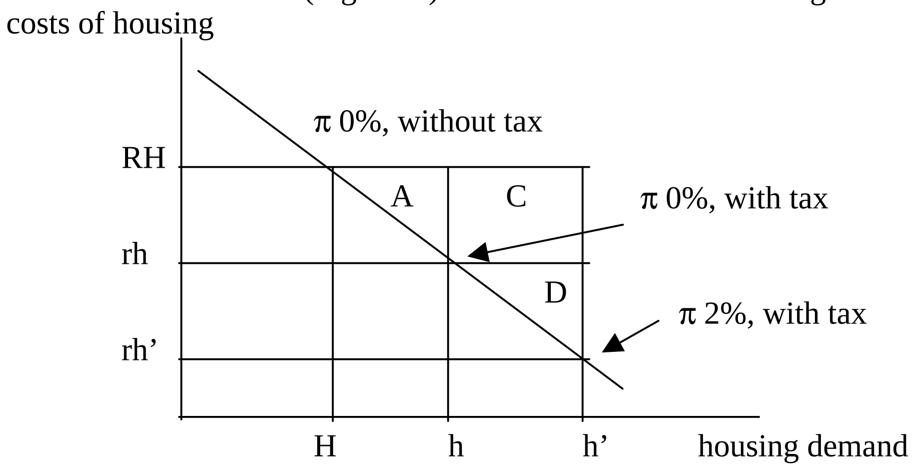
$$-(B+C) = -\{(p-P_0)(c-c')+0.5(p'-p)(c-c')\}.$$

In reality, there is no such frictionless income transfer (or lump-sum tax) in Japan—tax revenue and transfer cause some distortion in resource allocation. Suppose that the increase in tax revenue reduces the deadweight loss by the ratio l. Since the increase in tax revenue due to inflation is equal to the area of E-B, its benefit becomes l(E-B). One problem here is that this model cannot derive a particular value of l without making some arbitrary assumptions.

Housing investment

Inflation reduces corporate (non-housing) capital return. This reduces the relative costs of housing investment, which may end up as excessive demand for housing stock. The increase in the deadweight loss amounts to the area of C+D in Figure below. *RH*, *rh* and *rh'* are the costs of housing investment. *H, h* and *h'* are housing demand (in the order of "no tax and no inflation," "tax and no inflation," and "tax and inflation").

(Fig. B- 2) Costs and demand of housing

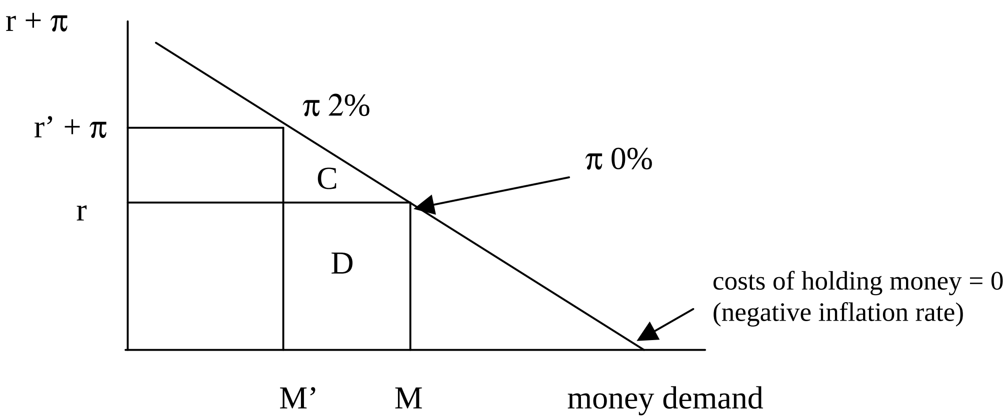


Excessive housing investment affects tax revenue through the following three channels. First, tax credit increases because of the increase in housing mortgage. Second, the shift of capital from firms (non-housing) to housing reduces tax revenue from corporate (non-housing) capital return. Third, property tax revenue increases.

Seigniorage and money demand

Inflation increases the costs of holding non-interest-bearing money balances and reduces money demand below the optimal level. The area of C+D represents the cost due to inflation.

(Fig. B- 3) Costs of holding money and money demand



On the other hand, inflation affects fiscal balance in three ways. First, seigniorage increases. Second, the shift from money to corporate capital increases the tax revenue from corporate capital return. Third, the rise in inflation raises government interest payments since a decline in money demand makes the government issue more bonds.

Debt service and government budget constraint

Inflation increases tax revenue on interest income, as households receive more government debt service. Thus, the real costs of debt service decline.

B. Estimated results

Intertemporal substitution of consumption

The increase in deadweight loss resulting from inflation, G_1 (where a negative sign means an increase in the deadweight loss), is equal to the area of B+C (Fig. B- 1).

$$G_1 = -(B+C) = -\{(p-P_0)(c-c')+0.5(p'-p)(c-c')\}.$$

Corporate capital return, R, r and r', are substituted to r in the equation $p=(1+r)^{-T}$, which gives the prices of retirement consumption, P_0, p and p'.

Feldstein's model estimates retirement consumption, c and c', as follows: Change in retirement consumption can be approximated as

$$c-c' = -c\, e_{Cp}\, (p'-p)/p \,,$$

where e_{Cp} is the compensated elasticity of retirement consumption with respect to its price. The following equation represents the Slutsky equation:

$$e_{Cp} = h_{Cp} + s \,,$$

where h_{Cp} is uncompensated elasticity of retirement consumption and s is the propensity to save out of exogenous income. The relationship among saving, price and consumption, $s = pc$, yields the equation, $h_{Cp} = h_{Sp} - 1$, where h_{Sp} is the elasticity of saving with respect to the price of retirement consumption. Therefore, the following relation can be obtained.

$$G_1 = -\left(\frac{p-P_0}{p} + 0.5\frac{p'-p}{p}\right)\frac{p'-p}{p}\, s(1-h_{Sp} - s)$$

From $p=(1+r)^{-T}$, the elasticity of saving with respect to the real rate of return, h_{Sr}, becomes

$$h_{Sr} = -rT\, h_{Sp} / (1+r).$$

In a two-period model, the saving at the young generation, s, and the net personal saving, s_N, have a relation of

$$s_N = s - (1+n+g)^{-T} s,$$

where n is the rate of population growth and g is the rate of wages per capita. Calculation from the equation $s = s/(a*\mathrm{GDP})$, where a is the share of labor, gives the propensity to save out of exogenous income, s.

From the above formulas and the parameters in the following table, the increase in deadweight loss becomes

$$G_1 = -0.01716\mathrm{GDP}.$$

Variable	Value	Explanation
T	30	Number of years that the young engage in saving for retirement
P_0	0.266	Price under no inflation and no tax, $(1+R)^{-T}$ (Section II)
p'	0.515	Price under inflation and tax, $(1+r')^{-T}$ (Section II)
P	0.432	Price under no inflation and tax, $(1+r)^{-T}$ (Section II)
h_{Sr}	0.4	Elasticity of saving, cited from Feldstein [1999]
R	0.028	Real rate of return, r=0.0283 (Section II)
$n+g$	0.033	Real rate of increase in the sum of wages and salary of employees and income of private unincorporated enterprises (excluding imputed service of owner-occupied dwellings), "National Accounts," average from 1985 to 1998
s_N	0.091	Ratio of net household saving to GDP, "National Accounts," average from 1985 to 1998
S	0.147	Saving of the young, $s_N = s - (1+n+g)^{-T} s$
a	0.7	Share of labor
s	0.210	Propensity to save out of exogenous income, $s/(a$*GDP$)$

The increase in tax revenue due to inflation can be approximated as

$$\text{dREV} = \text{E-B} = (p'-p)\, c - (p'-P_0)\,(c-c')$$

$$= s\{(p'-p)/p - (p'-P_0)/p \bullet (p'-p)/p \bullet (1-h_{Sp})\}^{26}$$

$$= 0.00403\text{GDP} .$$

As a whole, the costs associated with the shift of inflation from zero to two percent with respect to intertemporal substitution of consumption become

$$G_2 = (-0.01716 + 0.00403\ l)\text{GDP} = -0.01555\text{GDP}.$$

This estimation assumes that the parameter l is equal to 0.4.

Housing investment

The area of C+D represents the increase in the deadweight loss due to inflation, G_3 (where a negative sign means the increase in the deadweight loss) (Fig. B- 2) :

$$G_3 = -(C+D) = -\{(RH-rh)(h'-h)+0.5(rh-rh')(h'-h)\}.$$

This equation can be rearranged as

$$G_3 = -e_{HHR}\left[\frac{RH-rh}{rh}\frac{rh-rh'}{rh}+0.5\left(\frac{rh-rh'}{rh}\right)^2\right]\cdot rh\cdot h\,,$$

where e_{HRH} is the elasticity of housing demand with respect to the costs of housing investment. Assume e_{HRH} =0.8 as Feldstein. Section III and Chart 5 give the values of the costs of housing investment, *RH*, *rh* and *rh'*. The observed housing stock *h* was 263.85 trillion yen in 1998, when GDP was 498.5 trillion yen (which is used for normalization). Substitution of these variables yields

$$G_3 = -0.00004\text{GDP} .$$

[26] Feldstein applies an uncompensated demand curve.

The three effects of tax revenue, which amount to 0.00014GDP in total, are summarized as follows:

- Tax credit increases because of the increase in housing mortgage. The fall in the cost of housing investment (*rh*) increases housing stock by $e_{HRH}(rh'/rh-1)h$=3.86 trillion yen. Multiplied the ratio of the mortgage to housing stock, 0.54, by the ratio of tax credit to the mortgage, 0.0039, the decrease in income tax revenue becomes 0.00002GDP.
- The shift from corporate capital investment to housing investment reduces tax revenue from corporate capital return. The decrease in tax revenue from corporate capital return becomes 0.00018GDP, which is obtained as a product of the increase in housing stock (3.86 trillion yen) and the difference between the pre- and post-tax returns (R-r'=0.0227, Section II).
- Property tax revenue increases. Property tax revenue increases by 0.00005GDP, which is equal to 0.67 percent (the property tax rate) of 3.86 trillion yen (the increase in housing stock).

In sum, this estimation obtains the deadweight loss of

$$G_4 = (-0.00004 - 0.00014\,\lambda)GDP = -0.00009GDP \quad (\text{when } \lambda = 0.4),$$

related to owner-occupied housing investment due to the shift of inflation from zero to two percent.

Seigniorage and money demand

The increase in deadweight loss of money holding, G_5, can be expresses as follows (Fig. B- 3):

$$G_5 = -(C+D) = -(r'+p+r)/2\ (M-M').$$

With the elasticity of money demand with respect to the nominal opportunity cost of holding money balances, e_M, this equation becomes

$$G_5 = -\frac{r'+p+r}{2}(r'+p-r)e_M\frac{M}{r}.$$

Substitution of the values of r and r' (from Section II) and $e_M=0.1$ (from Shiratsuka [2000]) gives

$$G_5 = -0.00020GDP$$ [27,28].

Three effects of inflation on government budget are:

- An increase in seigniorage amounts to 0.00224GDP as

$$d(\text{Seigniorage})/dp = M+p(dM/dp),$$

where $dM/dp = -M\, e_M[d(r+p)/dp]\,(r+p)^{-1}$,

[27] Feldstein assumes $e_M = 0.2$.
[28] M/GDP=0.112 (M:55.86 trillion yen <CY1998, monetary base>, Bank of Japan, “Financial and Economic Statistics”)

where *d(r+p)/dp* and *dM/dp* become 0.702 and -0.278 respectively from corporate capital returns *r* and *r'* (Section II).

- An increase in the tax revenue on corporate capital return due to the shift from money to corporate capital is 0.00013GDP. This is obtained as a product of a decrease in money balances by *-(M'-M) = -(dM/dp)dp* = 0.278*0.02 and the difference between the pre- and post-tax returns *(R-r')*.
- The government interest payments increase by 0.00020GDP because the government owes the interest payments—at the interest rate of 3.55 percent,[29] which is the real interest rate paid on interest-bearing debt—incurred by the additional bond issues to compensate a decline in money balance (*M'-M*).

Combining these three effects, the net welfare loss due to the decreased revenue becomes a product of l and 0.00217GDP.

Consequently, the deadweight loss with respect to money demand decreases by

$$G_6 = (-0.00020 + 0.00217\ l)\text{GDP} = 0.00067\text{GDP} \quad (\text{when } \lambda = 0.4).$$

Debt service and government budget constraint

Inflation increases tax revenue on interest income, as households receive more government debt service. Under the government budget constraint, changes in tax revenue amount to the product of *Dp* (two percentage points) and

$d(\text{tax revenue})/dp = -q\,B = -0.117\text{GDP}.$

The increase in tax revenue becomes 0.00234GDP.

Therefore, the real cost of debt service declines by

$$G_7 = 0.00234\ l\,\text{GDP} = 0.00093\text{GDP} \quad (\text{when } l = 0.4).$$

Summation of G_2, G_4, G_6 and G_7 yields the overall effect on the the deadweight losses in Chart 14, where those under the alternative cases are also found.

[29] The real interest rate = *(1-q)(b/B)-p*, where *q* is the tax rate on interest income (15 percent, national tax); *b* is the expenditure paid on interest bearing debt (11.2 trillion yen, FY1998, national budget); *B* is gross government liabilities (388.1 trillion yen, national, the end of FY1997); and *p* is the inflation rate (CPI, CY1998).

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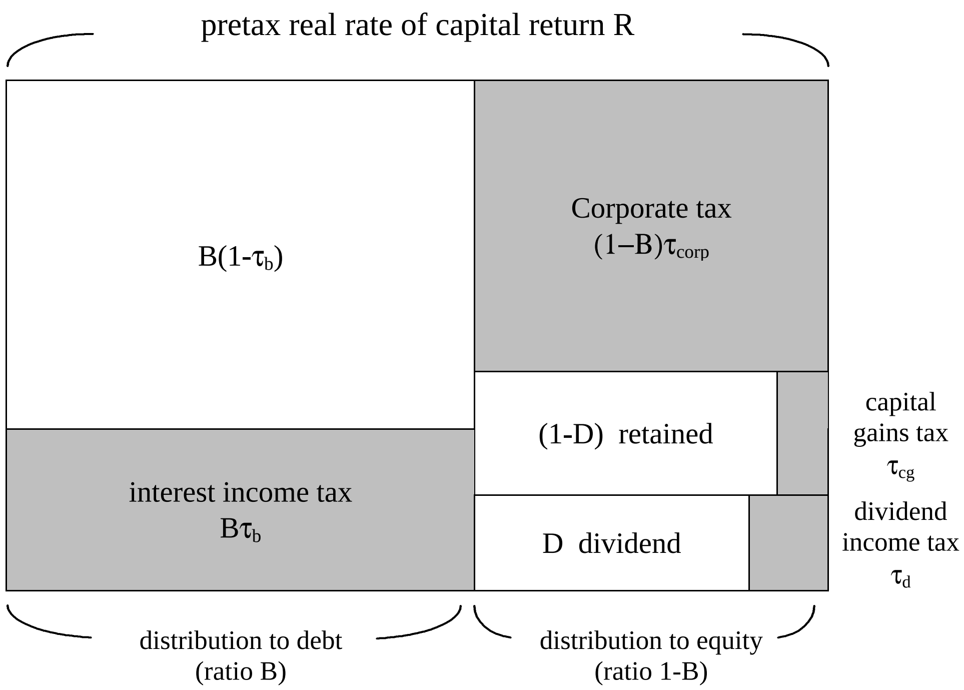
Corporate Finance and Distribution of Capital Return

Financing method	Distribution of return		Tax	
			Corporation	Household
debt	interest on debt		none	tax on interest income (withholding tax) (τ_b) (20%)
equity	corpor-ate return	Dividend	corporate tax (τ_{corp}) (40.87%)	tax on dividend income (τ_d) (20~35%)
		Retained, (Which leads to a stock price increase)		tax on capital gains (τ_{cg}) (1.05~26%)

Notes:
1. The above tax rate on dividend income is that of withholding tax. See Appendix A for more details on dividend taxes in Japan.
2. There are currently two types of taxes on capital gains. Investors can select either a straight tax of 26% on capital gains or a tax of 1.05% on total proceeds.



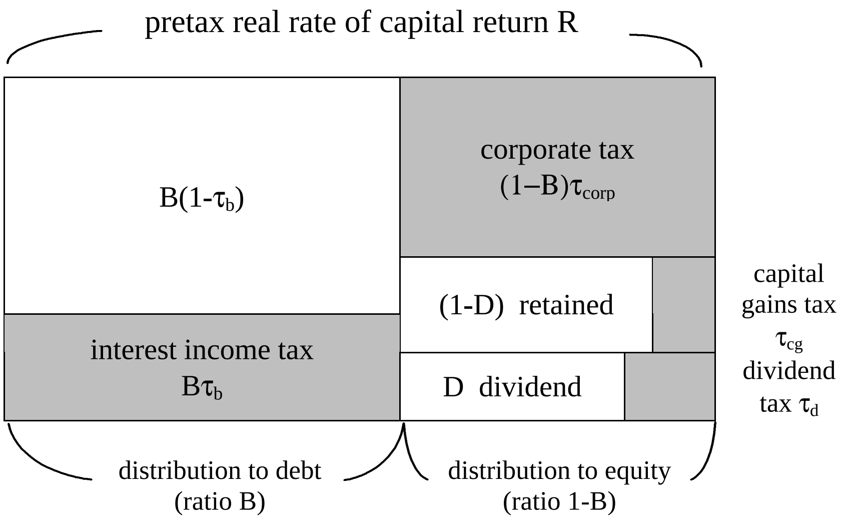
Note: Shaded and white areas indicate taxes and post-tax real return of household, respectively.

(Chart 2)

Rate of Capital Return and Effective Tax Rate

-- Method 1 --

Estimation of the rate of corporate capital return and the effective tax rate based on data from 1985 to 1998.



Note : refer to Chart 1.

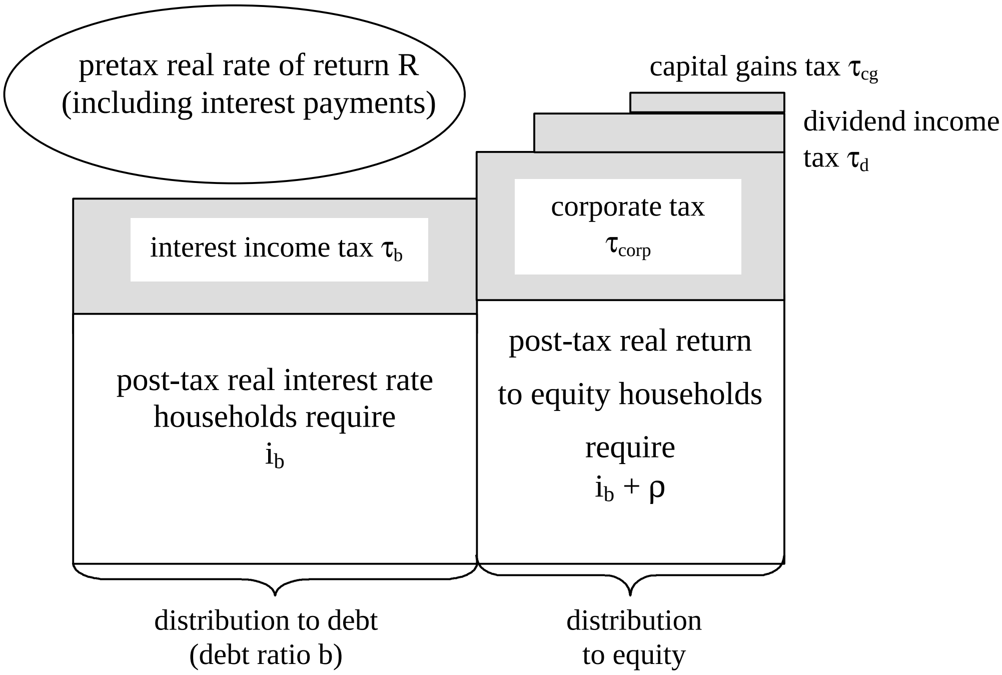
Variable		Value	Formula or explanation	Source, period
pretax real rate of capital return	R	0.04511	(receipts–dividend incomes) /(assets–corporate shares)	"National Accounts," average from 1985 to 1998
debt ratio	b	0.5	liabilities/assets = 0.49, liabilities/(assets–corporate shares)=0.54	"National Accounts," average from 1985 to 1998
interest payment ratio	B	0.45	(interest disbursement)/receipts = 0.44	"National Accounts," average from 1985 to 1998
dividend payout ratio	D	0.5	dividend/(net profit) = 0.57	"Financial Statements Statistics of Corporations by Industries," average from 1985 to 1998
corporation tax rate	τ_{corp}	0.4087	effective tax rate, FY2000	"Ikeda[2000]"
tax rate on capital gains	τ_{cg}	0.1	tax of 26% on capital gains or tax of 1.05% on total proceeds	"Ikeda[2000]"
tax rate on dividends	τ_d	0.25	0.2344 (ref. Appendix A)	
tax rate on interest income	τ_b	0.2		"Ikeda[2000]"
depreciation rate	d	0.1	(consumption of fixed capital)/(net fixed assets + consumption of fixed capital) = 0.090, (depreciation expenses)/(fixed assets–land+depreciation expenses) = 0.125	"National Accounts," "Financial Statements Statistics of Corporations by Industries," average from 1985 to 1998
capital cost	N	0.0267	$(1-\tau_{corp})\,R$	

Note: This estimation assumes τ_{cg} as 10 percent, considering the following two factors. First, the government levies tax on capital gains only when households sell their stock. Second, under the Japanese tax system, there are currently two choices of tax on capital gains. Investors can select between a straight tax of 26% on capital gains and a tax of 1.05% on total proceeds.

(Chart 3)

Rate of Capital Return and Effective Tax Rate
-- Method 2 --

Estimation of the pretax real rate of corporate capital return and the effective tax rate, to be consistent with post-tax real return and a certain risk premium which households require.



Note: Shaded areas indicate taxes. The areas in sum (white plus shaded areas) correspond to pretax real return.

Variable		Value	Formula or explanation	Source, period
post-tax real interest rate	i_b	0.044	(interest disbursements) / (interest bearing liability)×(1-τ_b) = 0.055 (1-0.2)	"National Accounts," average from 1985 to 1998
debt ratio	b	0.5	same as Chart2	
dividend payout ratio	D	0.5	same as Chart2	
risk premium	ρ	0.01	supposition	
corporation tax rate	τ_{corp}	0.4087	same as Chart2	
tax rate on capital gains	τ_{cg}	0.1	same as Chart2	
tax rate on dividends	τ_d	0.25	same as Chart2	
tax rate on interest income	τ_b	0.2	same as Chart2	
depreciation rate	d	0.1	same as Chart2	
capital cost	N	0.0483	(1-τ_{corp}) R	

(Chart 4)

International Comparison of Return and Tax Rates

(1) Capital return and the effective tax rate before inflation changes

	Japan		United States		Germany	Spain	U.K.
	Method 1	Method 2	Feldstein [1999]	modified			
inflation rate	0%		+2%		+2%	+2%	+2%
pretax rate of return R	4.51%	8.17%	9.20%	9.20%	10.80%	11.9%	8.2%
post-tax rate of return r	2.83%	4.90%	4.05%	5.72%	4.24%	7.31%	4.9%
effective tax rate τ_1	37.17%	40.06%	55.98%	37.83%	60.74%	38.66%	40.24%

(2) Changes in the effective tax rate after inflation rises from 0 to 2%

	Japan		United States		Germany	Spain	U.K.
	Method 1	Method 2	Feldstein [1999]	modified			
effective tax rate (π 0%)	37.17%	40.06%	50.65%	32.41%	54.91%	35.13%	37.07%
effective tax rate (π 2%)	50.36%	46.39%	55.98%	37.83%	60.74%	38.66%	40.24%
change in tax rates	+13.19%	+6.33%	+5.33%	+5.42%	+5.83%	+3.53%	+3.17%

Notes:

1. For countries other than Japan, the average inflation rate is 2 percent during the estimation period. The table in the bottom panel shows estimated results when the inflation rate falls from 2 to 0 percent for these countries.
2. The figures in “modified” in the U.S. are obtained by the same procedure described in Section II. Parameters are from Feldstein [1999] with assumptions that both the interest payment ratio (B) and debt ratio (b) are 0.4, and that the dividend payout ratio (D) is 0.5.

Sources:

United States (Feldstein [1999]), United Kingdom (Bakhshi et.al. [1999]), Germany (Tödter et.al. [1999]), Spain (Dolado et.al. [1999]), Abel [1997,1999].

(Chart 5)

Cost of Housing Capital Investment

(1) Definition of variables

	Definition	Value	Explanation and source
R	rate of capital return	0.04511	
m	maintenance cost	0.025	Cited from EPA[1999][1], “Family Income and Expenditure Survey”, “National Accounts”
δ	rate of depreciation	0.083	Cited from EPA[1999][2], “National Accounts”
μ	ratio of the mortgage to the housing stock	0.54	CY1998, “Flow of Funds Accounts,” “National Accounts”
i	interest rate paid on the mortgage	0.047	average from 1985 to 1999, real, weighted average on both city banks and housing loan corporations, “Financial and Economic Statistics,” “Flow of Funds Accounts”
θ	rate of tax credit on the mortgage	0.0039	(total amount of tax credit on the mortgage<559 billion yen, FY2000>)/(balance of the mortgage<CY1998>), “Ikeda[2000],” “Flow of Funds Accounts”
τ	property tax rate	0.0067	(property tax revenue)/(fixed tangible assets), excluding land, FY1998, “Ikeda[2000],” “National Accounts”

(2) Cost of housing capital investment and tax incentive

	RH	rh	rh’		τ_2	$\Delta\tau_2$	
	cost of housing capital investment				tax rate	change in the tax rate	
	pretax	post-tax	post-tax				
	π=0	π=0	$\Delta\pi$=0.02	$\Delta\pi$= -0.02		$\Delta\pi$=0.02	$\Delta\pi$= -0.02
Method 1	0.1531	0.1498	0.1471	0.1525	-0.0216	-0.0179	0.0179
Method 2	0.1898	0.1593	0.1569	0.1617	-0.1605	-0.0125	0.0125

Notes: 1. Method 1 and Method 2 indicate estimation methods of corporate capital return, respectively.

2. Tax rates are calculated from τ_2 = -(1 – rh/RH), $\tau_2+\Delta\tau_2$ = -(1 – rh’/RH) [3].

[1] Maintenance cost = (total amounts of maintenance expenditures<SNA base>)/(housing stock). Total amounts of maintenance expenditures are derived from the ratio of “repairs and maintenance for housing” to total expenditure in “Family Income and Expenditure Survey.”

[2] The depreciation rate is calculated by comparison of the housing stock in 1997 with the sum of that in 1974 and annual housing investment, assuming the constant rate of depreciation.

[3] Negative tax rates mean favorable treatment of housing capital investment.

(Chart 6)

International Comparison of Housing Investment Cost and Tax Incentive Rate

(1) Housing investment cost and tax incentive rate before the inflation rate changes

	Japan		U.S.	Germany	Spain	U.K.
	Method 1	Method 2				
inflation rate	0%		+2%	+2%	+2%	+2%
investment cost in the without tax: RH	15.31%	18.98%	13.2%	14.8%	16.1%	9.6%
investment cost with tax: rh	14.98%	15.93%	9.98%	8.85%	8.21%	6.9%
tax incentive rate: τ_2	2.16%	16.05%	20.61%	40.20%	37.78%	25.83%

(2) Changes in the tax incentive rate after the inflation rate rises from 0 to 2%

	Japan		U.S.	Germany	Spain	U.K.
tax incentive rate	Method 1	Method 2				
under the inflation rate of 0%, (A)	2.16%	16.05%	17.24%	38.58%	34.62%	23.42%
under the inflation rate of 2%, (B)	3.95%	17.30%	20.61%	40.20%	37.78%	25.83%
(B)-(A)	1.79%	1.25%	3.37%	1.62%	3.16%	2.41%

Notes:

1. See Note 1 of Chart 4.
2. The housing investment costs (RH and rh) in countries other than Japan are those applied to tax payers who make use of their tax deductions.

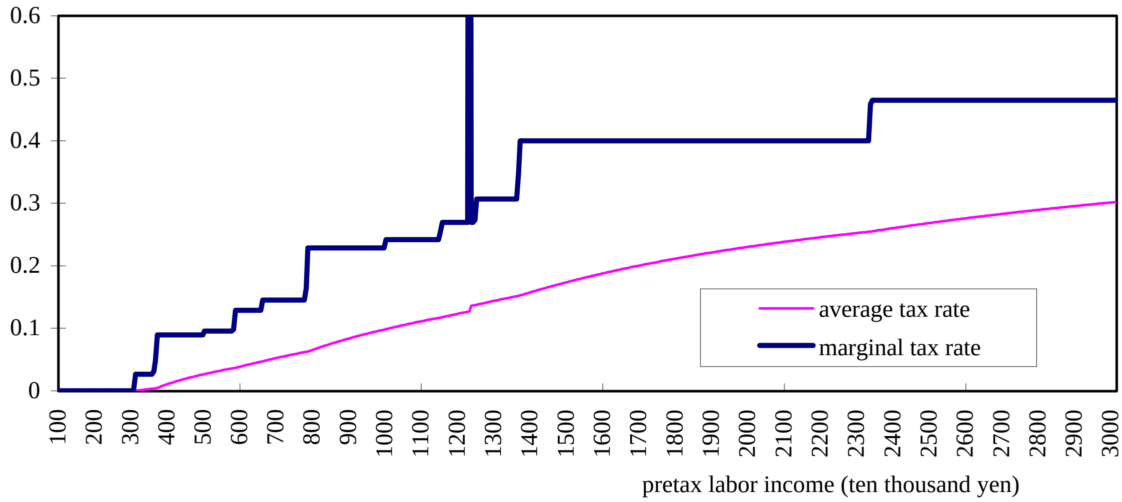
Sources:

United States (Feldstein [1999]), United Kingdom (Bakhshi et.al. [1999]), Germany (Tödter et.al. [1999]), Spain (Dolado et.al. [1999]), Abel [1997,1999].

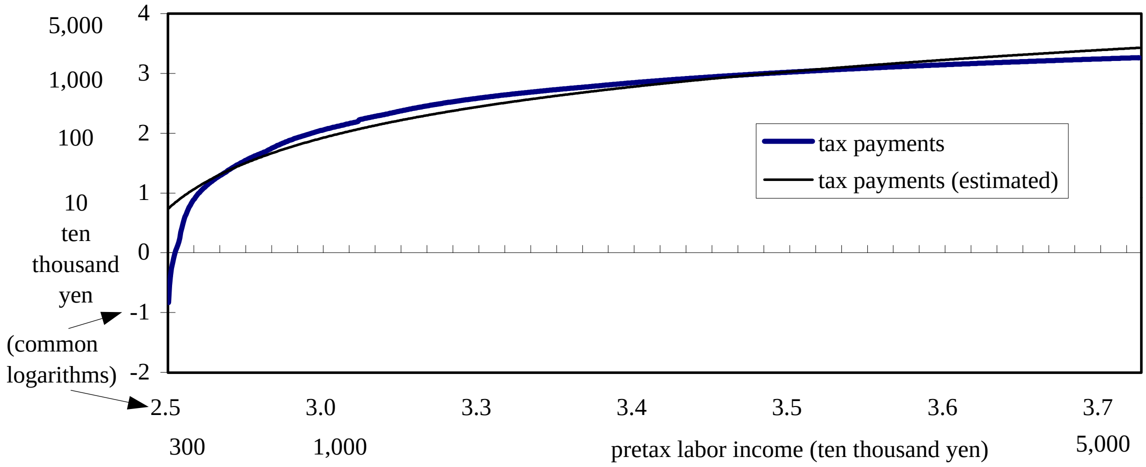
(Chart 7)

Tax Rates on Labor Income

(1) Average and marginal tax rates



(2) Estimation of tax payments by labor income bracket (log scale)



(3) Average and marginal tax rates of an average household

	weighted tax rate by tax payments	weighted tax rate by persons
average	0.112	0.043
marginal	0.240	0.107

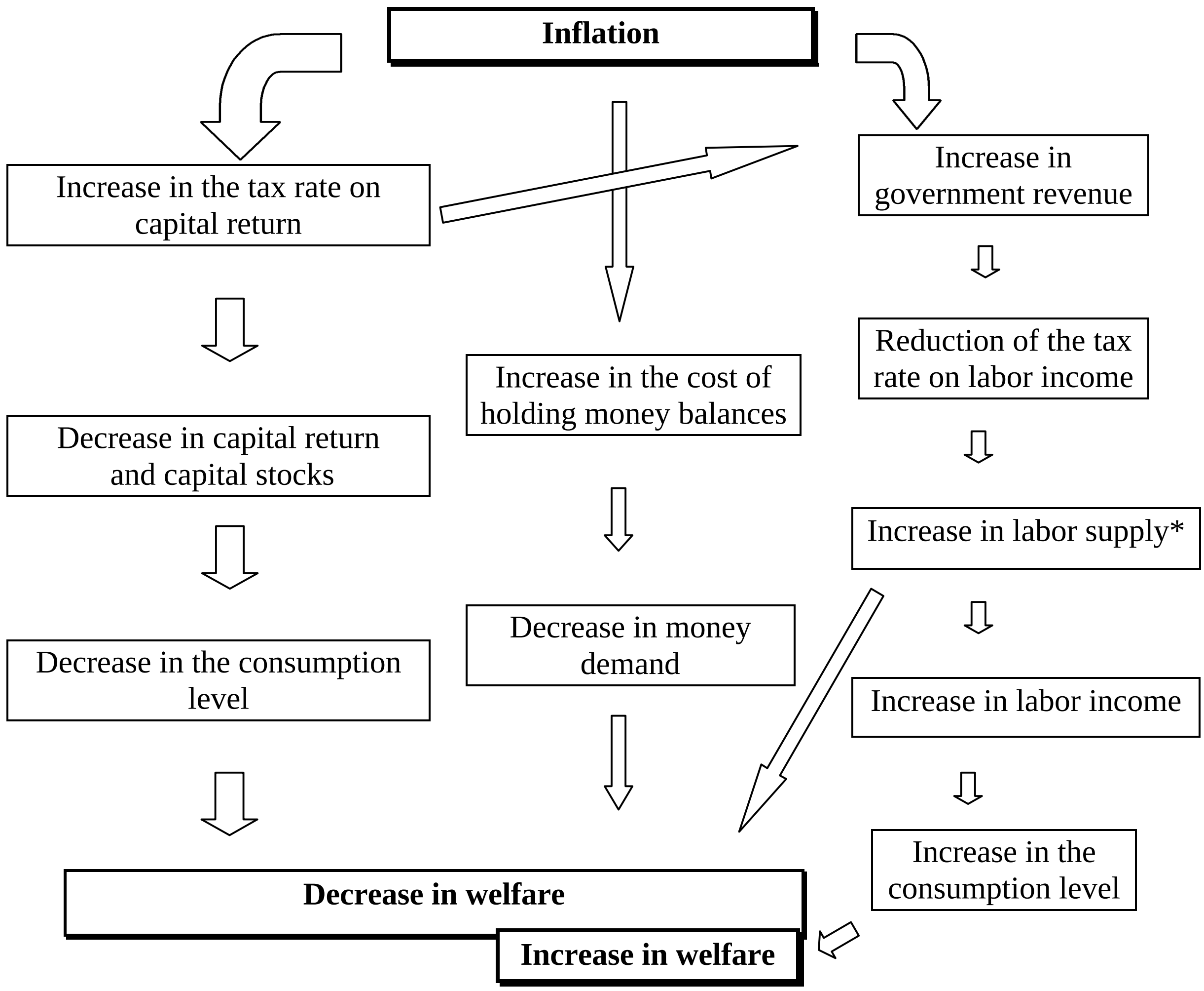
Notes:
1. See Nishizaki and Nakagawa [2000] for further details.
2. Average tax rate = (tax liability) / (pretax labor income)
   Marginal tax rate = D(tax liability) / D(pretax labor income)<50,000 yen>
3. Both national and local taxes are included.
4. Tax above liability is applied to a taxpayer with a spouse and two children.
5. Based on the tax schedule in FY2000
6. The weighted tax rates by tax payments are weighted average of the tax rates by actual shares of tax burdens of each labor income bracket (FY1998).
7. The weighted tax rate by persons are weighted average of the tax rates by actual population distributions of each labor income bracket (FY1998).

Sources: National Tax Administration, Ministry of Finance, Ikeda [2000]

(Chart 8)

Image of the Costs of Inflation

– Abel's Model (General Equilibrium Model) –



* In fact, it is uncertain whether the fall in the tax rate on labor income leads to increase in labor supply or not. It depends on the sizes of the substitution effect and the income effect. The diagram above supposes the former effect exceeds the latter effect.

(Chart 9)

Initial Calibration of the Abel's Model

Vari-able	Value	Explanation	
Preference Parameter			
β	0.97	discount rate	exogenous
ρ	4	coefficient of relative risk aversion on consumption	exogenous
η	10	coefficient of relative risk aversion on labor	exogenous
δ	10	coefficient of relative risk aversion on money	exogenous
ϕ	667219	money demand parameter	chosen to satisfy m^0 below
ψ	$1.824\ 10^{-8}$	labor parameter	chosen to satisfy l^0 below
Production Function Parameter			
A	45.670	production function factor	chosen to satisfy y^0 below
α_1	0.227	share of corporate capital	exogenous*
α_2	0.073	share of housing capital	exogenous*
Government Policy Variable			
g/y	0.2	government expenditure to net national product	exogenous
b/y	1.0	government bond ratio net national product	exogenous
π	1.00	inflation rate	exogenous
$\Delta\pi$	0.02 (or –0.02)	change in the inflation rate	exogenous
τ_1	0.3717	tax rate on corporate capital return	exogenous
τ_2	-0.0216	tax rate on housing capital investment	exogenous
$\Delta\tau_1$	+(-)0.1319	change in τ_1	exogenous, ( ) for $\Delta\pi$=-0.02
$\Delta\tau_2$	-(+)0.0179	change in τ_2	exogenous, ( ) for $\Delta\pi$=-0.02
τ_c	0.05	consumption tax rate	exogenous
τ_w	0.1548	tax rate on labor income etc.	endogenous (from government budge constraint)
Initial Value of Aggregate Variable			
y^0	422.52	net national product (Initial)	yr.98, trillion yen
m^0	55.86	monetary base (Initial)	yr.98, trillion yen
l^0	1	labor supply (Initial)	Exogenous
n	0.00	population growth rate	Exogenous

Note: α_1 and α_2 are set to satisfy $k_2/k_1=\{(1-\tau_2)\ \alpha_2/(1-\tau_1)\ \alpha_1\}=0.528$ (CY1998, SNA) under the condition of $\alpha_1+\alpha_2=0.3$.

(Chart 10)

Effects of the Changes in the Inflation Rate

-- Method 1 --

(1) Inflation (π : from 0 to 2%)

		(1)	(2)	(3)	(4)
		Only changes in the inflation rate	Only changes in the tax rate on capital return	Only changes in the tax rate on housing capital	Considering all three effects
Government Policy Changes : Exogenous					
$\Delta\tau_1$	tax rate on capital return	0	0.1319	0	0.1319
$\Delta\tau_2$	tax rate on housing	0	0	-0.0179	-0.0179
π	inflation rate	1.02	1.00	1.00	1.02
Government Policy Changes : Endogenous					
θ	multiplied rate of taxes	0.992	0.885	1.006	0.882
Steady-State Effects (Changes, %)					
k_1	capital stock	0.620	-14.445	-0.289	-14.042
y	output	0.135	-2.984	0.049	-2.790
c	consumption	0.135	-2.984	0.049	-2.790
m	money	-4.932	-1.258	0.022	-6.102
l	labor	-0.020	1.070	-0.025	1.021
$\mathbf{(c^*-c^0)/ c^0}$	**consumption**	**0.118**	**-3.684**	**0.067**	**-3.493**

(2) Deflation (π : from 0 to -2%)

		(1)	(2)	(3)	(4)
		Only changes in the inflation rate	Only changes in the tax rate on capital return	Only changes in the tax rate on housing capital	Considering all three effects
Government Policy Changes : Exogenous					
$\Delta\tau_1$	tax rate on capital return	0	-0.1319	0	-0.1319
$\Delta\tau_2$	tax rate on housing	0	0	0.0179	0.0179
π	inflation rate	0.98	1.00	1.00	0.98
Government Policy Changes : Endogenous					
θ	multiplied rate of taxes	1.010	1.149	0.994	1.152
Steady-State Effects (Changes, %)					
k_1	capital stock	-0.765	19.319	0.283	18.925
y	output	-0.167	3.462	-0.052	3.250
c	consumption	-0.167	3.462	-0.052	3.250
m	money	11.543	1.442	-0.023	13.131
l	labor	0.024	-1.236	0.026	-1.188
$\mathbf{(c^*-c^0)/ c^0}$	**consumption**	**-0.151**	**4.425**	**-0.070**	**4.206**

(Chart 10-2)

Effects of Changes in Inflation Rate

-- Method 2 --

		Inflation (π: from 0 to 2%)	Deflation (π: from 0 to -2%)
		Considering all three effects	Considering all three effects
Government Policy Changes : Exogenous			
$\Delta\tau_1$	tax rate on capital return	0.0633	-0.0633
$\Delta\tau_2$	tax rate on housing	-0.0125	0.0125
π	inflation rate	1.02	0.98
Government Policy Changes : Endogenous			
θ	multiplied rate of taxes	0.935	1.076
Steady-State Effects (Changes, %)			
k_1	capital stock	6.795	7.886
y	output	-1.373	1.495
c	consumption	-1.373	1.495
m	money	-5.534	12.317
l	labor	0.513	-0.561
$(c^*-c^0)/c^0$	**consumption**	**-1.756**	**1.945**

(Chart 11)

International Comparison of the Estimated Results

		Japan		United States	Germany	Spain	United Kingdom
π	inflation rate	from 0 to 2%	from 0 to –2%	from 0 to 2%	from 0 to 2%	from 0 to 2%	from 0 to 2%
Parameters							
R	pretax return	0.0451		0.0920	0.1080	0.119	0.082
τ_1	tax rate on capital return	0.3717		0.5598	0.6074	0.3866	0.4024
$\Delta\tau_1$	change in τ_1	0.1319	-0.1319	0.0533	0.0583	0.0353	0.0317
τ_2	tax rate on housing	-0.0216		-0.2061	-0.4020	-0.3778	-0.2583
$\Delta\tau_2$	change in τ_2	-0.0179	0.0179	-0.0337	-0.0162	-0.0316	-0.0241
τ_c	consumption tax rate	0.05		0	0	0	0
β	discount rate	0.97		0.95	0.95	0.95	0.95
ρ	relative risk aversion (consumption)	4		4	4	4	4
η	relative risk aversion (labor)	10		10	10	10	10
δ	relative risk aversion (money)	10		5	4	4	4
α_1	share of corporate capital	0.227		0.233	0.233	0.233	0.233
α_2	share of housing capital	0.073		0.067	0.067	0.067	0.067
n	population growth rate	0.00		0.01	0.01	0.01	0.01
g/y	government expenditure ratio	0.2		0.2	0.22	0.19	0.24
b/y	Government bond ratio	1.0		0.5	0.60	0.65	0.50
m/y	Monetary base ratio	0.132		0.065	0.104	0.145	0.055
Effects on the Consumption Level (%)							
corporate capital		-3.68	4.43	-1.64	-2.09	-1.06	-1.02
housing stock		0.07	-0.07	-0.15	-0.11	0.01	0.03
money demand		0.12	-0.15	0.08	0.17	0.06	-0.00
Overall		-3.49	4.21	-1.69	-2.04	-1.00	-0.98
(Appendix) Estimated Results by Feldstein method (% of GDP)							
corporate capital		-1.56	0.29	-0.56~ -0.95	-1.48	-0.55~ -0.88	-0.21~ -0.37
housing stock		-0.01	0.00	-0.22	-0.09	-1.33	-0.11
money demand		0.07	-0.07	0.03	0.04	0.07	0.02
overall		-1.40	0.13	-0.65~ -1.04	-1.41	-1.71~ -2.04	-0.21~ -0.37

(Chart12-1)

Robustness of Results (1)

(1) Changes in the estimation methods of return and tax rates

Altered variable		Value before	→	Value after	$(c^*-c^0)/c^0$ [%] Change in the consumption level before(A)	→	after(B)	(B)-(A)
Method 1					**-3.493**			
R	pretax rate of corporate return	0.045	→	**0.07**		→	**-2.122**	+1.371
		0.045	→	**0.10**		→	**-1.366**	+2.127
B	interest payment ratio	0.45	→	**0.3**		→	**-3.530**	-0.037
b	debt ratio	0.5	→	**0.8**		→	**-3.036**	+0.456
τ_{corp}	corporate tax	0.4087	→	**0.48**		→	**-3.797**	-0.304
τ_{cg}	tax rate on capital gains	0.1	→	**0.26**		→	**-5.165**	-1.672
d	depreciation rate	0.1	→	**0.05**		→	**-2.958**	+0.535
		0.1	→	**0.15**		→	**-3.724**	-0.232
Method 2					**-1.756**			
b	debt ratio	0.5	→	**0.8**		→	**-1.962**	-0.206
i_b	post-tax interest rate	0.044	→	**0.03**		→	**-2.595**	-0.839
		0.044	→	**0.02**		→	**-3.737**	-1.981
ρ	risk premium	0.01	→	**0**		→	**-2.072**	-0.316
τ_{corp}	corporate tax	0.4087	→	**0.48**		→	**-1.676**	+0.080
τ_{cg}	tax rate on capital gains	0.1	→	**0.26**		→	**-2.592**	-0.836

Notes: 1. The changes in the consumption level are those when the inflation rate rises from 0 to 2 percent.
2. τ_{corp}, 0.48, is calculated based on the past corporate tax rate from 1985 to 1998 on the SNA base.

(Chart12-2)

Robustness of Results (2)

(2) Changes in the values such as preference parameters

Altered variable		Value before		Value after	$(c^*-c^0)/c^0$ [%] Change in the consumption level before(A)		after(B)	(B)-(A)	
Method 1					**-3.493**				
β	discount rate	0.97	→	**0.95**		→	**-3.737**	-0.244	
		0.97	→	**0.98**		→	**-3.359**	+0.133	
ρ	relative risk aversion on consumption	4	→	**10**		→	**-3.129**	+0.364	
		4	→	**2**		→	**-3.648**	-0.155	
η	relative risk aversion on labor	10	→	**1000**		→	**-3.805**	-0.312	
		10	→	**1**		→	**-2.935**	+0.558	
δ	relative risk aversion on money	10	→	**20**		→	**-3.467**	+0.026	
		10	→	**2**		→	**-3.670**	-0.178	
$\alpha_1+\alpha_2$	share of capital	0.3	→	**0.4**		→	**-4.057**	-0.565	α_1=0.30, α_2=0.10
		0.3	→	**0.2**		→	**-2.645**	+0.847	α_1=0.15, α_2=0.05
n	population growth	0.00	→	**-0.01**		→	**-4.177**	-0.685	
b/y	government bond ratio	1.0	→	**0.5**		→	**-3.288**	+0.204	
		1.0	→	**1.5**		→	**-3.671**	-0.178	

(3) Changes in the parameters after the inflation rate changes

a) Progressive income tax

$\Delta\tau_w$	tax rate on labor income	0	→	**0.003**	→	**-3.343**	+0.150

b) Increase in the government expenditure

Δ(g/y)	government expenditure ratio	0	→	**0.01**	→	**-5.631**	-2.138

c) Choice of tax cuts

cuts of tax on only consumption and labor income (the consumption tax rate falls from 5 to 3.8 percent.)

θ	multiplied rate of tax	0.882	→	**0.794**	→	**-6.589**	-3.096

cuts of tax on only capital returns

θ	multiplied rate of tax	0.882	→	**0.733**	→	**0.263**	+3.755

d) Increase in the share of capital due to inflation

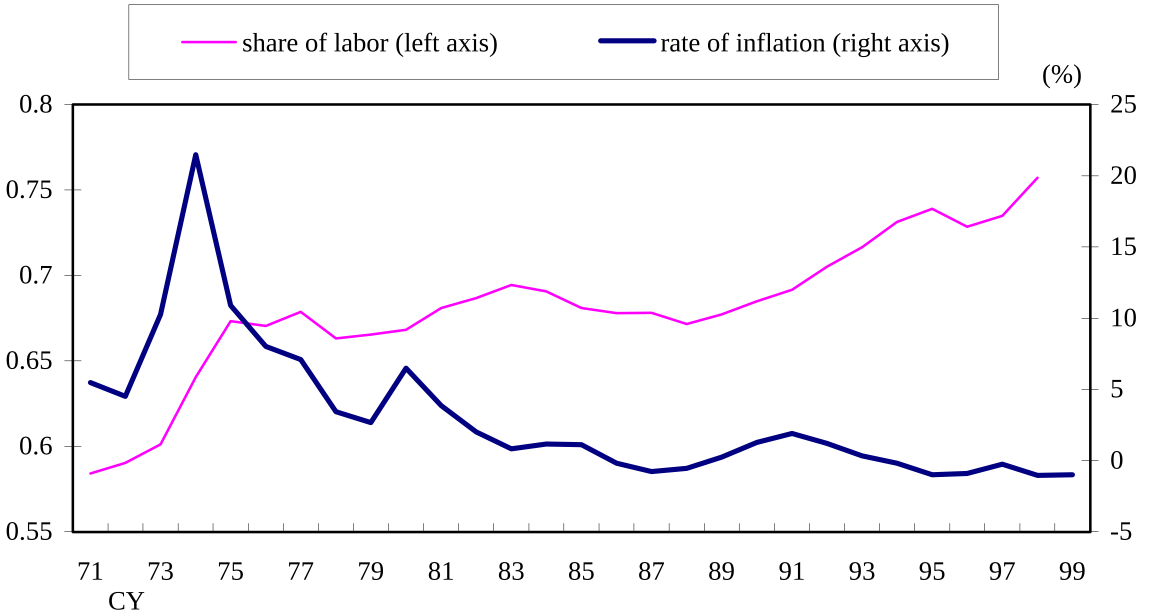
$\Delta\alpha_1$	share of corporate capital	0	→	**0.002**	→	**-1.254**	+2.239	
		0	→	**0.004**	→	**1.079**	+4.572	
$\Delta\alpha_1$ **&** $\Delta\alpha_2$	share of corporate and housing capital	0	→	**0.002**				Increase in
		0	→	**0.001**	→	**-0.219**	+3.274	α_1:0.002, α_2:0.001

Note: The changes in the consumption level are those when the inflation rate rises from 0 to 2 percent.

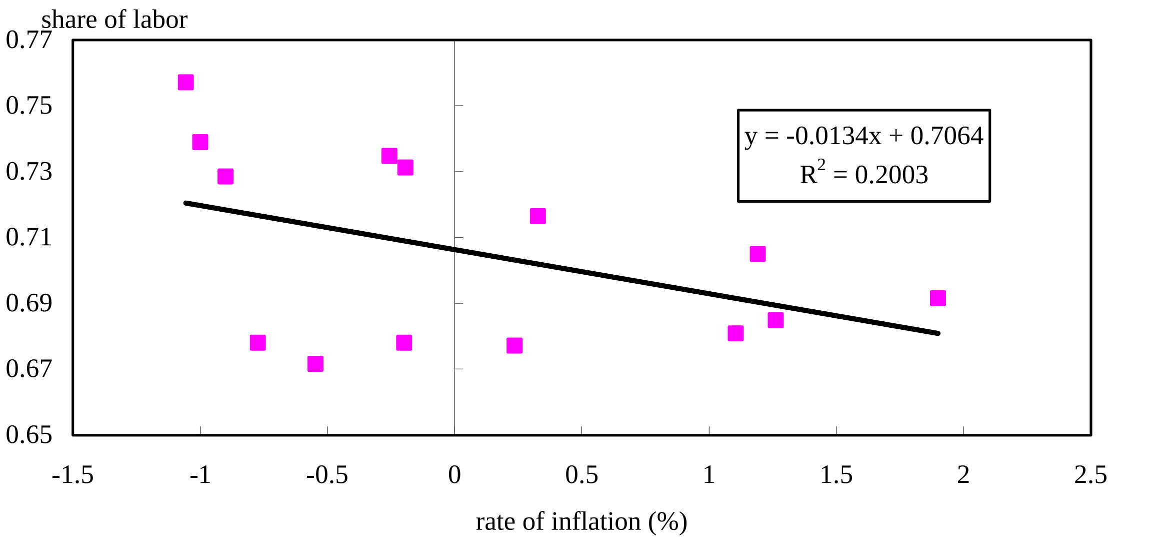
(Chart 13)

Inflation and Share of Labor

(1) Historical movement of the inflation rate and the share of labor



(2) Scatter diagram (after CY1985)



Notes: 1. The rate of inflation rate is adjusted by 0.9 percent.
2. Share of labor <SNA base>
= (Compensation of employees)/(Entrepreneurial income + Compensation of employees)

Sources: Cabinet Office "National Accounts,"
Ministry of Public Management, Home Affairs, Posts and Telecommunications "Consumer Price Index"

(Chart 14)

Estimated Results by Feldstein Approach

	Direct Effects of Reduced	Welfare Effects of Revenue Change		Total Effects	
		λ=0.4	λ=1	λ=0.4	λ=1

(1) π from 0 to 2% changes as % of GDP

consumption timing	-1.716%	0.161%	0.403%	**-1.555%**	-1.313%
housing demand	-0.004%	-0.006%	-0.014%	**-0.009%**	-0.018%
money demand	-0.020%	0.087%	0.217%	**0.067%**	0.197%
debt service		0.093%	0.234%	**0.093%**	0.234%
overall	-1.740%	0.336%	0.839%	**-1.404%**	-0.900%

(2) π from 0 to -2%

consumption timing	0.912%	-0.621%	-1.553%	**0.291%**	-0.641%
housing demand	0.002%	0.002%	0.005%	**0.003%**	0.006%
money demand	0.012%	-0.084%	-0.210%	**-0.072%**	-0.199%
debt service		-0.093%	-0.234%	**-0.093%**	-0.234%
overall	0.925%	-0.797%	-1.992%	**0.129%**	-1.066%

Note: Estimated results in Method 1.

(Appendix 1) Estimation in Method 2 (π from 0 to 2%)

consumption timing	-1.717%	0.023%	0.057%	**-1.694%**	-1.660%
housing demand	-0.020%	-0.008%	-0.021%	**-0.028%**	-0.041%
money demand	-0.019%	0.090%	0.225%	**0.071%**	0.206%
debt service		0.093%	0.234%	**0.093%**	0.234%
overall	-1.756%	0.198%	0.495%	**-1.558%**	-1.261%

(Appendix 2) Estimation in Method 2 (π from 0 to -2%)

consumption timing	1.153%	-0.327%	-0.817%	**0.826%**	0.336%
housing demand	0.019%	0.006%	0.015%	**0.024%**	0.033%
money demand	0.014%	-0.089%	-0.221%	**-0.074%**	-0.207%
debt service		-0.093%	-0.234%	**-0.093%**	-0.234%
overall	1.185%	-0.503%	-1.257%	**0.682%**	-0.072%

(Appendix 3) Results by Economic Planning Agency[1999] (π from 0 to 2%)

consumption timing	-1.65%	0.34%	0.85%	**-1.32%**	-0.81%
housing demand	-0.03%	-0.01%	-0.02%	**-0.04%**	-0.05%
money demand	-0.02%	0.09%	0.21%	**0.06%**	0.19%
debt service		0.07%	0.18%	**0.07%**	0.18%
overall	-1.70%	0.49%	1.22%	**-1.22%**	-0.48%