How much can corporate tax reduction contribute to economic recovery, employment and feedback of tax revenue?

Kazuki Hiraga*

Abstract
Recently, discussion of corporate tax reduction is hot political issue in Japan. Especially, some researchers and politicians insist on the reduction of corporate tax rate, following the fact of “Corporate tax paradox”, which means that corporate tax revenue per Gross Domestic Product (GDP) has a negative correlation with effective corporate tax rate. However, quantitative effect of corporate tax reduction is unclear and the discussion of finance methods does not proceed. Therefore, we examine the quantitative effect of corporate tax reduction to employment, output and total tax revenue which is the cost of tax reduction. To analyze the effect of corporate tax reduction, we use Dynamic General Equilibrium (DGE) model and we use shooting algorithm to calculate the large corporate tax reduction (i.e. 5% or 20% corporate tax rate reduction). As a result, long-run effect of corporate tax reduction not only prompts to economic growth, but also increases total tax revenue, when financed by lump-sum transfer. Because current corporate tax rate is the right hand side of the Laffer curve. With respect to the magnitude of tax reduction, absolute impact of 20% reduction is much larger than that of 5%. But relative impact (i.e. multiplier effect of tax reduction) of 20% reduction is a little smaller than that of 5%. However, short-run effect is smaller than long-run one. In the short-run, since capital accumulation is insufficient, households decrease consumption and tax revenue.

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Key words: Dynamic general equilibrium model, shooting algorithm, Laffer curve

Related Categories: 2(Public Finance and Fiscal Policy)

JEL Classification: E62, H25

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2 I would like to thank Nobuo Akai, Hiroo Harada and Tomomi Miyazaki for their helpful comments.
1. Introduction

Japanese corporate tax rate is relatively high comparing with other advanced countries. Figure 1 shows the effective corporate tax rate in each advanced and adjacent countries. Figure 1 proves that Japanese corporate tax rate is higher than these countries; except for U.S. This fact shows that Japan face relatively disadvantageous conditions with respect to tax rate. Especially, the discussion that higher corporate tax rate decreases corporate revenue itself, which is called “Corporate tax paradox”. This paradox can be explained as a distortion of corporate tax. That is, corporate tax distorts economic activity via changing factor price, and causes not small inefficiency. Therefore, the economic stimulates so large that the government can finance decreasing tax rate via increasing tax base.

Now, Japan has a lot of problems, such as long-run recession so called ‘lost two decade’, recovery from Tohoku earthquake and tsunami etc. There are a lot of discussions which deal with these problems, but long stagnation does not end, nor does recovery proceed well, because these discussions are opposed with not only among parties, but also within ruling party. Especially, the discussion about corporate tax rate does not proceed, though it has discussed for more than ten years. A reason why the Japanese government hesitates to reduce corporate tax rate is that the corporate tax is the main tax revenue in Japan. Figure 2 shows that recent Japanese corporate tax revenue, and Figure 3 shows that its share to total tax revenue. We can see that the quantity of corporate tax revenue is not small. But, it is fluctuated to business cycle and the tax revenue decreases in recession and expand fiscal deficit more. Therefore, the corporate tax is not appropriate when we deal with current problems: economic and disaster recovery and fiscal reconstruction.

This paper investigates the effect of corporate reduction using dynamic general equilibrium (henceforth we abbreviate DGE) model. The reason why we use DGE model is that we need to investigate how much the tax reduction contribute to the economic growth, employment and the change in tax revenue itself comprehensively, because we would like to investigate whether the corporate tax reduction makes prescription for the Japanese long stagnation or not. We calibrate Japanese data and compare with 5% and 20% corporate tax reduction. The value of 5% reduction is the recently discussion of corporate tax reduction and 20% is approximated in Singapore tax rate, as some economists suggest. Analyzing not small tax change like this paper,

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3 Although the U.S. corporate tax rate is still high, President Barak Obama states the necessary of corporate tax rate reduction to strengthen competitiveness for firms.

4 This word is quoted by Annual Report on the Japanese Economy and Public Finance 2010 (in Japanese).
we cannot use (log) linearized approach, and then we use shooting algorithm to solve the non-linear simultaneous equation numerically. There are a lot of literatures of analyzing the effects of tax rate change in DGE model\textsuperscript{5}. Especially, the papers which deal with corporate tax are Turnovsky (2000) and Doi (2010). But, these papers do not deal with large change in tax rate and the feedback effect of corporate tax reduction. As for the feedback effect, there are several papers about dynamic scoring, which analyze the cost of the income tax reduction, such as Ireland (1994), Mankiw and Weinzierl (2006), Leeper and Yang (2008) and Trabandt and Uhlig (2011). But these papers do not analyze about the corporate tax. Therefore, this paper is the pioneer about analyzing the large corporate tax reduction and the feedback effects, as far as we know.

The rest of the paper is organized as follows. We state the basic idea of the feedback effect of tax rate reduction in Section 2. We set the model in Section 3 and calibrate the model in Section 4. We analyze the alternative situation in Section 5 and conclude in Section 6.

\textbf{Figure-1: International Comparison of Effective Corporate Tax Rate}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{International Comparison of Effective Corporate Tax Rate}
\end{figure}

Source: OECD Tax Revenue, Revenue Statistics

\footnote{For example, Chamley (1986), Braun (1994) and Macgrattan (1994) are discussed about capital income tax.}
2. The Basic Idea of the Feedback Effects of Corporate Tax Reduction

We state about the feedback effects of the corporate tax reduction. The critics to the corporate tax reduction are the discussion of the reduction in tax revenue. Corporate tax reduction decreases tax revenue when we calculate the value in the simplest model which all variables are exogenous. Of course, we need to consider the cost of corporate tax reduction, but they do not
know that there is another effect to tax revenue, that is, the corporate tax reduction increases tax base, since the reduction enhances economic activities. Eq. (1) shows the relation. The second-term of the right-hand side is the feedback effect of corporate tax reduction.

$$\frac{\Delta \text{Tax Revenue}}{\Delta \tau_F} |_{\text{DGE}} = \frac{\Delta \text{Tax Revenue}}{\Delta \tau_F} |_{\text{Simple}} - \left( \tau_F - \Delta \tau_F \right) \frac{\Delta \text{Tax Base}}{\Delta \tau_F},$$

where $\tau_F$ is the corporate tax rate.

The left-hand side of Eq. (1) is the total effect of the corporate tax change, and the first-term of the right-hand is the simplest effect which consider all macroeconomics variables as exogenous. The second-term of the right-hand side is the feedback effect in this paper. If the second-term of the right-hand side is larger than the first term, the corporate tax reduction increases the tax revenue, which used to discuss “Laffer-Curve” effect. Therefore, we focus on this effect in later sections.

3. The Model

We explain the economy environment. In this environment, we follow our model á la Hayashi and Prescott (2002) with distortionary income, consumption and corporate taxes. On the other hand, we do not consider the growth components, which are technology and population growth because current Japan faces reduction population rather than increase and we would like to analyze tax reduction effects themselves.

3.1. The (Representative) Household

The representative household utility function is

$$\sum_{i=0}^{\infty} \beta^i U(c_i, l_i) \quad \text{with} \quad U(c_i, l_i) = \log c_i - \alpha l_i,$$

where $c_i$ is consumption, $l_i$ is labor supply equals to the employment rate, $\alpha$ is the disutility parameter of labor supply and $\beta$ is discount factor.

The household budget constraint is
\( (1 + r_c) c_t + k_{t+1} = (1 - \tau_n) w_t l_t + (1 - \tau_k) r_t k_t + (1 - \delta) k_t - T_t, \) \( (3) \)

where \( k_t \) is capital stock, \( w_t \) is real wage; \( r_t \) is the rate of return, \( T_t \) is transfer from the government, \( \delta \) is the depreciation rate of capital, \( \tau_c \) is consumption tax rate, \( \tau_n \) is labor income tax rate and \( \tau_k \) is capital income tax rate.

3.2. The (Representative) Firm

The representative firm’s production function is

\[
y_t = k_t^{\theta} l_t^{1-\theta},
\]

where \( y_t \) is output (GDP) and \( \theta \) is the parameter of capital share.

The firm controls capital stock and labor to maximize profit. Therefore, the profit function is

\[
(1 - \tau_{F,t}) \pi_t - r_t k_t = (1 - \tau_{F,t}) \left( k_t^{\theta} l_t^{1-\theta} - w_t l_t \right) - r_t k_t,
\]

Where \( \pi \) is the profit and \( \tau_{F,t} \) is the corporate tax rate \à la Harberger (1962) which tax rate levies on the revenue minus wage. Harberger (1962) regards capital income (\( r_t k_t \)) as dividends.

3.3. The Government

The government budget constraint is

\[
T_t = \tau_c c_t + \tau_n w_t l_t + \tau_k r_t k_t + \tau_{F,t} \left( k_t^{\theta} l_t^{1-\theta} - w_t l_t \right)
\]

We assume that the government repays tax revenue as a transfer, such as social security, or public pension\(^6\).

3.4. The Equilibrium Conditions

Solving the household and firm’s problems, we can obtain the following equations

\[
c_t = \frac{(1 - \tau_n)(1 - \theta)}{\alpha(1 + \tau_c)} \left( \frac{k_t}{l_t} \right)^\theta.
\]

\( ^6 \) In this model, lump-sum transfer or tax is indifferent from government debt, because the Ricardian equivalence is satisfied. Therefore, we can make the same discussion which the cost of corporate tax reduction is financed by issuing government debt which is financed by future lump-sum tax.
\frac{c_t}{c_i} = \beta \left\{ 1 + (1 - \tau_k)(1 - \tau_{F,t+1}) \phi \left( \frac{k_{t+1}}{l_{t+1}} \right)^{1-\theta} - \gamma \right\}, \quad (8)

k_{t+1} = k_t^{\theta} l_t^{1-\theta} - c_t + (1 - \delta) k_i,

T_t = \left[ \tau_n (1 - \theta) + \left[ \tau_k (1 - \tau_{F,t}) + \tau_{F,t} \right] \phi \right] k_t^{\theta} l_t^{1-\theta} + \tau_c c_t. \quad (10)

Getting rid of dated notation, we can obtain the steady state values of \{c, l, k, T\} analytically.\(^7\)

### 3.5. Graphical Interpretation

We interpret the dynamics of the model using phase diagrams. We first show labor (\(\triangle l \geq 0\)) and capital (\(\triangle k \geq 0\)) loci:

\[\triangle l \geq 0 \text{ locus } \quad l_t \leq \left[ \frac{\beta \theta (1 - \tau_k)(1 - \tau_{F,t})}{1 - \beta (1 - \delta)} \right]^{1-\theta}, \quad (11)\]

\[\triangle k \geq 0 \text{ locus } \quad \frac{(1 - \tau_w)(1 - \theta)}{1 + \tau_c A} \left( \frac{k_t}{l_t} \right)^{\theta} + k_t^{\theta} l_t^{1-\theta} \leq \delta k_i. \quad (12)\]

We illustrate the phase diagram in Figure 7. Figure 7 shows the phase diagram of labor supply and capital stock using two loci (represented by Eq. (11) and (12)). These cross at the steady states of labor(l*) and capital stock (k*) and this steady state is a saddle. On the other hand, Figure 8 represents the dynamic behavior of labor and capital stock to the corporate tax reduction. Corporate tax reduction upward-shift the \(\triangle l = 0\) locus to \(\triangle l' = 0\) locus and the steady state also shift to (k**,l**). But, after the initial labor supply overshoots the value of steady state l** and take l1, because the economy rides a saddle-path. After riding a saddle-path, the economy converges to a new steady state and decreases labor and accumulates capital stock. This behavior is consistent with the previous calibration results. Comparing with Figure 8 and 9, the larger tax rate change is, the larger deviation is and the more slowly the economy converges to

\(^7\) We put the analytical values of steady state in Appendix.
steady state. Because $\Delta l=0$ locus is upward-shifted to $\Delta l''=0$ locus and initial labor input climbs more to ride a saddle path shown in Figure 9.

Figure-7. The phase diagram of labor and capital stock.
Figure 8. The dynamic behavior of labor and capital stock to the corporate tax reduction.
4. Calibration

We calibrate the model to quote the parameters and tax rates of several papers, which deal with Japanese economy. And then, we analyze the corporate tax reduction statically and dynamically.

4.1. Parameters and Steady State Tax Rates

We set $\theta=0.362$, $\beta=0.99$ and $\delta=0.02215$ following Hayashi and Prescott (2002) arranged in quarterly frequency and $\alpha=0.784$ to equalize the current employment rate 0.611 (61.1%) which value is the average employment rate in 1968-2010. As for tax rates, we set $\tau_n=0.33$, $\tau_k=0.2$ and $\tau_F=0.4$ quoted in Gunji and Miyazaki (2011) of the average marginal tax rate with social security premiums (with respect to labor income tax), and we set $\tau_c=0.05$ quoted by current tax rate.
When we analyze the feedback effect, we redefine the following criterion:

\[
\frac{\Delta \text{Tax Revenue}}{\Delta \tau} \bigg|_{\text{DGE}} = \left(1 - \chi \right) \frac{\Delta \text{Tax Revenue}}{\Delta \tau} \bigg|_{\text{Simple}},
\]

We define \( \chi \) as a feedback ratio of corporate tax reduction. \( \chi \) equals to the second term of the right hand side in Eq.(1), that is, the feedback effect of increasing tax base.

**4.2. Static Analysis**

We compare with two steady states, one is the pre-tax reduction, and the other is post-tax reduction. Figure 4 shows the Laffer curve of each tax revenues with respect to each corporate tax rate and other tax rates are set in calibrated parameters. We can see that the corporate tax revenue (solid line) decreases when both 5% (that is corporate tax rate is 35%) and 20% (that is corporate tax rate is 20%) reduction, although the decreasing speed is mild because of feedback effect of increasing tax base. On the other hand, total tax revenue (broken line) increases slightly when both 5% and 20% reduction. Therefore, the feedback effects dominate the power of decreasing tax revenue to reduce the corporate tax rate. This is because the incidence of corporate tax attributes to households. That is, corporate tax reduction decreases household’s burden to increase their tax-excluded income, and also increases labor and capital income tax and consumption tax revenues.

Table 1 show the long-run growth rate of output (GDP) and deviation of employment rate when 5% or 20% corporate tax rate reduction. Table 1 show that the corporate tax reduction enhances economic growth well, but does not increase employment well in the long-run. This is because the corporate tax reduction affects investment behavior rather than labor input, that is, the corporate tax reduction decreases the rental cost of capital and increases the real wage relatively explained by substitution effects. But, the corporate tax reduction also stimuli the labor demand, and then total labor input increases. Table 2 shows the feedback effect of corporate tax reduction. The result shows that the feedback effect to corporate tax revenue is not so large like “corporate tax paradox”, but the total tax revenue increases when corporate tax rate is reduced, because the others taxes increase their tax bases and revenue themselves, and then their gains are larger than loss of corporate tax revenue.
Figure-4: Each Tax Revenues with respect to Each Corporate Tax Rates (standardized benchmark (corporate tax rate=40%) to 100)

Table 1: The Deviation of Economic Growth Rate and Employment Rate

<table>
<thead>
<tr>
<th>$\Delta \tau F$</th>
<th>Growth Rate</th>
<th>Employment Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5%</td>
<td>5.83%</td>
<td>0.63%</td>
</tr>
<tr>
<td>-20%</td>
<td>23.24%</td>
<td>2.63%</td>
</tr>
</tbody>
</table>

Table 2: The Feedback Ratio of The Corporate Tax Reduction

<table>
<thead>
<tr>
<th>$\Delta \tau F$</th>
<th>Corporate Tax Revenue</th>
<th>Total Tax Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5%</td>
<td>40.8%</td>
<td>151.04%</td>
</tr>
<tr>
<td>-20%</td>
<td>23.24%</td>
<td>136.19%</td>
</tr>
</tbody>
</table>

Note: The feedback effect is calculated in the second-term of the right-hand side in Eq. (1).
4.3. Dynamic Analysis

We analyze the dynamic effects of 5% and 20% corporate tax reduction. Stated the former section, we use the method of shooting algorithm to solve the non-linear equation numerically. Figure 5 shows the dynamic deviation rates of output, employment rate and corporate tax and total tax revenue when 5% reduction and Figure 6 shows the one when 20% reduction. These figures are resemble qualitative, but we can make interpretations differed from static analysis. First, total tax revenue decreases in the short-run. This is because the output cannot increase soon, since capital accumulation is immature in the short-run. But the total tax revenue increases as the capital accumulation is mature and output increases. Second, on the other hand, the short-run employment rate is higher than the long-run one. The reason why the short-run employment rate is higher is that the corporate tax reduction makes the firms produce more, but the capital accumulation is immature. As a result, the firm’s labor demand increases and raises employment rate. Table 3 and 4 show the dynamic feedback effects of corporate tax revenue and total tax revenue when 5% and 20% corporate tax rate reduction. These tables prove that the situation to large tax rate change converges to more slowly than that to small change.

Table 3: The Dynamic Feedback Ratio of 5% Corporate Tax Reduction

<table>
<thead>
<tr>
<th>Time(quarterly)</th>
<th>corporate tax</th>
<th>aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (=3 month)</td>
<td>26.82%</td>
<td>38.56%</td>
</tr>
<tr>
<td>4 (=1 year)</td>
<td>30.25%</td>
<td>69.71%</td>
</tr>
<tr>
<td>10 (=2.5 year)</td>
<td>35.50%</td>
<td>117.61%</td>
</tr>
<tr>
<td>20 (=5 year)</td>
<td>39.80%</td>
<td>147.8%</td>
</tr>
</tbody>
</table>

Table 4: The Dynamic Feedback Ratio of 20% Corporate Tax Reduction

<table>
<thead>
<tr>
<th>Time(quarterly)</th>
<th>time</th>
<th>corporate tax</th>
<th>aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (=3 month)</td>
<td>1</td>
<td>12.13%</td>
<td>49.78%</td>
</tr>
<tr>
<td>4 (=1 year)</td>
<td>4</td>
<td>14.21%</td>
<td>61.33%</td>
</tr>
<tr>
<td>10 (=2.5 year)</td>
<td>10</td>
<td>17.16%</td>
<td>77.91%</td>
</tr>
<tr>
<td>20 (=5 year)</td>
<td>20</td>
<td>19.98%</td>
<td>94.11%</td>
</tr>
</tbody>
</table>

Shooting algorithm is the method for seeking non-linear saddle path numerically. Concretely, we set plausible control variables which converge to the new steady state under the initial state variables.
Figure 5: Dynamic Effects of 5% Corporate Tax Rate Reduction (percentage deviation from initial steady states (except for employment rate which is deviation from initial steady state))

Figure 6: Dynamic Effects of 20% Corporate Tax Rate Reduction (percentage deviation from initial steady states (except for employment rate which is deviation from initial steady state))
5. Alternative analyses: Deviation from pure DGE model

We check the corporate tax reduction under different setting. we consider the following situations: first is imperfect competition and second is the externalities used by Ireland (1994) and Mankiw and Weinzierl (2006) and calibrate in static analyses.

5.1. Imperfect Competition

Many markets in the actual economy are imperfectly competitive. For example, patents, copyrights and fixed costs raises prices and causes markup. To incorporate imperfect competition, it is useful to imagine an economy that produces in two stages. In the first stage, a competitive intermediate firms produce intermediate goods using capital and labor inputs and a Cobb-Douglas production function. Competition ensures that price equals marginal cost. In the second stage, final good firm has a monopolistic power and set price adding markup.

With this market structure, the price of the final good P is:

\[ P = \mu P_M = \mu MC. \]

Where \( \mu \) is markup more than one, \( P_M \) is the price of intermediate good and \( MC \) is the marginal cost. Hereafter, we let the final good be the numeraire, so \( P=1 \).

Since the intermediate good is produced with both capital and labor, its marginal cost can be computed from the marginal product of either factor, that is:

\[ MC = \frac{w}{\partial y/\partial l} = \frac{r}{\partial y/\partial k}. \]

The above two equations yield equilibrium factor prices:

\[ r = \frac{\theta \left( \frac{k}{l} \right)^{\theta - 1}}{\mu}, \]

\[ w = \frac{\left( 1 - \theta \right) \left( \frac{k}{l} \right)^{\theta}}{\mu}. \]

Using Eq. (13) and (14), we can rewrite the equilibrium conditions as followings:
\[ c_i = \frac{(1-\tau_h)(1-\theta)}{\alpha\mu(1+\tau_c)} \left( \frac{k_i}{l_i} \right)^\theta, \]  
(15)

\[ \frac{c_{i+1}}{c_i} = \beta \left[ 1 + (1-\tau_k)(1-\tau_{F,i+1}) \frac{\theta}{\mu} \left( \frac{k_{i+1}}{l_{i+1}} \right)^{\theta-1} - \delta \right], \]  
(16)

\[ k_{i+1} = k_i^\theta l_i^{1-\theta} - c_i + (1-\delta)k_i, \]  
(17)

\[ T_i = \left[ \tau_h (1-\theta) + \left[ \tau_k (1-\tau_{F,i}) + \tau_{F,i} \right] \theta \right] \mu^{-1} k_i^\theta l_i^{1-\theta} + \tau_c c_i, \]  
(18)

We derive the steady state of endogenous variables, and calculate its benefits and cost to the corporate tax reduction effects at each markup values (\( \mu = 1.01, 1.1, 2, 10 \)) in Table 3, 4 and 5. These tables show that markup diminishes the economic stimulus effects of corporate tax reduction similar to Mankiw and Weinzierl (2006).

Table 5. Comparison of long-run economic growth rate (%) effect at each \( \mu \)

<table>
<thead>
<tr>
<th>( \Delta \tau )</th>
<th>( F )</th>
<th>( \mu )</th>
<th>1.01</th>
<th>1.1</th>
<th>2</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5%</td>
<td>5.82%</td>
<td>5.71%</td>
<td>5.20%</td>
<td>4.75%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-20%</td>
<td>23.18%</td>
<td>22.66%</td>
<td>20.25%</td>
<td>18.2%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6. Comparison of long-run employment growth rate (%) effect at each \( \mu \)

<table>
<thead>
<tr>
<th>( \Delta \tau )</th>
<th>( F )</th>
<th>( \mu )</th>
<th>1.01</th>
<th>1.1</th>
<th>2</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5%</td>
<td>0.56%</td>
<td>0.51%</td>
<td>0.14%</td>
<td>0.01%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-20%</td>
<td>2.30%</td>
<td>2.11%</td>
<td>0.56%</td>
<td>0.02%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7. Comparison of feedback effects of total tax revenue (%) at each \( \mu \)

<table>
<thead>
<tr>
<th>( \Delta \tau )</th>
<th>( F )</th>
<th>( \mu )</th>
<th>1.01</th>
<th>1.1</th>
<th>2</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5%</td>
<td>150.78%</td>
<td>148.68%</td>
<td>138.82%</td>
<td>130.26%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-20%</td>
<td>135.91%</td>
<td>133.67%</td>
<td>123.35%</td>
<td>114.64%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.2. Externalities to capital

Some economists have suggested that the social marginal product of capital exceeds its private marginal product, such as Romer (1987) and DeLong and Summers (1991). Therefore, we explore the model to introduce the externalities to capital.

We assume that each firm’s production $y_i$ is Cobb-Douglas but is a function not only of its own capital $k_i$, but also of the general pool of knowledge $\kappa$:

$$ y_i = \kappa_i k_i^{\theta} l_i^{1-\theta}, \quad (19) $$

Each firm takes $\kappa$ as given, but $\kappa$ is assumed to be an increasing function of the average firm’s level of capital $k$:

$$ \kappa_i = k_i^{\omega}. \quad (20) $$

The parameters $\theta$ and $\omega$ measure the private and social benefit of capital. In this economy, since the firms are homogeneous, the firm’s capital stock is equal to the average one (that is, $k_i = k$). Therefore, we can obtain the following equilibrium conditions:

$$ c_{i,t} = \frac{(1-\tau_k)(1-\delta)k_{i,t}^{\theta+\omega}}{\alpha(1+\tau_c)l_{i,t}^{\omega}}, \quad (21) $$

$$ \frac{c_{i,t+1}}{c_{i,t}} = \beta \left[ 1 + (1-\tau_k)(1-\tau_{F,t+1})\kappa_{i,t+1}^{\omega} \left( \frac{k_{i,t+1}}{l_{i,t+1}} \right)^{\theta-1} - \delta \right], \quad (22) $$

$$ k_{i,t+1} = k_i^{\theta+\omega} l_i^{1-\theta} - c_i + (1-\delta)k_i, \quad (23) $$

$$ T_i = \left[ \tau_k (1-\theta) + \tau_{F,t+1} \tau_j \right] k_i^{\theta+\omega} l_i^{1-\theta} + \tau_c c_i. \quad (24) $$

We set $\omega = 1/12$ used in Mankiw and Weinzierl (2006) and $\omega = 0.3$ estimated by DeLong and Summers (1991). Table 6 and 7 show the comparison of long-run economic growth rate and feedback effects of total tax revenue at each $\omega$. These figures clarify the results that the larger externalities are, the larger output growth and feedback effects are. As for employment rate, however, there is not long-run effect because positive wealth effect completely cancels out by negative substitution effect via capital accumulation and wage increase in this economy.

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9 Steady state of labor is calculated in following:
Table 8. Comparison of long-run economic growth rate (%) effect at each $\omega$

<table>
<thead>
<tr>
<th>$\Delta \tau F \backslash \omega$</th>
<th>1/12</th>
<th>0.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5%</td>
<td>6.43%</td>
<td>15.68%</td>
</tr>
<tr>
<td>-20%</td>
<td>23.10%</td>
<td>40.67%</td>
</tr>
</tbody>
</table>

Table 9. Comparison of feedback effects of total tax revenue (%) at each $\omega$

<table>
<thead>
<tr>
<th>$\Delta \tau F \backslash \omega$</th>
<th>1/12</th>
<th>0.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5%</td>
<td>253.54%</td>
<td>462.25%</td>
</tr>
<tr>
<td>-20%</td>
<td>254.47%</td>
<td>512.60%</td>
</tr>
</tbody>
</table>

6. Conclusion

We analyze the static and dynamic effect of the corporate tax reduction using DGE model and obtain the two main results. First, in the long-run, the corporate tax reduction increases total tax revenue and output but does not affect employment recovery. Second, in the short-run, the corporate tax reduction increases the employment rate well, but does not affect output well. On the contrary, it decreases total tax revenue, that is, the short-run effects are reverse to the long-run effects. Therefore, when we discuss the corporate rate reduction, we need to set the most important policy object and time span. For example, when the government object is the short-run job recovery, the corporate tax reduction is adequate policy. But, if the government object is the long-run job creation, the other policy package is better.

There are three points which improve and expand in this paper. First, we do not consider the other financing methods, such as consumption tax and income tax change. Especially, recent discussion is also discussed in these financing methods. Second, we need to introduce more plausible model setting. For example, we are worth trying to add the capital adjustment cost or labor friction. Third, we do not consider foreign counties and agents in this model. But, foreign factor is also important to discuss about corporate tax reduction, such as tax competition and capital and firm fright.

We will tackle these points as future works.

\[
l = \left\{ \left[ \frac{(1-\tau_c)(1-\theta)}{\alpha(1+\tau_c)} \right]^{-1} - \delta \right\}^{-1}.
\]
Appendix: Steady State Values of Endogenous Variables

\[ r = \frac{1}{1-\tau_F} \left( \frac{1-\beta}{\beta} + \delta \right), \]

\[ \frac{k}{l} = \left[ \frac{(1-\tau_k)\rho}{r} \right]^{1-\theta} = \left[ (1-\tau_k)(1-\tau_F)\theta \left( \frac{1-\beta}{\beta} - \delta \right) \right]^{-\frac{1}{\gamma-\theta}}, \]

\[ w = (1-\theta) \left[ \frac{k}{l} \right]^\theta = (1-\theta) \left[ (1-\tau_k)(1-\tau_F)\theta \left( \frac{1-\beta}{\beta} - \delta \right) \right]^{-\frac{\theta}{\gamma-\theta}}, \]

\[ c = \frac{(1-\tau_c)(1-\theta)}{\alpha(1+\tau_c)} \left[ (1-\tau_k)(1-\tau_F)\theta \left( \frac{1-\beta}{\beta} - \delta \right) \right]^{-\frac{\theta}{\gamma-\theta}}, \]

\[ l = c \left[ \left( \frac{k}{l} \right)^\theta - \delta \frac{k}{l} \right]^{-1}, \]

\[ k = \frac{k}{l} \cdot l, \]

\[ T = \{\tau_n(1-\theta) + [\tau_k(1-\tau_F)+\tau_F]\theta\}k^{\theta l^{1-\theta}} + \tau_c c. \]
References


