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Incidence of Corporate Income Tax and Optimal Capital Structure: A dynamic analysis

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Incidence of Corporate Income Tax and Optimal Capital Structure: A dynamic analysis[1]

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Abstract

In this study, we analyze the incidence of corporate income tax using a dynamic general equilibrium model. The dynamic macroeconomic model enables us to analyze both the instantaneous and the intertemporal incidence of corporate income tax. We include capital structure (i.e., choices of equity, debt, and retained earnings) in the proposed model in order to implement investment. The model also includes a progressively increasing per unit agency cost on debt. We implement a simulation based on the dynamic model, and measure the incidence of corporate income tax on labor income, when the (effective) corporate income tax rate decreases from 34.62% to 29.74% in Japan. We find that the percentage of the incidence on labor income is about 20%-60%, in the short term (one year), and the percentage of the incidence on capital income is about 40%-80%. In the long term, about 90% of the incidence is on labor income. Thus, almost all of the incidence shifts to labor income in the long term. In contrast, in a neo-classical dynamic general equilibrium model, the entire incidence shifts to labor income in the long term. The difference between these results is caused by the inclusion of the agency cost on debt.

Keywords: Incidence of corporate income tax, Capital structure, Debt financing, Cost of capital, Dynamic analysis

JEL classification: H22, H25

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1. Introduction

The incidence of corporate income tax is both an old and a new issue in the field of public economics. In Japan, tax reforms will need to raise consumption tax (value added tax: VAT) and the burden on corporate income tax is heavier than in other countries. However, some believe that a policy package including a consumption tax increase and a corporate income tax cut is politically unacceptable. As a background to this discussion, the intuitive belief is that consumption tax is borne mainly by consumers and corporate income tax is borne mainly by corporations. However, this ignores the findings of public economics studies on the shifts and incidence of corporate income tax.

Given this situation, it is necessary to analyze the incidence of corporate income tax before discussing the tax reform, particularly in terms of an increase in consumption tax and a decrease in corporate income tax. In this study, we propose a theoretical model to investigate the tax incidence, and conduct a numerical analysis based on this model.

Static analyses of tax incidence began with the pioneering study of Harberger (1962), which was subsequently developed into dynamic analyses in order to consider intertemporal resource allocations. Many studies use dynamic models to investigate tax incidence, including Feldstein (1974), Boadway (1979), Atkinson and Stiglitz (1980), Homma (1981), Turnovsky (1982), Fullerton and Metcalf (2002), and Doi (2010).

On the other hand, simulation analyses of tax reforms in Japan became popular in the late 1980s, when consumption tax (VAT) was introduced, as well as in the mid-1990s, when the tax system was revised. However, there have been few such analyses in recent years. In addition, previous simulation analyses of the tax reforms focus mainly on the loss and gain of each agent as a result of the tax reform. Thus, these analyses in Japan do not prove the incidence of the burden of corporate income tax.

Recently, in the United States, Gravelle and Smetters (2006), Randolph (2006), and others conducted numerical analyses of the incidence of corporate income tax. However, they employ a static model, without corporate finance. Unfortunately, there have been no empirical studies on this topic in Japan for several decades.

In this study, and taking into account previous studies, we analyze the incidence of the burden of corporate income tax within the Japanese tax system using macroeconomic data. In particular, it is necessary that we employ a dynamic macroeconomic model in order to analyze and explain the intertemporal incidence. Therefore, this model enables us to analyze both the instantaneous and intertemporal incidence of corporate income tax.

Section 2 establishes the dynamic general equilibrium model that we use to analyze the incidence of corporate income tax. This model incorporates capital structure (i.e., choices of equity, debt, and retained earnings) in order to implement investment. It also includes a progressively increasing agency cost on debt. In Section 3, we present the results of the numerical analysis using the model established in Section 2. Finally, Section 4 concludes this paper.

2. Theoretical Framework

2-1. Behavior of Each Agent

In this section, we present the proposed theoretical model. In the following numerical analysis, we adopt a discrete time model. Turnovsky (1982, 1995) provides a continuous time model, which is similar to our model. The representative household lives indefinitely, and gains utility from the consumption of private goods and from leisure in each period. The representative household decides on its consumption and leisure to maximize its lifetime utility. In addition, households in this economy are homogeneous, and the population of households is one and is fixed in each period.

The price of private goods is 1, as the numeraire good, and the household is assumed to be a price taker. To simplify the analysis, we assume the economy is closed.

The lifetime utility function of the representative household is

$$\sum_{t=1}^{\infty} \rho^t U(c_t, l_t) \qquad\qquad 1 > \rho > 0,$$

where $U_c > 0$, $U_{cc} < 0$, $U_l < 0$, $U_{ll} \leq 0$, $U_{cl} \leq 0$,

c_t: private consumption (numeraire)

l_t: labor supply

ρ: discount factor of the household (constant over time).

The budget constraint of the representative household in period t is given as follows:

$$b_{t+1}^G - b_t^G + b_{t+1}^P - b_t^P + s_{t+1}(E_{t+1} - E_t) + (1+\tau_C)c_t$$

$$= (1-\tau_W)w_t l_t + (1-\tau_R)(r_t^G b_t^G + r_t^P b_t^P) + (1-\tau_D)D_t - \tau_G(s_{t+1}-s_t)E_t + T_t$$

where

b^G_t: outstanding government bonds (at the beginning of period t),

b^P_t: outstanding corporate bonds (at the beginning of period t),

D_t: dividends

E_t: number of shares outstanding (at the beginning of period t)

s_t: (relative) price of equities

w_t: wage rate

r^G_t: interest rate on government bonds

r^P_t: interest rate on corporate bonds

τ_C: consumption tax rate

τ_W: labor income tax rate

τ_R: interest income tax rate

τ_D: dividend income tax rate

τ_G: capital gains tax rate

T_t: lump-sum transfer from the government

$\chi_t \equiv \dfrac{D_t}{s_t E_t}$: dividend payout ratio.

The initial conditions of bonds and shares are as follows:

$b^G_0 = \overline{b^G}$, $b^P_0 = \overline{b^P}$, $E_0 = \overline{E}$

The representative household maximizes its lifetime utility under perfect foresight $\{c_t, l_t, b^G_t, b^P_t, E_t\}$:

$$\max \sum_{t=1}^{\infty} \rho^t U(c_t, l_t)$$

$$\text{s.t. } b_{t+1}^G - b_t^G + b_{t+1}^P - b_t^P + s_{t+1}(E_{t+1} - E_t) + (1+\tau_C)c_t$$
$$= (1-\tau_W)w_t l_t + (1-\tau_R)(r_t^G b_t^G + r_t^P b_t^P) + (1-\tau_D)D_t - \tau_G(s_{t+1}-s_t)E_t + T_t$$

given: w_t, r^G_t, r^P_t, s_t, τ_W, τ_R, τ_C, τ_D, τ_G, T_t

In this optimization problem, we obtain the first-order conditions for the representative household as follows (μ_t: Lagrangian multiplier of this optimization problem):

$U_{ct} \le (1 + \tau_C)\mu_t$

$c_t\{U_{ct} - (1 + \tau_C)\mu_t\} = 0$ (1)

$U_{lt} \le - w_t(1 - \tau_W)\mu_t$

$l_t\{U_{lt} + w_t(1 - \tau_W)\mu_t\} = 0$ (2)

$r^G_t(1 - \tau_R) \le \dfrac{\mu_{t-1}}{\rho\mu_t} - 1$

$$b^{G}_{t}\{r^{G}_{t}(1-\tau_{R}) - \frac{\mu_{t-1}}{\rho\mu_t} + 1\} = 0 \tag{3}$$

$$r^{P}_{t}(1-\tau_{R}) \leq \frac{\mu_{t-1}}{\rho\mu_t} - 1$$

$$b^{P}_{t}\{r^{P}_{t}(1-\tau_{R}) - \frac{\mu_{t-1}}{\rho\mu_t} + 1\} = 0 \tag{4}$$

$$(1-\tau_{D})\frac{D_t}{s_tE_t} + (1-\tau_{G})\frac{s_{t+1}-s_t}{s_t} \leq \frac{\mu_{t-1}}{\rho\mu_t} - 1$$

$$E_t\{(1-\tau_{D})\frac{D_t}{s_tE_t} + (1-\tau_{G})\frac{s_{t+1}-s_t}{s_t} - \frac{\mu_{t-1}}{\rho\mu_t} + 1\} = 0 \tag{5}$$

In addition, the transversality conditions are given by

$$\lim_{t\to\infty} \mu_t b^{G}_{t}\rho^{t} = 0,$$

$$\lim_{t\to\infty} \mu_t b^{P}_{t}\rho^{t} = 0,$$

$$\lim_{t\to\infty} \mu_t s_t E_t\rho^{t} = 0.$$

In the above conditions, the rate of return on consumption is denoted as

$$\theta_t \equiv \frac{\mu_{t-1}}{\rho\mu_t} - 1. \tag{6}$$

From (4) and (5), we obtain

$$\frac{(1-\tau_{G})(s_{t+1}-s_t)E_t + (1-\tau_{D})D_t}{s_tE_t} = \theta_t = r^{P}_{t}(1-\tau_{R}) = r^{G}_{t}(1-\tau_{R}). \tag{7}$$

The above equation provides an arbitrage condition between equity and corporate bonds for the representative household. Therefore, we have:

$$(s_{t+1}-s_t)E_t = \frac{\theta_t s_t E_t}{1-\tau_{G}} - \frac{(1-\tau_{D})D_t}{1-\tau_{G}}. \tag{5'}$$

Next, the firm decides on the amount of labor, capital (investment), and finance (by equity or debt) to maximize the intertemporal corporate value. We set the following production function of the representative firm:

$y_t = F(k_t, l_t)$,

where $F_l > 0$, $F_{ll} < 0$, $F_k > 0$, $F_{kk} < 0$

y_t: output

l_t: labor input

k_t: capital input.

Furthermore, we assume homogeneity of degree one in the production function. Then,

$$F(k_t, l_t) = F(\frac{k_t}{l_t}, 1)l_t \equiv f(\frac{k_t}{l_t})l_t \qquad f'(\frac{k_t}{l_t}) > 0,\ f''(\frac{k_t}{l_t}) < 0.$$

Therefore, we have:

$$F_k(k_t, l_t) = f'(\frac{k_t}{l_t}),$$

$$F_l(k_t, l_t) = f(\frac{k_t}{l_t}) - \frac{k_t}{l_t} f'(\frac{k_t}{l_t}).$$

The production function is assumed to satisfy the Inada condition. Then, we describe the dynamics of capital as follows:

$$k_{t+1} = I_t + (1-\delta)k_t, \qquad (8)$$

where I_t: (gross) investment.

In order to make the model more realistic, we introduce an adjustment cost to private investment. Here, we set an adjustment cost function of capital, as follows:

$$C(I_t, k_t).$$

As established by Hayashi (1982), the adjustment cost function is assumed to be homogenous and of degree one:

$$C(I_t, k_t) = C_I(I_t, k_t)I_t + C_k(I_t, k_t)k_t$$

and

$$C(I_t, k_t) \geq 0,\ C(0, k_t) = 0,\ C_I(0, k_t) = 0,$$

Furthermore, the model needs to incorporate the capital structure of the firm. Now, the debt-equity ratio is expressed as

$$\lambda_t \equiv \frac{b^P{}_t}{s_t E_t},\ 0 \leq \lambda_t$$

(net worth to total assets ratio: $\frac{s_t E_t}{b^P{}_t + s_t E_t} = \frac{1}{1+\lambda_t}$)

As proposed by Osterberg (1989), we suppose there is an agency cost on debt. Here, $a(\lambda_t)$ denotes the per unit agency cost on debt, which we assume to be a convex function of λ_t, where $a(0) > 0$, $a_\lambda > 0$, and $a_{\lambda\lambda} \geq 0$. This can be interpreted as a financial distress cost to the firm. Hence, the effective interest payment by the firm in period t is expressed as $\{r^P{}_t + a(\lambda_t)\}b^P{}_t$. This agency cost is crucial to the incidence of corporate income tax in the long term, particularly when comparing our findings to those of previous studies. We discuss this in detail later in the paper.

The after-tax profit of the representative firm in period t is represented as follows:

$$y_t - w_t l_t - \{r^P{}_t + a(\lambda_t)\}b^P{}_t - \delta k_t - C(I_t, k_t)$$
$$- \tau_F[y_t - w_t l_t - \{r^P{}_t + a(\lambda_t)\}b^P{}_t - \delta k_t - C(I_t, k_t)] + \sigma I_t = D_t + RE_t \qquad (9)$$

where

τ_F: corporate income tax rate

RE_t: retained earnings

σ : rate of investment tax credit

δ : depreciation rate ($0 \le \delta \le 1$: constant over time).

Then, we can describe the corporate finance for investment as follows:

$$I_t = RE_t + s_{t+1}(E_{t+1} - E_t) + b_{t+1}^P - b_t^P \tag{10}$$

From (9) and (10), we obtain

$$s_{t+1}(E_{t+1} - E_t) + b_{t+1}^P - b_t^P$$
$$= D_t - (1-\tau_F)[y_t - w_t l_t - \{r_t^P + a(\lambda_t)\}b_t^P - \delta k_t - C(I_t, k_t)] + (1-\sigma)I_t \tag{11}$$

In (10), the dividend D_t and the share repurchase (the negative value of $s_t(E_{t+1} - E_t)$) are equivalent. This is theoretically natural, but if we adopt or assume a shareholder return policy in this model, the volumes of dividends and share repurchases cannot be determined numerically. The assumption of a shareholder return policy will be described in more detail later.

We define the corporate value of the representative firm in period t, V_t, as follows:

$$V_t = s_t E_t + b^P_t.$$

We suppose that the representative firm maximizes its initial market value, V_0, given the following initial conditions:

$$k_0 = \overline{k}\ ,\ b^P_0 = \overline{b^P}\ ,\ E_0 = \overline{E}\ .$$

The equation of motion of V_t is described as

$$V_{t+1} - V_t = s_{t+1}E_{t+1} + b_{t+1}^P - s_t E_t - b_t^P$$
$$= (s_{t+1} - s_t)E_t + s_{t+1}(E_{t+1} - E_t) + b_{t+1}^P - b_t^P.$$

Substituting the above equation and (5)' into (11), we have

$$V_{t+1} - V_t = \frac{\theta_t s_t E_t}{1-\tau_G} - \frac{(1-\tau_D)D_t}{1-\tau_G} + D_t$$
$$- (1-\tau_F)[y_t - w_t l_t - \{r^P_t + a(\lambda_t)\}b^P_t - \delta k_t - C(I_t, k_t)] + (1-\sigma)I_t \tag{12}$$

In (12), we define

$$\Gamma_t \equiv (1-\tau_F)[y_t - w_t l_t - \delta k_t - C(I_t, k_t)] - (1-\sigma)I_t.$$

Then, (12) becomes

$$V_{t+1} = [1 + (1-\tau_F)\{r^P_t + a(\lambda_t)\}\frac{\lambda_t}{1+\lambda_t} + \frac{\theta_t}{1-\tau_G}\frac{1}{1+\lambda_t}]V_t + \frac{(\tau_D - \tau_G)D_t}{1-\tau_G} - \Gamma_t \tag{13}$$

Here, the shareholder return policy or the financing instrument for investment matter. Hence, we adapt the tax capitalization view ("new view") of the shareholder return policy, as proposed by King (1974) and Auerbach (1979, 1981) (see Auerbach (2002)). The new view implies that

$$I_t = RE_t.$$

Thus, $s_{t+1}(E_{t+1} - E_t) + b^P_{t+1} - b^P_t = 0$, from (10). This view is assumed to be satisfied in all periods in the proposed model.

From (11), we obtain

$$D_t = (1 - \tau_F)[y_t - w_t l_t - \{r^P{}_t + a(\lambda_t)\}b^P{}_t - \delta k_t - C(I_t, k_t)] - (1 - \sigma)I_t.$$

From the above equations, (13) can be rewritten as

$$V_{t+1} = [1 + \frac{1 - \tau_D}{1 - \tau_G}(1 - \tau_F)\{r^P{}_t + a(\lambda_t)\}\frac{\lambda_t}{1+\lambda_t} + \frac{\theta_t}{1 - \tau_G}\frac{1}{1+\lambda_t}]V_t - \frac{1 - \tau_D}{1 - \tau_G}\Gamma_t.$$

In this equation, we define

$$\gamma_t \equiv \frac{1 - \tau_D}{1 - \tau_G}\frac{1 - \tau_F}{1 - \tau_R}\{\theta_t + (1 - \tau_R)a(\lambda_t)\}\frac{\lambda_t}{1+\lambda_t} + \frac{\theta_t}{1 - \tau_G}\frac{1}{1+\lambda_t} \tag{14}$$

using $r^P{}_t = \dfrac{\theta_t}{1 - \tau_R}$ (4)'

Here, γ_t is the weighted average of the cost of debt capital and equity capital, and denotes the (instantaneous) cost of capital in period *t*. Then, (13) becomes

$$V_{t+1} = (1 + \gamma_t)V_t - \frac{1 - \tau_D}{1 - \tau_G}\Gamma_t.$$

Solving the above difference equation, we have

$$V_0 = \sum_{t=0}^{\infty}\frac{1-\tau_D}{1-\tau_G}\Gamma_t\left\{\prod_{i=0}^{t}(1+\gamma_i)\right\}^{-1}.$$

The representative firm maximizes its corporate value by choosing $\{k_t, I_t, l_t, b^P{}_t, E_t, \lambda_t\}$:

$$\max\ V_0 = \sum_{t=0}^{\infty}\frac{1-\tau_D}{1-\tau_G}\Gamma_t\left\{\prod_{i=0}^{t}(1+\gamma_i)\right\}^{-1} \tag{15}$$

$$\text{s.t.}\ \ k_{t+1} = I_t + (1-\delta)k_t \tag{8}$$

given: $w_t, r^P{}_t, \theta_t, s_t, \tau_R, \tau_W, \tau_G, \tau_D, \tau_F, \sigma$.

The firm chooses the real cash flow or the instantaneous cost of capital (the rate of discount) in order to maximize the corporate value. Then, (14) indicates that the instantaneous cost of capital γ_t (the rate of discount in (15)) depends only on the debt-equity ratio λ_t as variables that the firm can manipulate. Therefore, in order to maximize the corporate value, the firm decides on the value of λ_t to minimize the instantaneous cost of capital in period *t*.

In this problem, the firm first minimizes the instantaneous cost of capital γ_t by choosing λ_t, given θ_t, τ_R, τ_G, τ_D, and τ_F:

$$\frac{\partial \gamma_t}{\partial \lambda_t} = 0 .$$

This implies the following:

$$\frac{(1-\tau_D)(1-\tau_F)}{1-\tau_R}\{\theta_t + (1-\tau_R)a(\lambda_t) + (1-\tau_R)a'(\lambda_t)(1+\lambda_t)\lambda_t\} - \theta_t = 0 \qquad (16)$$

Here, λ^*_t denotes λ_t such that equality holds in (16). Solving (16), the minimized (instantaneous) cost of capital γ^*_t is defined as

$$\gamma_t^* = \frac{\theta_t}{1-\tau_G} - a'(\lambda_t^*)\frac{(1-\tau_D)(1-\tau_F)}{1-\tau_G}(\lambda_t^*)^2 \qquad (17)$$

In (17), we find that the (minimized) instantaneous cost of capital γ^*_t is affected by the corporate income tax rate τ_F and is (a function of) the agency cost on debt.

Secondly, the representative firm maximizes its corporate value by choosing $\{k_t, I_t, l_t\}$ under γ^*_t, as follows:

$$\max \;\; V_0 = \sum_{t=0}^{\infty}\frac{1-\tau_D}{1-\tau_G}\Gamma_t\left\{\prod_{i=0}^{t}(1+\gamma_i^*)\right\}^{-1} \qquad (15)'$$

$$\text{s.t.} \;\; k_{t+1} = I_t + (1-\delta)k_t \qquad (8)$$

given: w_t, r^P_t, θ_t, s, τ_R, τ_W, τ_G, τ_D, τ_F, σ.

The optimality conditions of this optimization problem are expressed as follows (q_t: the Lagrangian multiplier for (8)):

$$\frac{1-\tau_D}{1-\tau_G}(1-\tau_F)(F_{lt} - w_t) = 0$$

$$-\frac{1-\tau_D}{1-\tau_G}\{1-\sigma + (1-\tau_F)C_{It}\} + q_t = 0$$

$$q_t - q_{t-1} - \gamma^*_t q_{t-1} = -\frac{(1-\tau_D)(1-\tau_F)}{1-\tau_G}(F_{kt} - \delta - C_{kt}) + \delta q_t.$$

The transversality condition of this problem is given by

$$\lim_{t\to\infty} q_t k_t \left\{\prod_{i=0}^{t}(1+\gamma_i^*)\right\}^{-1} = 0.$$

Therefore, we obtain the following conditions for the representative firm:

$$F_{lt} = w_t \qquad (18)$$

$$q_t = \frac{1-\tau_D}{1-\tau_G}\{1-\sigma + (1-\tau_F)C_{It}\} \qquad (19)$$

$$(1-\delta)q_t = (1+\gamma^*_t)q_{t-1} - \frac{(1-\tau_D)(1-\tau_F)}{1-\tau_G}(F_{kt} - \delta - C_{kt}) \qquad (20)$$

Finally, we describe the behavior of the government. The government operates in accordance with its flow budget constraint:

$$b_{t+1}^G - b_t^G + \tau_W w_t l_t + \tau_R (r_t^G b_t^G + r_t^P b_t^P) + \tau_D D_t + \tau_G (s_{t+1} - s_t) E_t + \tau_C c_t$$
$$+ \tau_F [y_t - w_t l_t - \{r^P_t + a(\lambda_t)\} b^P_t - \delta k_t - C(I_t, k_t)] - \sigma I_t = r^G_t b^G_t + T_t \qquad (21)$$

2-2. Perfect Foresight Equilibrium

In this system, there are five endogenous variables $\{c_t, l_t, k_t, q_t, \lambda_t\}$ and eight exogenous variables $\{T_t, \tau_R, \tau_W, \tau_C, \tau_D, \tau_G, \tau_F, \sigma\}$ for the household and the firm. In the private goods market, the following equilibrium condition is satisfied:

$$y_t = c_t + I_t + C(I_t, k_t) \qquad (22)$$

Then, the perfect foresight equilibrium includes the following conditions:

$$\frac{U_l(c_t, l_t)}{U_c(c_t, l_t)} = -\frac{1 - \tau_W}{1 + \tau_C} F_l(k_t, l_t) \qquad (23)$$

$$a(\lambda_t^*) + a'(\lambda_t^*)(1 + \lambda_t^*)\lambda_t^* = \theta_t \left\{ \frac{1}{(1-\tau_D)(1-\tau_F)} - \frac{1}{1-\tau_R} \right\} \qquad (16)'$$

$$\text{where } \theta_t = \frac{U_c(c_{t-1}, l_{t-1})}{\rho U_c(c_t, l_t)} - 1 \qquad (6)'$$

$$q_t = \frac{1 - \tau_D}{1 - \tau_G} \{(1 - \sigma) + (1 - \tau_F) C_I(k_{t+1} - (1-\delta)k_t, k_t)\} \qquad (19)'$$

$$(1-\delta) q_t = (1 + \gamma^*_t) q_{t-1}$$
$$- \frac{(1 - \tau_D)(1 - \tau_F)}{1 - \tau_G} \{F_k(k_t, l_t) - \delta - C_k(k_{t+1} - (1-\delta)k_t, k_t)\} \qquad (20)'$$

$$\text{where } \gamma_t^* = \frac{\theta_t}{1-\tau_G} - a'(\lambda_t^*) \frac{(1-\tau_D)(1-\tau_F)}{1-\tau_G} (\lambda_t^*)^2 \qquad (17)$$

$$F(k_t, l_t) = c_t + k_{t+1} - (1-\delta)k_t + C(k_{t+1} - (1-\delta)k_t, k_t) \qquad (22)'$$

2-3. Steady-State Equilibrium

In the steady state, $c_{t+1} = c_t = c$, $k_{t+1} = k_t = k$, $l_{t+1} = l_t = l$, $q_{t+1} = q_t = q$, $\lambda_{t+1} = \lambda_t = \lambda$, $b_{t+1}^P = b_t^P = b^P$, and $E_{t+1} = E_t = E$. In the steady state, the following conditions hold:

$$(1 + \tau_C) U_l(c, l) + F_l(k, l)(1 - \tau_W) U_c(c, l) = 0 \qquad (23)'$$

$$a(\lambda^*) + a'(\lambda^*)(1 + \lambda^*)\lambda^* = \theta \left\{ \frac{1}{(1-\tau_D)(1-\tau_F)} - \frac{1}{1-\tau_R} \right\} \qquad (16)''$$

where $\theta = \dfrac{1}{\rho} - 1$ (6)”

$$q = \frac{1-\tau_D}{1-\tau_G}\{1-\sigma+(1-\tau_F)C_I(\delta k, k)\} \quad (19)”$$

$$(\delta + \gamma^*)q = \frac{(1-\tau_D)(1-\tau_F)}{1-\tau_G}\{F_k(k, l) - \delta - C_k(\delta k, k)\} \quad (20)”$$

where $\gamma^* = \dfrac{\theta}{1-\tau_G} - a'(\lambda^*)\dfrac{(1-\tau_D)(1-\tau_F)}{1-\tau_G}(\lambda^*)^2$ (17)’

$$F(k,l) = c + \delta k + C(\delta k, k) \quad (22)”$$

2-4. Function Specifications

We conduct a numerical analysis to investigate the incidence of corporate income tax using this model. For the numerical analysis, we specify the aforementioned functions. In order to explore the incidence in the Japanese economy, we adopt functional forms based on Hayashi and Prescott (2002), which examines the recent Japanese economy using a dynamic macroeconomic model.

The instantaneous utility function is specified as

$$U(c_t, l_t) = \frac{c_t^{1-\omega}}{1-\omega} - \alpha l_t^{1+\eta}.$$

In Hayashi and Prescott (2002), $\omega = 1$ and $\eta = 0$; that is,

$$U(c_t, l_t) = \ln c_t - \alpha l_t.$$

The production function is assumed to be the Cobb-Douglas function,

$$y_t = A k_t^{\zeta} l_t^{1-\zeta} \qquad 0 \le \zeta \le 1.$$

The adjustment cost function of investment is given as

$$C(I_t, k_t) = \psi\left(\frac{I_t^2}{k_t}\right),$$

where ψ is a positive constant, based on Pratap (2003), which is not used in Hayashi and Prescott (2002). The function of the agency cost on debt is specified as

$$a(\lambda_t) = a_0 + a_1 \lambda_t^2,$$

where a_0 and a_1 are positive constants. Next, we introduce the constant term a_0 into the above equation. This can be interpreted as an interest rate spread between corporate bonds and government bonds. From the arbitrage condition in (7), $r^P{}_t = r^G{}_t$ for the representative household, in equilibrium. From the debtors’ point of view, the effective interest rate of the representative firm is $r^{P}_{t} + a(\lambda_t) > r^{G}_{t}$. This situation is quite normal. However, if $a_0 = 0$, the representative firm's marginal increase of λ_t from zero (all-equity financed) means it can issue its corporate bond at almost the same (effective) interest rate r^{P}_{t} as the interest rate of a government bond r^{G}_{t}. In the other words, the firm faces no spread between the two in this situation, which is not realistic. Therefore, we set $a_0 > 0$, which implies a basic spread between corporate and government bonds.

In addition, a_1 means that the interest rate spread between corporate and government bonds widens by a_1 basis points with a one-percentage-point increase in the debt-equity ratio λ_t.

Substituting these functions into (6)', (16)', (17), (19)', (20)', (22)', and (23), we have:

$$\frac{c_t}{c_{t-1}} = \left\{\rho(1+\theta_t)\right\}^{\frac{1}{\omega}} \tag{6)'''$$

$$r^{P}_{t} = \frac{\theta_t}{1-\tau_R} \tag{4)'$$

$$\lambda_t^{\,2}(3+2\lambda_t) = \frac{\theta_t}{a_1}\left\{\frac{1}{(1-\tau_D)(1-\tau_F)} - \frac{1}{1-\tau_R}\right\} - \frac{a_0}{a_1} \tag{16)'''$$

$$\gamma_t = \frac{\theta}{1-\tau_G} - \frac{(1-\tau_D)(1-\tau_F)}{1-\tau_G}2a_1\lambda_t^3 \tag{17)''$$

$$\frac{k_{t+1}}{k_t} = \frac{\frac{1-\tau_G}{1-\tau_D}q_t - 1 + \sigma}{2\psi(1-\tau_F)} + 1 - \delta \tag{8)'$$

$$\begin{aligned}(1-\delta)q_t = (1+\gamma_t)q_{t-1} - \frac{1-\tau_D}{1-\tau_G}\Bigg[&(1-\tau_F)\left\{A\zeta\left(\frac{k_t}{l_t}\right)^{\zeta-1} - \delta\right\} \\ &+ \frac{1}{4\psi(1-\tau_F)}\left(\frac{1-\tau_D}{1-\tau_G}q_t - 1 + \sigma\right)^2\Bigg]\end{aligned} \tag{20)'''$$

$$w_t = A(1-\zeta)\left(\frac{k_t}{l_t}\right)^{\zeta} \tag{18)'$$

$$\begin{aligned}c_t = {}& Ak_t^{\zeta}l_t^{1-\zeta} \\ &- \frac{k_t}{2\psi(1-\tau_F)}\left(\frac{1-\tau_G}{1-\tau_D}q_t - 1 + \sigma\right)\left\{1 + \frac{1}{2(1-\tau_F)}\left(\frac{1-\tau_G}{1-\tau_D}q_t - 1 + \sigma\right)\right\}\end{aligned} \tag{22)'''$$

$$\frac{w_t}{c_t^{\,\omega}} = \frac{1+\tau_C}{1-\tau_W}(1+\eta)\alpha l_t^{\eta} \tag{23)''$$

The cubic equation (16)''' has two imaginary roots and one real root. The only real root is

$$\lambda_t = \frac{1}{2}\left[\left\{2Z_t - 1 + 2\sqrt{Z_t(Z_t - 1)}\right\}^{-1/3} + \left\{2Z_t - 1 + 2\sqrt{Z_t(Z_t - 1)}\right\}^{1/3} - 1\right] \tag{24}$$

where $Z_t = \frac{\theta_t}{a_1}\left\{\frac{1}{(1-\tau_D)(1-\tau_F)} - \frac{1}{1-\tau_R}\right\} - \frac{a_0}{a_1}$.

We assume (24) holds in this system.

In this system, which is composed of the above equations, the steady-state solutions for the endogenous variables are

$$\theta = \frac{1}{\rho} - 1 \tag{25}$$

$$r^{\mathrm{P}} = \frac{\theta}{1 - \tau_{\mathrm{R}}} \tag{26}$$

$$Z = \frac{\theta}{a_1}\left\{\frac{1}{(1-\tau_D)(1-\tau_F)} - \frac{1}{1-\tau_R}\right\} - \frac{a_0}{a_1} \tag{27}$$

$$\lambda = \frac{1}{2}\left[\left\{2Z - 1 + 2\sqrt{Z(Z - 1)}\right\}^{-1/3} + \left\{2Z - 1 + 2\sqrt{Z(Z - 1)}\right\}^{1/3} - 1\right] \tag{28}$$

$$\gamma^* = \frac{\theta}{1-\tau_G} - \frac{(1-\tau_D)(1-\tau_F)}{1-\tau_G} 2a_1\lambda^3 \tag{29}$$

$$q = \frac{1 - \tau_{\mathrm{D}}}{1 - \tau_{\mathrm{G}}}\{1 - \sigma + 2\psi(1 - \tau_{\mathrm{F}})\delta\} \tag{30}$$

$$\frac{k}{l} = \left[\frac{(1-\tau_D)(1-\tau_F)A\zeta}{(1-\tau_G)(\delta+\gamma^*)q + (1-\tau_D)(1-\tau_F)(\delta - \psi\delta^2)}\right]^{\frac{1}{1-\zeta}} \tag{31}$$

$$w = A(1-\zeta)\left(\frac{k}{l}\right)^{\zeta} \tag{32}$$

$$\frac{c}{l} = A\left(\frac{k}{l}\right)^{\zeta} - (\delta + \psi\delta^2)\frac{k}{l} \tag{33}$$

$$l = \left(\frac{(1-\tau_W)w}{(1+\tau_C)(1+\eta)\alpha}\right)^{\frac{1}{\eta+\omega}} \left(\frac{c}{l}\right)^{-\frac{\omega}{\eta+\omega}} \tag{34}$$

$$k = \left(\frac{k}{l}\right) l \tag{35}$$

$$c = \left(\frac{c}{l}\right) l \tag{36}$$

From these equations, the steady-state values are expressed as $\{\theta, r^{\mathrm{P}}, \lambda, \gamma^*, q,$

$w, l, k, c\}$.

3. Simulation

3-1. Parameter Settings

First, we conduct a numerical analysis of a corporate income tax reduction in Japan, based on the proposed model by using Dynare. Here, we set the values of the parameters in the various functions and the policy variables to replicate the economic situation in Japan (see Table 1). Our analysis is based on quarters and, thus, one period refers to one quarter. Then, we set $\zeta = 0.362$, $\rho = 0.993945$ (= $(0.976)^{1/4}$), $\alpha = 0.34325$ (= 1.373/40), $\delta = 0.021543$ (= $(1 + 0.089)^{1/4} - 1$), as in Hayashi and Prescott (2002). These values are close to the present condition of the Japanese economy. The values of a_0 and a_1 in the agency cost on debt function are set so as to make λ in (28), or the net worth to total assets ratio, in the existing steady state more realistic. The net worth to total assets ratio of commercial corporations in all industries, excluding the finance and insurance industries, at the end of March 2015 was 43.3%, according to the "Financial Statements Statistics of Corporations by Industry" issued by the Ministry of Finance. The values of A and ψ are standardized to one. The tax rates used in this study are almost the same as the current rates in Japan.

Then, we clarify the equilibrium in the steady state from (25)~(36). Table 1 shows the solution for each variable in the steady state when the parameters are set to the above values. We find that these values are practical. U denotes the value of the instantaneous utility in the steady state.

Here, we can analyze the economic effects using a dynamic macroeconomic model based on these parameters and the above simultaneous equations.

3-2. Incidence of Corporate Income Tax

In this section, we conduct a quantitative analysis on the incidence of corporate income tax in Japan. Here, we employ the definition of tax incidence proposed by Feldstein (1974).

The incidence of a change in tax on labor income is defined as

$$\frac{ld[(1-\tau_W)F_l]}{ld[(1-\tau_W)F_l]+kd[(1-\tau_K)F_k]} \tag{37}$$

where τ_K: (effective) tax rate on capital income.

Now, (37) can be rewritten as

$$\frac{d[(1-\tau_W)(f-\kappa f')]}{d[(1-\tau_W)(f-\kappa f')]+\kappa d[(1-\tau_K)f']}$$

$$\text{where } \kappa \equiv \frac{k}{l},\ f \equiv \frac{F(k,l)}{l}.$$

In this study, we change only the corporate income tax rate in order to investigate the incidence of corporate income tax. However, (27), (30), (31), and (34) indicate that the other tax rates may affect the steady-state values of this model. Therefore, we include the other tax rates in the following numerical analysis. In addition, we assume that the change in tax revenue following a change in the corporate income tax rate is appropriated for a change in the lump-sum transfer to households (T_t), consistent with the government's budget constraint (21).

Initially, we investigate the incidence on labor income after a 4.88% decrease in the corporate income tax rate. A 4.88% decrease means the (effective) corporate income tax rate decreases from 34.62% to 29.74%.[1] The (effective) corporate income tax rate in Japan was 34.62% in 2014. The Japanese government plans to decrease the (effective) corporate income tax rate to 29.74% by 2018.[2]

Figure 1 shows the incidence on labor income over 100 periods after a once-off decrease in the corporate income tax rate. In addition, Figure 2 shows the percentage deviation of each variable from the existing steady state (at period zero) on the transition path.

The values of the other variables in the new steady state are shown in Table 2. Table 2 indicates that θ and r^P are unchanged after a decrease in corporate income tax rate, as (25) and (26) are suggested. In addition, the costs of capital γ^* rises due to a decrease in corporate income tax rate, and the instantaneous utility U rises with the tax reduction.

Figure 1 shows that 18.0% of the burden of corporate income tax, calculated from (37), results in labor income, while the remaining 82.0%

1 The "effective" tax rate is the sum of the corporate income tax rate (a national tax), the inhabitants tax rate for corporations (a local tax), and the income component of the enterprise tax rate (a local tax), with its tax deductibility, applied to a company with capital of over 100 million yen. See Doi and Ihori (2009) for further details on the Japanese tax system.

2 At the same time, the Japanese government will increase the size-based business tax rates (added value component and capital component) in the enterprise tax of local tax. The effects of these increases are not included in this numerical analysis, and are left as topics for future research.

results in capital income in the short term (i.e., the first quarter), given the parameter values specified above.

Over one year (in the fourth quarter), about 60% of the burden results in labor income and the remaining 40% results in capital income. Over time, the ratio of the burden resulting in labor income increases, reaching 90% in the long term (see Figure 1).

Turnovsky (1995) shows that the entire burden of corporate income tax results in labor income in the long term. In addition, based on a dynamic general equilibrium model, without an agency cost on debt and an adjustment cost of investment, Doi (2010) shows the same result using numerical analyses. Turnovsky (1995) uses a theoretical model without an agency cost on debt. Thus, even if the corporate income tax rate changes, the instantaneous cost of capital in the steady state remains unchanged at $\gamma^* = \frac{\theta}{1-\tau_G}$, because the rate of return on consumption in the steady state, θ, is fixed, regardless of the corporate income tax rate. With no agency cost on debt, the instantaneous cost of capital converges to the same value as in the previous steady states when the rate of corporate income tax changes. Therefore, it is affected by the corporate income tax rate in the short term, but converges to the same rate of return on capital in the long term. Therefore, in the long term, the burden of corporate income tax does not result in capital income at all, but results in labor income completely.

On the other hand, our analysis proves that about 10% of the burden results in capital income in the long term. This is caused by the agency cost on debt. Thus, as represented in (17)' or (29), as the corporate income tax rate changes, the instantaneous cost of capital in the steady state fluctuates according to the effect of the agency cost on debt. If the corporate income tax rate increases, there is some incentive to raise the debt-equity ratio λ_t because the effect of tax avoidance on finance debt increases. However, the higher the debt-equity ratio λ_t is raised, the more the agency cost on debt increases. Therefore, the burden of corporate income tax also results in capital income in the long term because of the influence of the increase in the agency cost on debt caused by the increase in the corporate income tax rate.

3-3. Sensitivity Analyses

The result of the benchmark case may vary with the parameter values. When the firm spends more on wages, the labor share of income increases. This implies that ζ decreases in the production function. Figure 3 shows the incidence on labor income after a 4.88% decrease in the corporate income tax rate for $\zeta = 0.25$, with the other parameters remaining the same as in the benchmark case. Figure 4 shows the percentage deviation of each variable from the existing steady state on the transition path in this case.

Here, about 23.7% of the burden of corporate income tax results in labor income and the remaining 76.3% results in capital income in the short term (i.e., the first quarter).

After one year (in the fourth quarter), about 70% of the burden results in labor income and about 30% results in capital income. Over time, the ratio of the burden resulting in labor income increases, reaching about 90% in the long term.

In this case, the incidence of corporate income tax in the long term is the same as in the benchmark case, because ζ does not affect the instantaneous cost of capital in the new steady state, γ^* (0.006236). The values of the other variables are shown in Table 3. We find that the instantaneous utility U rises after a decrease in corporate income tax.

Parameter a_1 in the agency cost on debt function may affect the instantaneous cost of capital in the steady state, based on (29). Figure 5 shows the incidence on the transition path for $a_1 = 0.0037$, which is 10 times larger than the previous value, with the other parameters remaining the same as in the benchmark case. This change implies that the interest rate spread between corporate and government bonds widens by 0.0037, not 0.00037, basis points with a one percentage point increase in the debt-equity ratio λ_t. Figure 6 describes the percentage deviation of each variable from the existing steady state on the transition path in this case. As shown in Tables 1 and 4, we cannot directly compare the transition paths of the main variables between this case and the benchmark case, because the costs of capital γ^* in the existing steady states of the two cases are different.

In this case, when a_1 increases, about 17.9% of the burden of corporate income tax results in labor income and 82.1% results in capital income in the short term (in the first quarter). In the short term, the effects are almost the same, but in the long term, the incidence of labor income increases.

After a year (in the fourth quarter), about 60% of the burden results in labor income and about 40% results in capital income. Over time, the ratio of the burden resulting in labor income increases to about 95% in the long term. This ratio increases as parameter a_1 increases because a_1 affects the instantaneous cost of capital in the new steady state, γ^* (0.006439, not 0.006236). The values of the other variables are shown in Table 4. Table 4 implies that the instantaneous utility U rises after a decrease in corporate income tax.

4. Concluding Remarks

In this study, we analyzed the incidence of corporate income tax using a dynamic general equilibrium model. We conducted a simulation using parameter values based on the Japanese economy, and measured the incidence of corporate income tax on labor income. Here, we assume the Japanese government decreases the (effective) corporate income tax rate from 34.62% to 29.74%.

The benchmark case indicates that after a 4.88% decrease in the (effective) corporate income tax rate, the percentage of the incidence on labor income is about 20–60%, and the percentage of the incidence on capital income is about 40–80%, in the short term (one year). In the long term, about 90% of the incidence is on labor income. Almost all the incidence shifts to labor income.

According to Turnovsky (1995), the entire incidence shifts to labor income in the long term. The difference between these results seems to be caused by the agency cost on debt. In this study, the instantaneous cost of capital in the steady state is expressed as

$$\gamma^* = \frac{\theta}{1-\tau_G} - a'(\lambda^*)\frac{(1-\tau_D)(1-\tau_F)}{1-\tau_G}(\lambda^*)^2 \tag{17'}$$

On the other hand, without the agency cost on debt (as in Turnovsky (1995)), this becomes

$$\gamma^* = \frac{\theta}{1-\tau_G}.$$

A policy implication of the analysis presented here is that a large share of the incidence of corporate income tax is on labor income in Japan. Moreover, the percentage of the incidence on labor income increases in the long term. Thus, we conclude that a reduction in the corporate income tax rate is more advantageous to labor income (more specifically, the labor income after taxation changes).

We have adapted the tax capitalization view (“new view”) of the shareholder return policy. However, firms can use a different type of shareholder return policy. Moreover, the above results are derived within a closed economy model, although firms face international competition in a real economy. These are important issues that need to be addressed in future research.

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Table 1

Parameter Values and Steady-State Values of Variables

α	0.34325
ζ	0.362
ψ	1
A	1
ρ	0.993945
δ	0.021544
a_0	0.0004
a_1	0.00037
τ_C	0.08
τ_D	0.2
τ_F	0.3462
τ_G	0.15
τ_R	0.2
τ_W	0.1
σ	0.01

Steady state	
τ_F	0.3462
θ	0.006092
r^P	0.007615
γ^*	0.006121
λ	1.31944
q	0.958279
k/l	15.05822
c/y	0.875847
k/y	5.641884
U	0.464864

Table 2

Values of Variables in the New Steady State

(Benchmark Case)

τ_F	0.2974
θ	0.006092
r^P	0.007615
γ^*	0.006341
λ	1.19075
q	0.960258
k/l	16.06285
c/y	0.870620
k/y	5.879157
U	0.484294

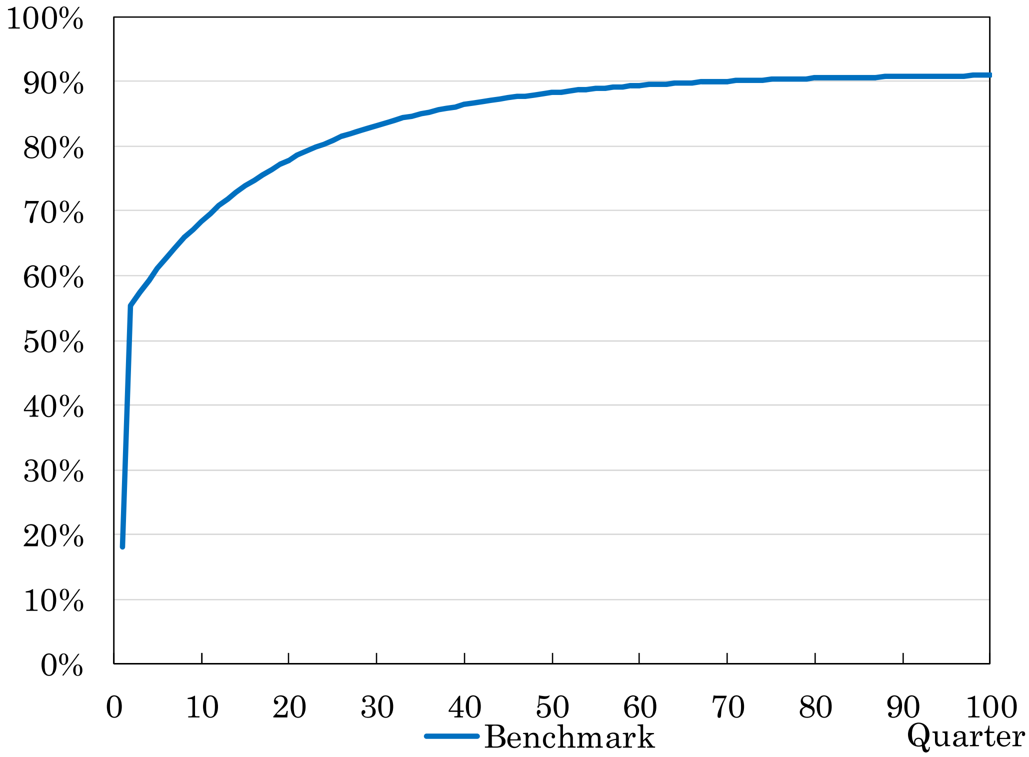
Table 3
Values of Variables in Steady States
($\zeta = 0.25$)

	Existing		New
τ_F	0.3462		0.2974
θ	0.006092		0.006092
r^P	0.007615		0.007615
γ^*	0.006121		0.006341
λ	1.31944	$\rightarrow$	1.19075
q	0.958279		0.959296
k/l	6.131175		6.477477
c/y	0.91422		0.910664
k/y	3.896262		4.060372
U	0.019054		0.030146

Table 4
Values of Variables in Steady States
($a_1 = 0.0037$)

	Existing		New
τ_F	0.3462		0.2974
θ	0.006092		0.006092
r^P	0.007615		0.007615
γ^*	0.006344		0.006525
λ	0.874543	$\rightarrow$	0.785845
q	0.958279		0.960258
k/l	14.93207		15.95465
c/y	0.876499		0.871157
k/y	5.611706		5.853763
U	0.459246		0.479874

Figure 1
The Incidence on Labor Income after a 4.88% (from 34.62% to 29.74%) Decrease in the Corporate Income Tax Rate
(Benchmark Case)



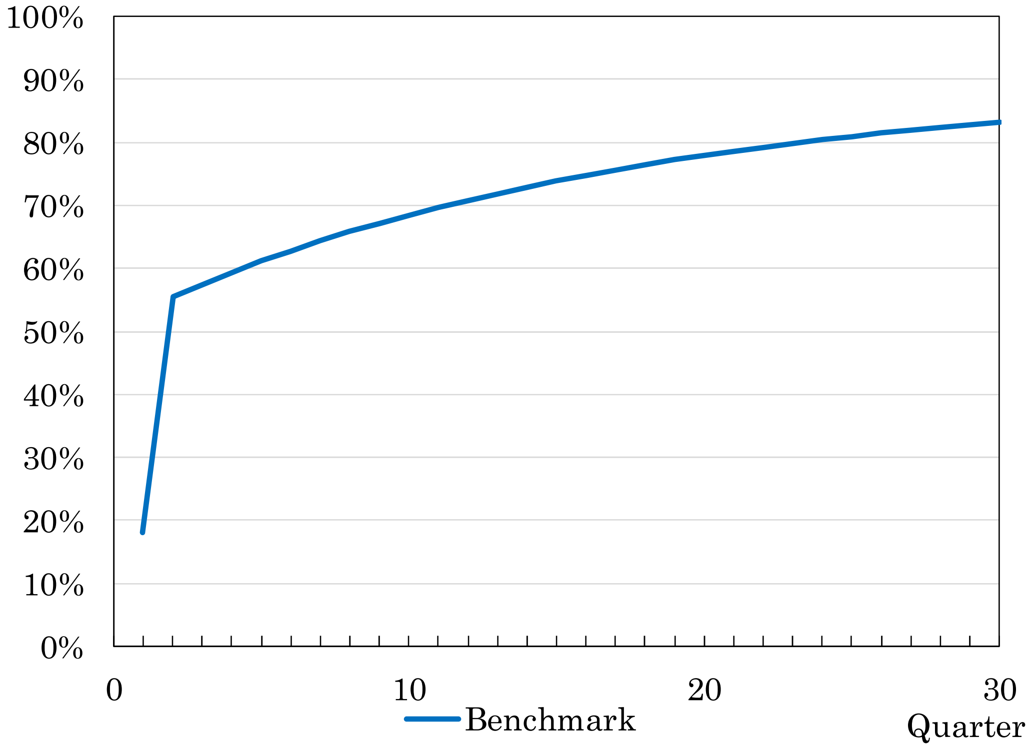


Figure 2-1

Transition Paths of the Main Endogenous Variables from the Existing Steady State to the New Steady State after a Corporate Income Tax Reduction (Benchmark Case)

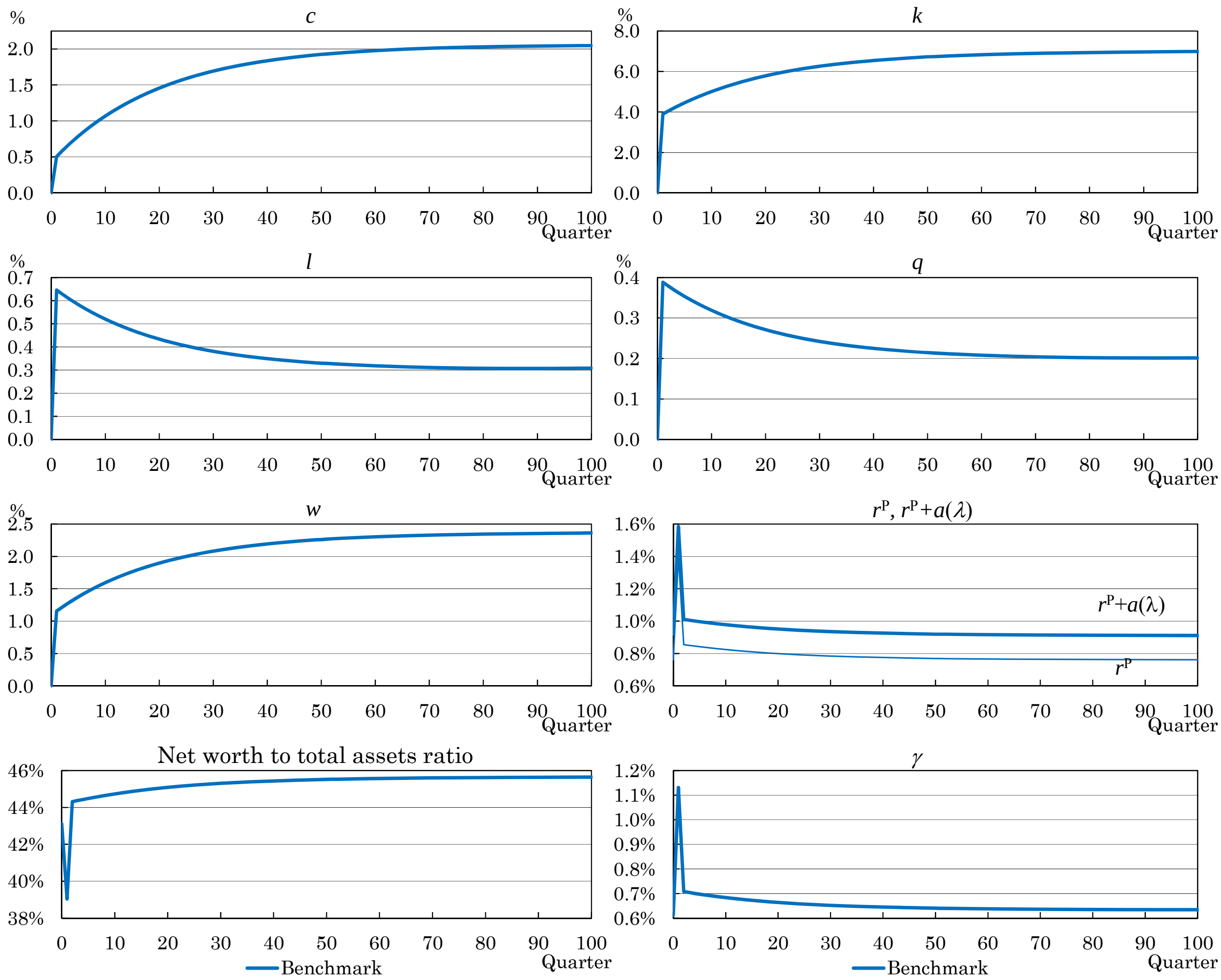


Figure 2-2

Transition Paths of the Main Endogenous Variables from the Existing Steady State to the New Steady State after a Corporate Income Tax Reduction: For First 30 Periods

(Benchmark Case)

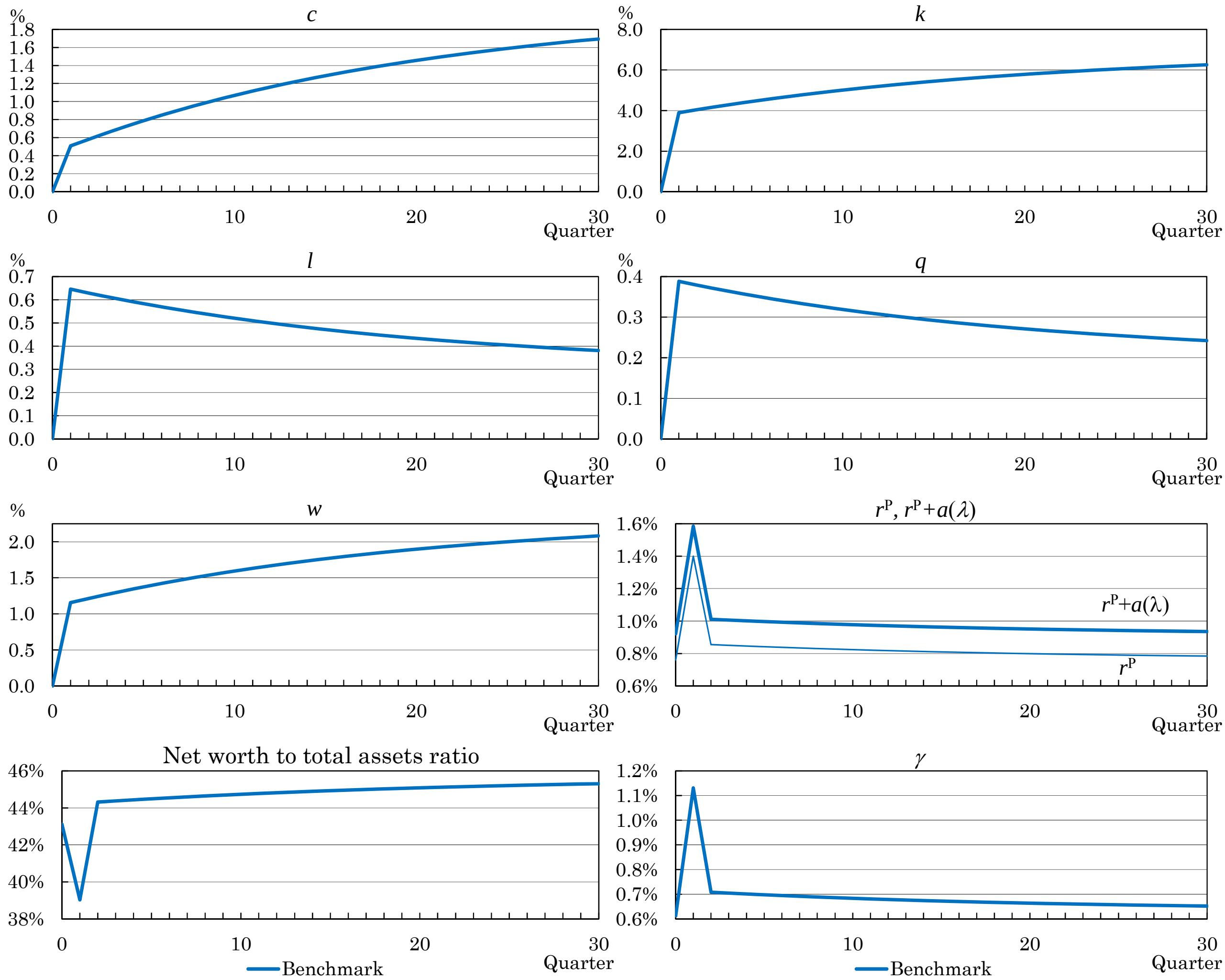
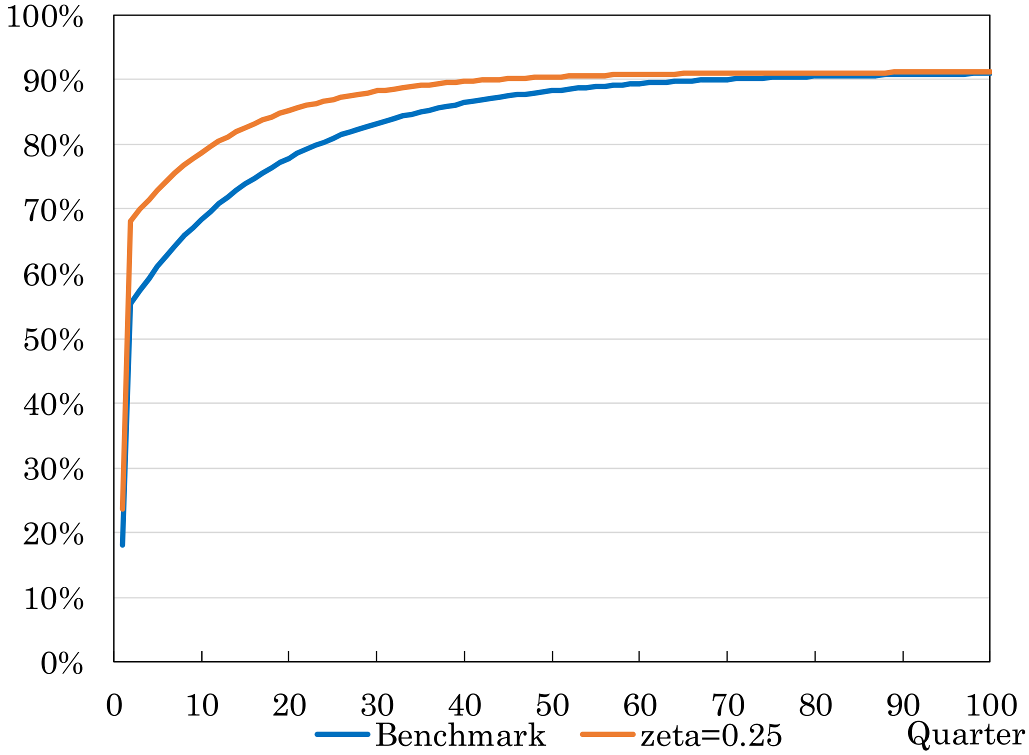


Figure 3

The Incidence on Labor Income after a 4.88% (from 34.62% to 29.74%) Decrease in the Corporate Income Tax Rate ($\zeta = 0.25$)



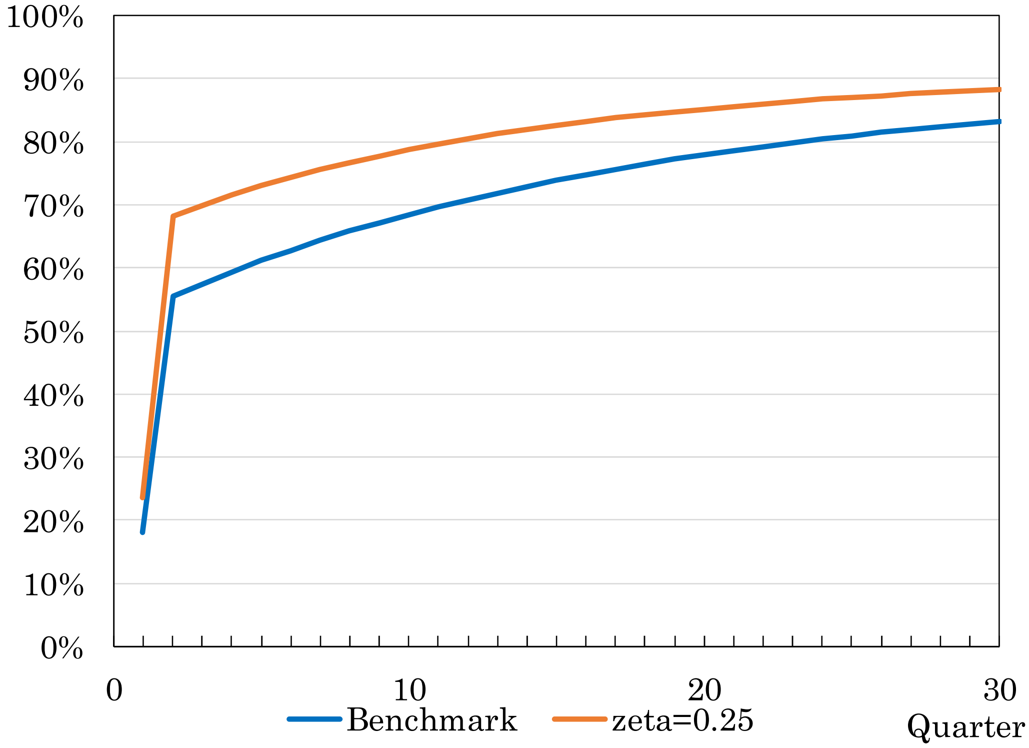


Figure 4-1

Transition Paths of the Main Endogenous Variables from the Existing Steady State to the New Steady State after a Corporate Income Tax Reduction ($\zeta = 0.25$)

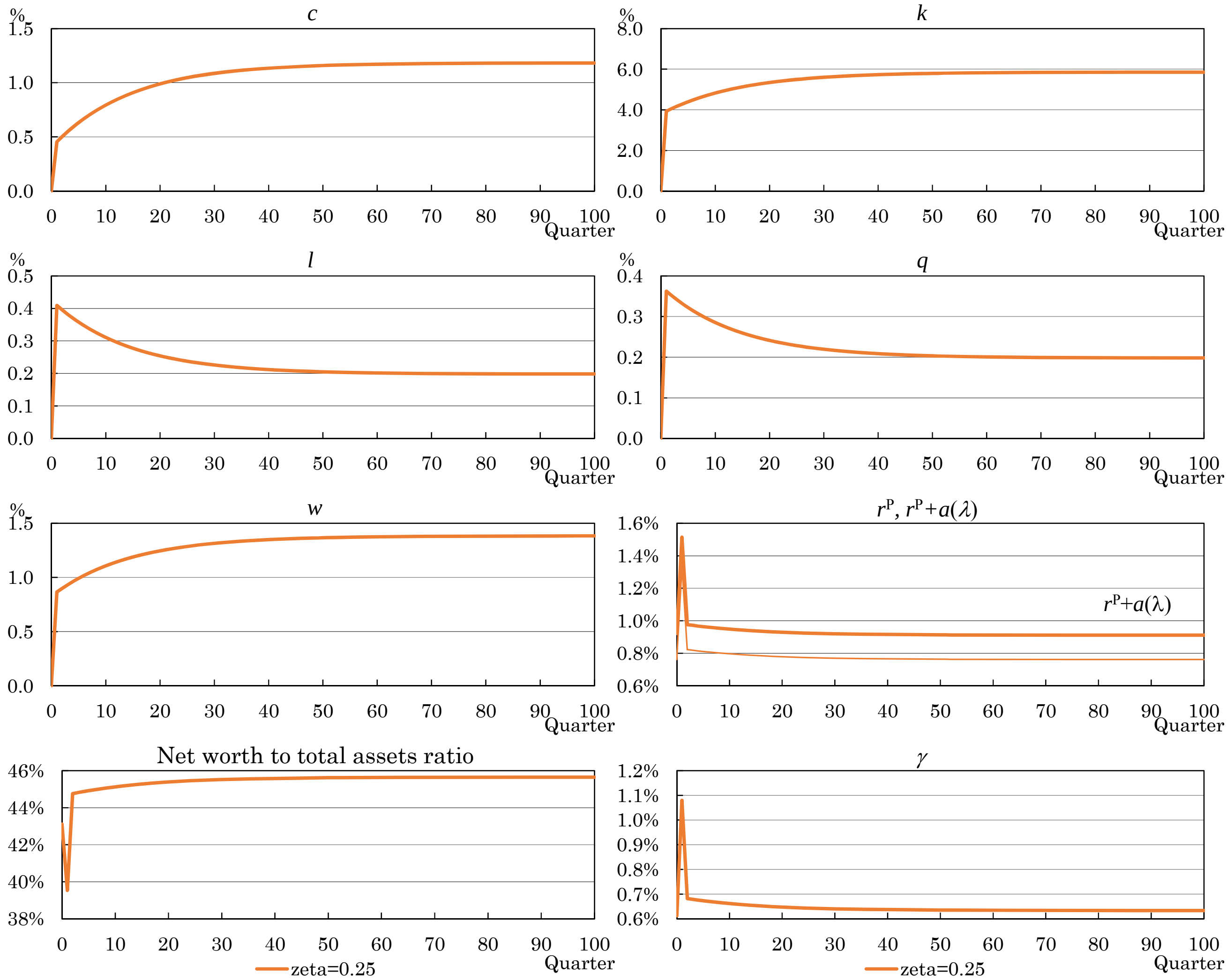


Figure 4-2
Transition Paths of the Main Endogenous Variables from the Existing Steady State to the New Steady State after a Corporate Income Tax Reduction: For First 30 Periods
($\zeta = 0.25$)

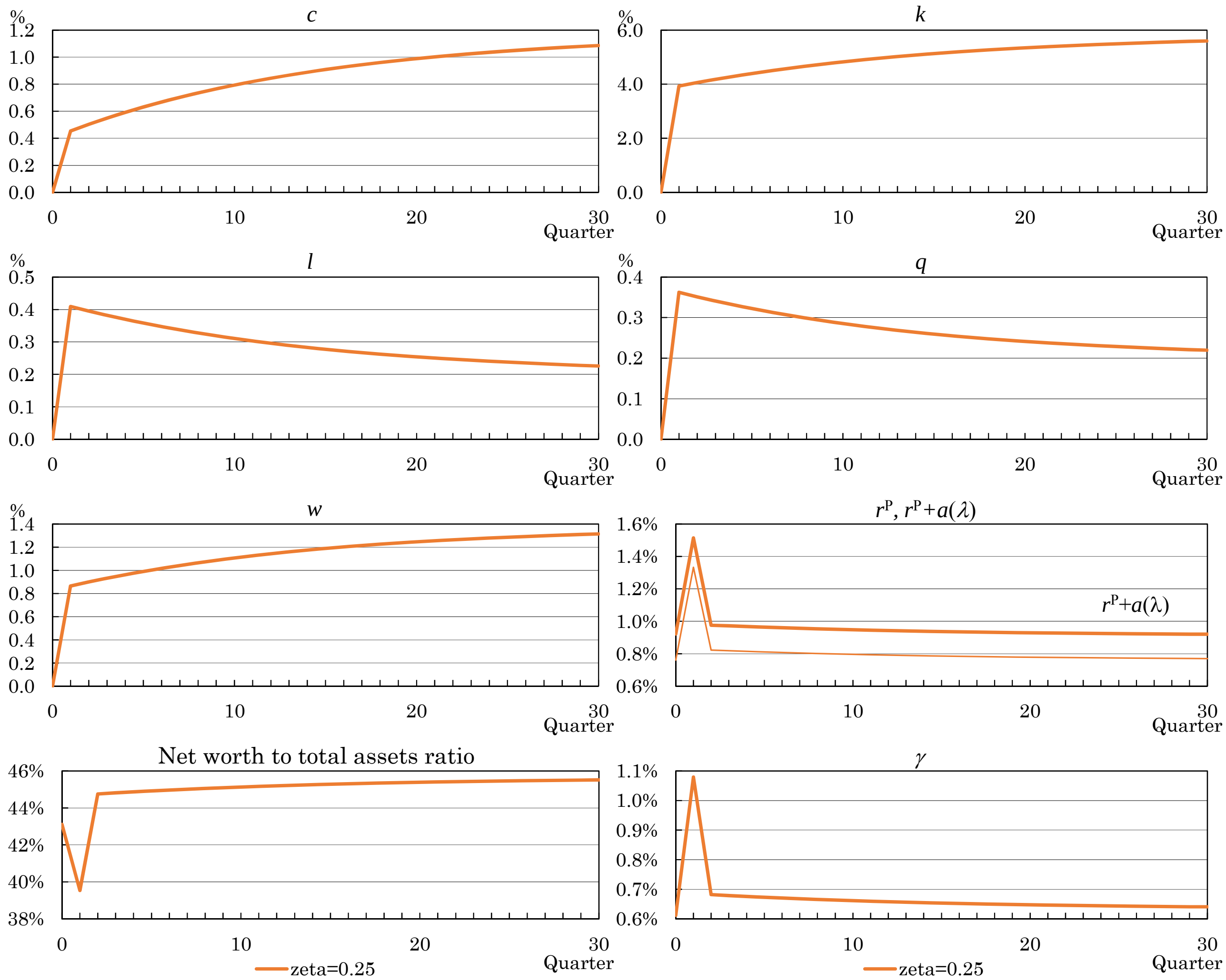
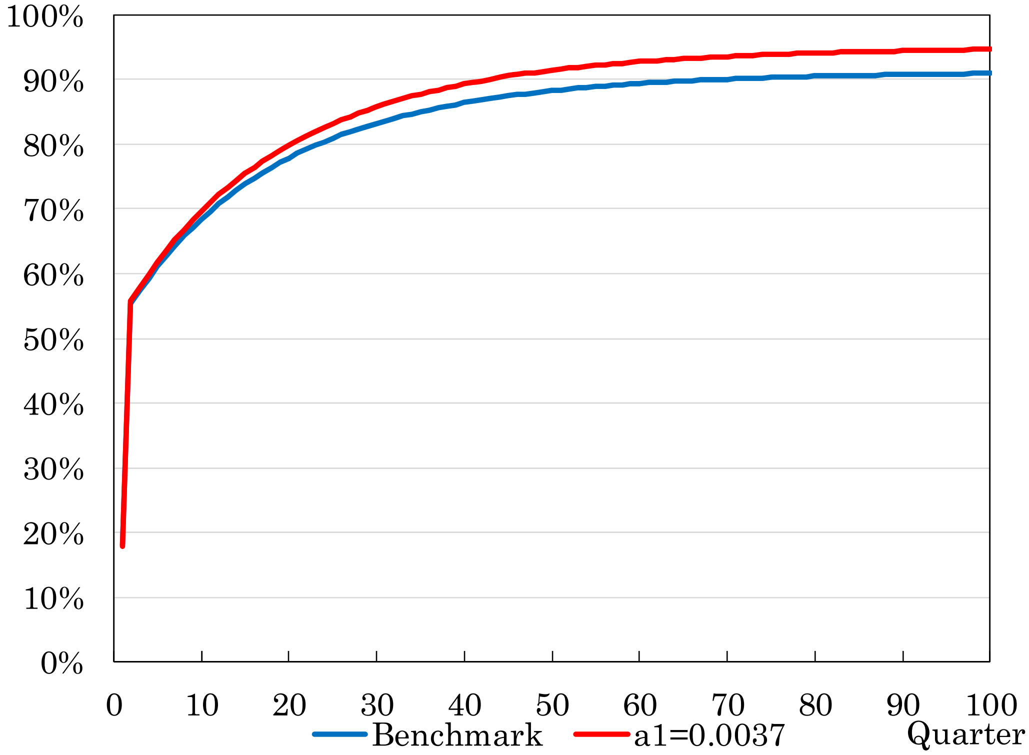


Figure 5
The Incidence on Labor Income after a 4.88% (from 34.62% to 29.74%) Decrease in the Corporate Income Tax Rate (a_1 = 0.0037)



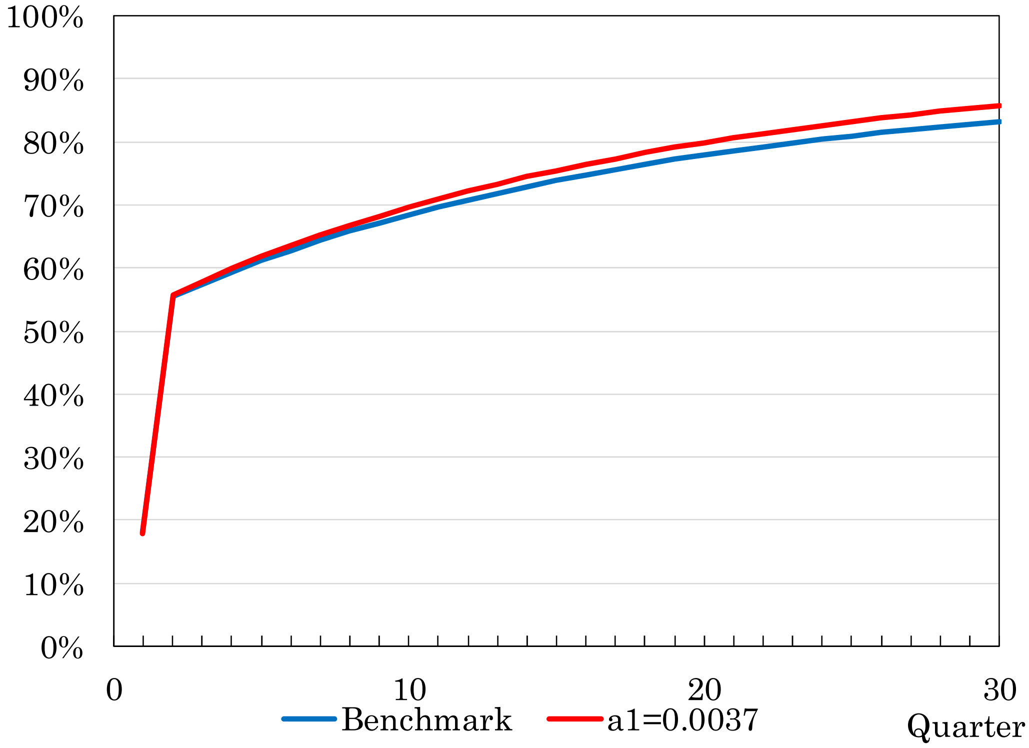


Figure 6-1

Transition Paths of the Main Endogenous Variables from the Existing Steady State to the New Steady State after a Corporate Income Tax Reduction (a_1 = 0.0037)

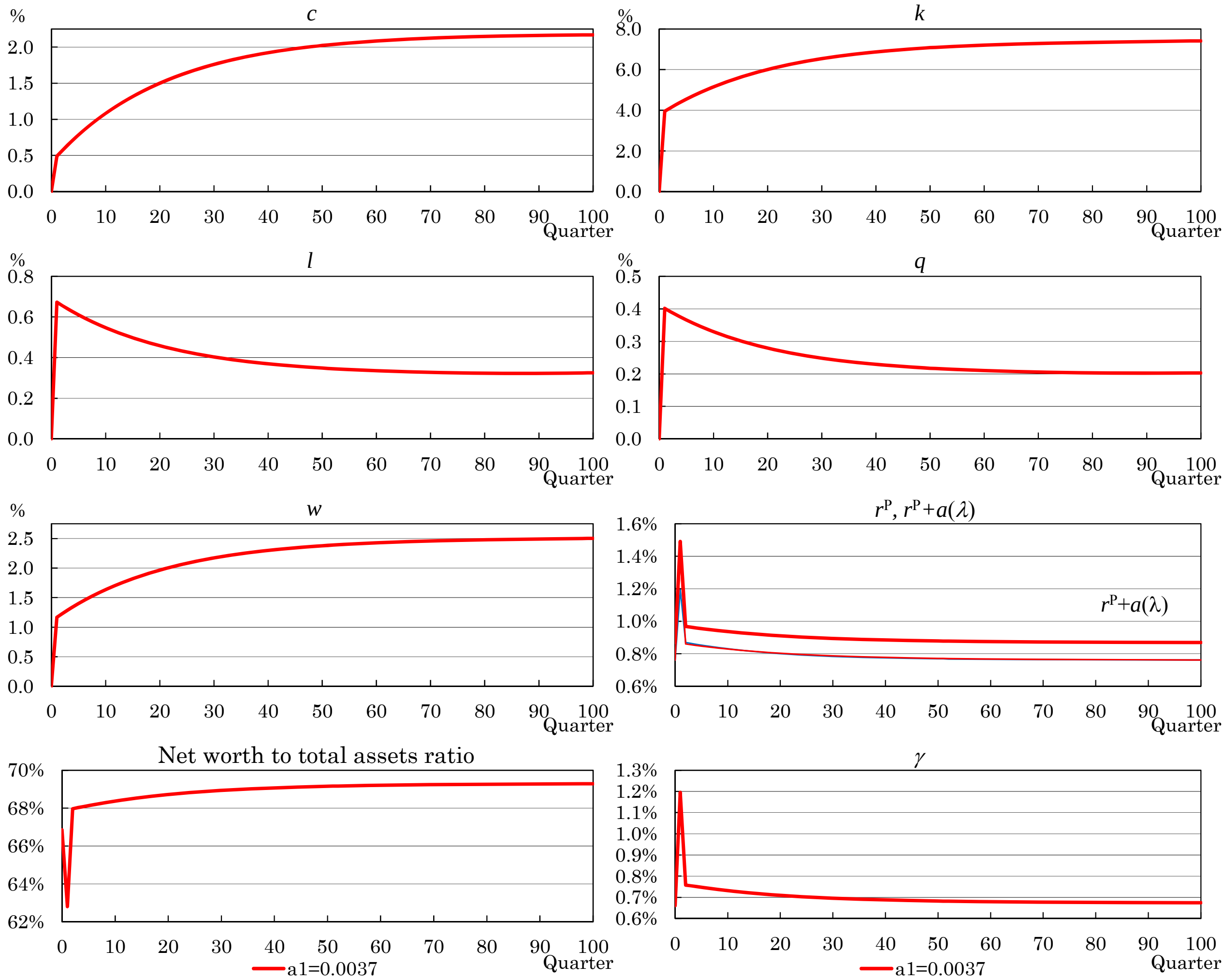


Figure 6-2

Transition Paths of the Main Endogenous Variables from the Existing Steady State to the New Steady State after a Corporate Income Tax Reduction: For First 30 Periods

(a_1 = 0.0037)