The Government Spending Multiplier and Fiscal Financing: Insights from Japan*

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Abstract

All fiscal stimulus measures must ultimately be financed, and thus their effects critically depend on the expectations of how they are to be financed. This paper examines the importance of tax rules in determining the size of the government spending multiplier by estimating and simulating a New Keynesian dynamic stochastic general equilibrium model of the Japanese economy. This paper shows that the debt-stabilizing tax policies employed in Japan during the 1980s and 1990s played a role in making the short-run multipliers large. Provided that monetary policy is accommodative, fiscal stimulus becomes more effective if it is initially financed by debt and if that debt is repaid largely through a gradual increase in capital tax. Capital taxation has the smallest dampening effect on labor input, whereas an increase in labor input is the key factor contributing to the effectiveness of stimulus. Because the prospect of future taxation considerably affects the size of the multiplier, fiscal stimulus plans should be announced alongside financing schemes.

JEL classification: C11, E32, E62.

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1 Introduction

The recent global financial crisis has increased attention on the effects of fiscal stimulus. With limited room for further monetary easing, governments around the world responded by announcing massive fiscal stimulus packages. Although fiscal stimulus has helped to generate a more rapid global recovery than previously anticipated, fiscal sustainability has become an issue of growing concern. In the Toronto Summit Declaration of 2010, the G-20 leaders announced that they are "recognizing the circumstances of Japan." Japan’s current headline debt-to-output ratio is much higher than that of Greece, which is in the midst of a debt crisis. However, Japan did make progress with fiscal consolidation in the 1980s. Responding to the rapid accumulation of public debt following the prolonged recession after the oil crisis in 1973, the Japanese Government started its consolidation effort at the end of 1970s. Figure 1 plots the time series for aggregate effective tax rates on capital in major countries as well as the debt-to-output ratio in Japan.\(^1\) Although the 1980s was a time of decreasing capital taxation in many major countries, Figure 1 shows an upward trend in Japan; several measures designed to increase corporate tax revenues were introduced during that period. Once progress was made in fiscal consolidation in the late 1980s, however, the Japanese Government started to follow the international trend of reducing corporate tax rates. Consequently, Japan’s effective capital tax rate is largely correlated with its debt-to-output ratio throughout the 1980s and 1990s as seen in Figure 1.\(^2\)

- Insert Figure 1 Here -

Unlike monetary policy, fiscal policy cannot be implemented without affecting government budgets. An increase in government spending must eventually be repaid through taxes, even if the spending increase is initially financed by debt. Under the rational expectations framework, households’ behaviors are affected by their expectations
regarding future fiscal adjustments to achieve government debt sustainability. Therefore, the macroeconomic effects of fiscal stimulus critically depend on how it is financed. Recently, Corsetti et al. (2009) and Corsetti et al. (2010) suggested that the stimulative effects of fiscal expansion could be amplified by a "spending reversal" policy that would offset the initial expansion via future spending reductions below trend level.³ Corsetti et al. (2009) have also shown that the dynamics underlying the spending reversal fit the U.S. time series data. In contrast, the debt stabilization that occurred in Japan in the 1980s owed much to capital taxation, as seen in Figure 1. Financing debt via future taxation sounds straightforward, but the existing literature does not sufficiently explore the consequences of tax-financed fiscal stimulus, especially in the case of distortionary taxes. Once we introduce distortionary taxation instead of lump-sum taxation, a temporary substitution of debt for taxation increases economic variables, such as consumption, labor hours, investment, and output (see Trostel (1993)).⁴ Therefore delaying the timing of taxation to repay debt issued to finance an increase in government spending has a positive effect on the increases in economic variables after the fiscal expansion. Furthermore, when different tax instruments are available, a choice of distortionary taxes to repay the debt affects the time paths of economic variables because each tax has different distortionary effects.

Motivated by Japan’s distinct experience of fiscal consolidation efforts during the 1980s and 1990s, this paper examines how debt-stabilizing tax rules affect dynamic responses to fiscal stimulus within a New Keynesian framework, focusing very much on its short-run effects. For this purpose, a dynamic stochastic general equilibrium (DSGE) model of the Japanese economy was estimated, featuring non-Ricardian households with three distortionary tax rules, and the models were simulated under different tax rules.

The method of "new normative macroeconomics" has taken center stage in macro-
economic policy analysis (see Taylor (2000)); it has become popular to assume that fiscal rules are analogous to monetary policy. The literature on fiscal policy analysis in this vein is growing rapidly, although most studies are based on neoclassical models. Leeper and Yang (2008) have examined the consequences of tax cuts under different fiscal financing rules in the context of *dynamic scoring*. More recently, Leeper et al. (2010a) and Leeper et al. (2010b) have shown that fiscal financing rules and the speed of fiscal adjustment or debt repayment have an important impact on the effects of fiscal expansion. Uhlig and Drautzburg (2010) have also examined the effect of changing the speed of fiscal adjustment and show that a slower adjustment raises the short-run government spending multiplier. Of the studies conducted within the New Keynesian framework, Forni et al. (2009) (FMS, hereafter) was the first to attempt to examine the effects of fiscal policy using an estimated DSGE model augmented by distortionary tax rules and non-Ricardian households.

To follow, three distortionary tax rules will be introduced into an otherwise standard Smets and Wouters (2003) New Keynesian model. In addition, we will also allow for the coexistence of non-Ricardian and Ricardian households in our extended version. The estimated model of the Japanese economy exhibits rather strong positive responses to a government spending shock regardless of its low share of non-Ricardian households. Simulating the model under different tax rules showed that the debt-stabilizing tax rules employed in Japan during the 1980s and 1990s have helped to make the short-run multipliers large. The results of our analysis suggest that fiscal stimulus becomes more effective if the increase in government spending is initially financed by debt and if that debt is repaid largely via a gradual increase in capital income tax under an accommodative monetary policy. An increase in government spending leads to an increase in labor input which, in turn, increases investment. While the debt issued to finance the spending increase must eventually be repaid through tax increases, the increase in labor
input resulting from the fiscal stimulus is dampened least when only the capital tax rate is raised to repay the debt. Although capital income taxation has a dampening effect on investment, it is therefore possible to have an investment boom in the initial periods after fiscal stimulus if the timing of capital taxation is sufficiently delayed. This paper suggests that, overall, distortionary tax policy rules play a critical role in determining the size of the multiplier in the short term.

Whereas most of the current workhorse DSGE models employed by policy institutions use non-Ricardian households to amplify the effects of fiscal stimulus, particular tax policy rules can be of even greater importance. In addition, this present paper considers three distortionary taxes as financing instruments and examines how the government spending multiplier can change under different tax rules, instead of relying on the recently suggested concept of a spending reversal. Therefore, this paper complements and adds a new dimension to the recent debate regarding the government spending multiplier.

The remainder of this paper is organized as follows. In the next section, the model is introduced in detail. Section 3 presents the estimation results and Section 4 presents the results of the simulations under alternative tax rules. Lastly, conclusions and new directions for future research are suggested in Section 5.

2 The Model

2.1 Households

There is a continuum of households indexed by \( n \in [0, 1] \). A fraction \( 1 - \omega \) of this households indexed by \( i \in [0, 1 - \omega) \) has access to financial market and acts as Ricardian. I.e., each member of Ricardian households \( i \) maximizes its lifetime utility by choosing consumption, \( C^R_t(i) \), investment, \( I_t(i) \), government bonds, \( B_t(i) \), next period’s capital
stock, $K_t(i)$, and intensity of the capital stock utilization, $z_t(i)$, given the following lifetime utility function:

$$
E_t \sum_{\tau=0}^{\infty} \beta^\tau \varepsilon^b_t \left( \frac{1}{1-\sigma_c} \left( C^R_t(i) - hC^R_{t-1}(i) \right)^{1-\sigma_c} - \frac{\varepsilon^d_t}{1+\sigma_t} L^R_t(i)^{1+\sigma_t} \right),
$$

where $\beta$ is the discount factor, $\sigma_c$ denotes the inverse of the intertemporal elasticity of substitution, $\sigma_t$ is the inverse of the elasticity of work effort with respect to real wages, and $L^R_t(i)$ represents the labor supply. $h$ measures the degree of external habit formation in consumption. $C^R_{t-1}$ is lagged aggregate per capita Ricardian consumption.$^6$

Two serially correlated shocks, a preference shock, $\varepsilon^b_t$, and a labor supply shock, $\varepsilon^d_t$, are considered and are assumed to follow a first-order autoregressive process with an i.i.d.-normal error term: $\varepsilon^b_t = \rho_b \varepsilon^b_{t-1} + \eta^b_t$ and $\varepsilon^d_t = \rho_d \varepsilon^d_{t-1} + \eta^d_t$.

The Ricardian household faces a flow budget constraint:

$$
(1+\tau^c_t)C^R_t(i) + I_t(i) + \Psi(z_t(i))K_{t-1}(i) + \frac{B_t(i)}{R_tP_t} = (1-\tau^c_t)w_t(i)L^R_t(i) + (1-\tau^l_t)\tau^k_t z_t(i)K_{t-1}(i) + (1-\tau^k_t)\frac{D_t(i)}{P_t} + \frac{B_{t-1}(i)}{P_t},
$$

where $\Psi(z_t(i))$ is the cost associated with variations in the degree of capital utilization $z_t(i)$. $\tau^c_t$, $\tau^l_t$, and $\tau^k_t$ denote consumption, labor, and capital income tax rates, respectively. $D_t(i)$ denotes dividends distributed by firms to the Ricardian household $i$. $P_t$ is aggregate price level, $R_t$ is riskless return on government bonds, $w_t(i)$ is real wage income, and $\tau^k_t$ is real rental rate of capital.

The physical capital accumulation law for the Ricardian household is expressed as follows:

$$
K_t(i) = (1-\delta)K_{t-1}(i) + \left[ 1 - S \left( \frac{\varepsilon^s_t I_t(i)}{I_{t-1}(i)} \right) \right] I_t(i),
$$

where $\delta$ is the depreciation rate, $S(\cdot)$ represents the adjustment cost function in investment. $\varepsilon^s_t$ is a shock to investment cost function and is assumed to follow a process: $\varepsilon^s_t = \rho_s \varepsilon^s_{t-1} + \eta^s_t$. The steady-state value of the capital utilization rate is set at $\bar{z} = 1$. 
and the corresponding cost function is assumed to satisfy \( \Psi(z) = 0 \). Moreover, the investment adjustment cost function is assumed to satisfy \( S(1) = S'(1) = 0 \).

Letting \( \Lambda_t \) and \( \Lambda_t Q_t \) denote the Lagrange multipliers, the first-order conditions with respect to \( C_t^R(i) \), \( B_t(i) \), \( I_t(i) \), \( K_t(i) \), and \( z_t(i) \) are expressed as follows:

\[
(1 + \tau_t^e) \Lambda_t = \varepsilon_t^b \left( C_t^R(i) - hC_{t-1}^R \right)^{-\sigma_e},
\]

\[
\beta R_{t-1} \left[ \frac{\Lambda_{t+1}}{\Lambda_t} \frac{P_t}{P_{t+1}} \right] = 1,
\]

\[
Q_t \left[ 1 - S \left( \frac{\varepsilon_t^I I_t(i)}{I_{t-1}(i)} \right) \right] - Q_t S' \left( \frac{\varepsilon_t^I I_t(i)}{I_{t-1}(i)} \right) \frac{\varepsilon_t^I}{I_{t-1}(i)} I_t(i) = -\beta E_t \left[ \frac{\Lambda_{t+1}}{\Lambda_t} Q_{t+1} S' \left( \frac{\varepsilon_t^{I+1} I_{t+1}(i)}{I_t(i)} \right) \frac{\varepsilon_t^{I+1} I_{t+1}(i)}{I_t(i)^2} I_{t+1}(i) \right] + 1,
\]

\[
Q_t = \beta E_t \left[ \frac{\Lambda_{t+1}}{\Lambda_t} \left( (1 - \delta) Q_{t+1} + (1 - \tau_t^k) r_{t+1} z_{t+1} - \Psi(z_{t+1}(i)) \right) \right] + \eta_t^q,
\]

\[
(1 - \tau_t^k) r_t^k = \Psi'(z_t(i)).
\]

Here, \( Q_t \) represents the shadow price of additional unit of capital. \( \eta_t^q \) is introduced to capture an equity premium shock. Letting an over-bar denote a steady-state value, it can be shown that \( 1/\beta = \bar{R} = 1 - \delta + (1 - \bar{\tau}^k) \bar{z}^k \) and \( \bar{Q} = 1 \).

The remaining households, indexed by \( j \in [1 - \omega, 1] \) have the same preferences as Ricardian households, however, they do not have access to financial markets and are dubbed \textit{non-Ricardian}. Non-Ricardian households simply consume all of their current disposal income. Denoting consumption and labor input of non-Ricardian households as \( C_t^{NR}(j) \) and \( L_t^{NR}(j) \), the period-by-period budget constraint they face is given by:

\[
(1 + \tau_t^e) C_t^{NR}(j) = (1 - \tau_t^l) w_t(j) L_t^{NR}(j).
\]

The members of Ricardian households act as wage setters for their differentiated labor services, \( L_t^R(i) \), in monopolistically competitive markets. The nominal wages for differentiated labor services, \( W_t^R(i) \), are determined by staggered contracts \( \text{\textbeta la Calvo} \) (1983). On the other hand, the members of non-Ricardian households are assumed to set their wages, \( W_t^{NR}(j) \), for their differentiated labor services, \( L_t^{NR}(j) \), to be equal to
the average wage of Ricardian households. Because all households face the same labor
demand schedule, both wages and labor hours will be equal for every household, i.e.,
\[ W_t^R(i) = W_t^{NR}(j) = W_t(n) \text{ and } L_t^R(i) = L_t^{NR}(j) = L_t(n). \]

An independent and perfectly competitive employment agency bundles differentiated
labor, \( L_t(n) \), into a single type of effective labor input, \( L_t \), using the following technology:
\[ L_t = \left[ \int_0^1 L_t(n) \frac{1}{1 + \lambda_{w,t}} \, dn \right]^{1 + \lambda_{w,t}}, \]
where an i.i.d.-normal shock, \( \eta_{w,t} \), is assumed for the wage markup: \( \lambda_{w,t} = \lambda_w + \eta_{w,t} \). The
employment agency solves:
\[ \max_{L_t(n)} W_t \left[ \int_0^1 L_t(n) \frac{1}{1 + \lambda_{w,t}} \, dn \right]^{1 + \lambda_{w,t}} - \int_0^1 W_t(n)L_t(n)dn, \]
where \( W_t \equiv w_tP_t \) is aggregate nominal wage index.

With probability \( 1 - \xi_w \), each Ricardian household \( i \) is assumed to be allowed to
reset its wage optimally, unless otherwise it adjusts its wage partially according to the
following indexation scheme:
\[ W_t^R(i) = \left( \frac{P_{t-1}}{P_{t-2}} \right)^{\gamma_w} W_{t-1}^R(i), \]
where \( \gamma_w \) measures the degree of indexation. The Ricardian household \( i \), which is allowed
to optimally reset its wage, is assumed to maximize its lifetime utility taking aggregate
nominal wage, \( W_t \), and effective labor input, \( L_t \), as given. Since the household knows
the probability \( \xi_w \) that the wage it chooses in this period will still be in effect \( s \) periods
in the future, the optimal wage, \( W_t^{R*}(i) \), is obtained by solving the following problem:
\[
\max_{W_t^{R}(i)} E_l \sum_{s=0}^{\infty} \xi_w^s \beta^s \left[ \frac{1}{1 - \sigma_c} \left( C_{t+s}(i) - hC_{t+s-1} \right)^{1 - \sigma_c} - \frac{\beta_{t+s}}{1 + \sigma_l} \left( \frac{W_{t+s}(i)}{W_t} \right)^{1 + \lambda_{w,t+s}} L_{t+s} \right]^{1 + \sigma_l},
\]
subject to
\[
(1 + \tau_{t+s})C_{t+s}(i) + I_{t+s}(i) + \Psi(z_{t+s}(i))K_{t+s-1}(i) + \frac{B_{t+s}(i)}{R_{t+s}P_{t+s}} = (1 - \tau_{t+s}) \frac{W_{t+s}(i)}{P_{t+s}} \left( \frac{W_{t+s}(i)}{W_t} \right)^{1 + \lambda_{w,t+s}} L_{t+s}
\]
Since we know that \( W_t^{R}(i) = W_t^{NR}(j) = W_t(n) \), aggregate nominal wage law of motion is then expressed as follows:

\[
W_t = \left[ (1 - \xi_w) (W_t^*(n))^{\frac{1}{\lambda_{w,t}}} + \xi_w \left( \left( \frac{P_{t-1}}{P_{t-2}} \right)^{\gamma_w} W_{t-1}(n) \right)^{-\frac{1}{\lambda_{w,t}}} \right]^{-\lambda_{w,t}}, \tag{9}
\]

where \( W_t^*(n) = W_t^{R*}(i) \).

### 2.2 Firms

There are two types of firms: perfectly competitive final-good firms and monopolistically competitive intermediate-good firms indexed by \( f \in [0, 1] \). The final-good firm produces the good, \( Y_t \), combining the differentiated intermediate goods, \( y_t(f) \), produced by the firm \( f \).

The final-good producing firm combines intermediate goods using the following bundler technology:

\[
Y_t = \left[ \int_0^1 y_t(f)^{\frac{1}{\lambda_{k,t}}} df \right]^{1+\lambda_{p,t}},
\]

where an i.i.d.-normal shock \( \eta_t^p \) is assumed for the price markup: \( \lambda_{p,t} = \lambda_p + \eta_t^p \). The final-good firm solves:

\[
\max_{y_t(f)} P_t \left[ \int_0^1 y_t(f)^{\frac{1}{\lambda_{k,t}}} df \right]^{1+\lambda_{p,t}} - \int_0^1 p_t(f)y_t(f)df,
\]

where \( p_t(f) \) is the price of the intermediate good \( y_t(f) \).

Each intermediate-good firm \( f \) produces its differentiated output using an increasing-returns-to-scale Cobb-Douglas technology:

\[
y_t(f) = \varepsilon_t^a \tilde{k}_{t-1}(f)^{\alpha} l_t(f)^{1-\alpha} - \Phi,
\]

where \( \tilde{k}_{t-1}(f) \) is the effective capital stock at time \( t \) given by \( \tilde{k}_{t-1}(f) = z_{t+1} k_{t-1}(f) \). \( l_t(f) \) is the effective labor input bundled by the employment agency, and \( \Phi \) represents a fixed cost. \( \varepsilon_t^a \) is a technology shock assumed to follow a process: \( \varepsilon_t^a = \rho_{a} \varepsilon_{t-1}^a + \eta_t^a \).
Taking the real rental cost of capital, $r^k_t$, and aggregate real wage, $w_t$, as given, cost minimization subject to the production technology yields marginal cost:

$$mc_t = \frac{w_t^{1-\alpha}(r^k_t)^{\alpha}}{\varepsilon_t^\alpha \alpha^\alpha (1-\alpha)^{1-\alpha}},$$

and the labor demand function at the aggregate level is given by:

$$L_t = \frac{1-\alpha}{\alpha} r^k_t w_t z_t K_{t-1}.$$  

(10)

Nominal profits, $d_t(f)$, of the intermediate-good firm are expressed as follows:

$$d_t(f) = p_t(f)y_t(f) - P_t mc_t(y_t(f) + \Phi),$$

which are distributed to Ricardian households as dividends. Aggregation gives:

$$D_t = P_t Y_t - P_t mc_t(Y_t + \Phi).$$  

(12)

As in the case of wage setting, sluggish price adjustment due to the staggered price contracts à la Calvo (1983) is assumed. A fraction $1 - \xi_p$ of intermediate-good firms can re-optimize their prices, unless otherwise they follow the price indexation scheme:

$$p_t(f) = \left(\frac{P_{t-1}}{P_{t-2}}\right)^{\gamma_p} p_{t-1}(f),$$

where $\gamma_p$ measures the degree of indexation.

An intermediate-good firm $f$, which is allowed to re-optimize, knows the probability $\xi_p$ that the price it chooses in this period will still be in effect $s$ periods in the future. Taking aggregate nominal price index, $P_t$, and output, $Y_t$, as given, the optimal price, $p_t^{*}(f)$, is obtained by solving:

$$\max_{p_t(f)} E_t \sum_{s=0}^{\infty} (\beta \xi_p)^s \left[ (p_{t+s}(f) - P_{t+s}mc_{t+s}) \left( \frac{p_{t+s}(f)}{P_{t+s}} \right)^{-\frac{1+\lambda_p}{\gamma_p}} Y_{t+s} - P_{t+s}mc_{t+s}\Phi \right].$$

Aggregate price law of motion is then expressed as follows:

$$P_t = \left[ (1 - \xi_p)(p_t^{*}(f))^{-\frac{1}{\gamma_p}} + \xi_p \left( \frac{P_{t-1}}{P_{t-2}} \right)^{\gamma_p} p_{t-1}(f) \right]^{-\frac{1}{\gamma_p}}.$$

(13)
2.3 Fiscal and Monetary Authorities

The fiscal authority purchases final goods, $G_t$, issues bonds, $B_t$, and levies taxes on consumption, labor income, and capital income at rates, $\tau_c^t$, $\tau_l^t$, and $\tau_k^t$, respectively. The real flow budget constraint for the fiscal authority is expressed as follows:

$$G_t + \frac{B_{t-1}}{P_t} = \tau_c^t C_t + \tau_l^t w_t L_t + \tau_k^k r_t K_{t-1} + \tau_k^k D_t \frac{P_t}{P_t} + \frac{1}{\bar{R}_t} \frac{B_t}{P_t}. \quad (14)$$

We consider three feedback rules for each tax and a government spending rule in log-linearized form. The aggregate tax rates are assumed to positively respond to a predetermined debt-to-output ratio following FMS:

$$\hat{\tau}_c^c = \rho_{tc} \hat{\tau}_c^{c,t-1} + (1 - \rho_{tc}) \phi_{tc} (\hat{b}_t - \hat{Y}_{t-1}) + \eta^{tc}_t, \quad (15)$$

$$\hat{\tau}_l^l = \rho_{tl} \hat{\tau}_l^{l,t-1} + (1 - \rho_{tl}) \phi_{tl} (\hat{b}_t - \hat{Y}_{t-1}) + \eta^{tl}_t, \quad (16)$$

$$\hat{\tau}_k^k = \rho_{tk} \hat{\tau}_k^{k,t-1} + (1 - \rho_{tk}) \phi_{tk} (\hat{b}_t - \hat{Y}_{t-1}) + \eta^{tk}_t, \quad (17)$$

where the hats above variables denote log-deviations from the steady state. $b_t \equiv B_t/P_t$ denotes government bonds in real terms. $\eta^{g}_t$, $\eta^{c}_t$, $\eta^{l}_t$, and $\eta^{k}_t$ are i.i.d.-normal errors. It should be noted that the government budget constraint and the tax policy rules described here allow partial debt finance after a government spending increase, while the debt is to be repaid through tax revenue over time. The speed of fiscal adjustment is determined by the coefficient of the debt-to-output ratio. Government spending is assumed to follow a feedback rule that responds to output gap in log-linearized form:

$$\hat{G}_t = \rho_g \hat{G}_{t-1} + (1 - \rho_g) \phi_{gy} \hat{Y}_{t-1} + \eta^{g}_t. \quad (18)$$

The monetary authority sets the nominal interest rate according to a simple feedback rule:

$$\hat{R}_t = \rho_r \hat{R}_{t-1} + (1 - \rho_r) \phi_{r\pi} \hat{\pi}_{t-1} + (1 - \rho_r) \phi_{ry} \hat{Y}_t + \eta^{R}_t, \quad (19)$$

where $\pi_{t-1} \equiv \log(P_{t-1}/P_{t-2})$ denotes inflation rate. An i.i.d.-normal shock, $\eta^{R}_t$, to the interest rate is assumed.
2.4 Aggregation and Market Clearing

Aggregate consumption, $C_t$, and labor input, $L_t$, in per-capita term are given by a weighted average of the corresponding variables for each consumer type:

$$C_t = (1 - \omega)C^R_t(i) + \omega C^NR_t(j), \quad (20)$$

$$L_t = (1 - \omega)L^R_t(i) + \omega L^NR_t(j),$$

and again, since all households supply the same amount of labor by assumption, aggregate labor input is given by:

$$L_t = L^R_t(i) = L^NR_t(j).$$

Because only Ricardian households have access to financial markets, aggregate government bonds, $B_t$, investment, $I_t$, physical capital, $K_t$, and dividends, $D_t$, distributed by firms are expressed as follows:

$$B_t = (1 - \omega)B^R_t(i),$$

$$I_t = (1 - \omega)I^R_t(i),$$

$$K_t = (1 - \omega)K^R_t(i),$$

$$D_t = (1 - \omega)D^R_t(i).$$

Finally, aggregate production equation and the final-goods market equilibrium condition are given by:

$$Y_t = \phi_t^\alpha (z_t K_{t-1})^\alpha L_t^{1-\alpha} - \Phi, \quad (21)$$

$$Y_t = C_t + I_t + G_t + \Psi(z_t) K_{t-1}. \quad (22)$$
3 Bayesian Estimation of the Model

3.1 Preliminary Setting

In estimating the model parameters, we first log-linearize the model around the deterministic steady state and conduct Bayesian inference using the Markov Chain Monte Carlo (MCMC) method. The parameters are estimated for the Japanese data covering the period from 1980:Q1 to 1998:Q4. We utilize fiscal data on government spending (calculated as the sum of government consumption and investment) and aggregate effective tax rates on consumption and labor income. We also use the ordinary seven-part series typically employed in the literature, which includes output, private consumption and investment, labor hours, wages, the inflation rate, and the interest rate. The aggregate effective tax rates are calculated following Mendoza et al. (1994).\(^7\) All of the variables are detrended using the Hodrick-Prescott filter.

The end of the estimation period is determined for both computational and empirical reasons. It is determined not to include the period during which a zero-interest-rate policy is adopted.\(^8\) Moreover, Japan’s fiscal policy regime seems to have changed around 1999. The severe economic downturn in the aftermath of the Asian financial crisis in 1997-1998 forced the government to suspend its fiscal consolidation efforts temporarily. After that, because of the institutional reforms of the budget process that took place at the beginning of the 2000s, the government started to increase its focus on spending cuts as opposed to taxation as the dominant mode of fiscal consolidation.\(^9\)

To illustrate the changes in the fiscal policy regime in Japan, we estimate the following single-equation fiscal rules using the Ordinary Least Squares (OLS) method for different fiscal instruments for the subsamples 1980:Q1-1998:Q4 and 1999:Q1-2008:Q1:

\[
(fiscal \text{ instrument})_j = (constant \text{ term})_j + \alpha_j (\text{debt-to-output ratio})
\]

Table 1 reports the estimated values of the coefficients \(\alpha_j\) of debt-to-output ratio for
different fiscal instruments $j$ and the results of a Chow test in which the breakpoint is set equal to 1999:Q1. It appears that aggregate effective tax rates on consumption and capital income increased in response to debt-to-output ratios during the 1980-1998 period in Japan and that capital income tax played a greater role in stabilizing debt. It would also seem that government spending during the period responded positively to debt-to-output ratios. This contradicts the idea of a spending reversal. A spending reversal policy is weakly observed during the period 1999-2008 but not for 1980-1998. Also, note that the results of the Chow breakpoint test provide strong support for Japan’s fiscal policy regime change around 1999.

- Insert Table 1 Here -

Because the model is an extended variant of Smets and Wouters (2003) and based on its use as a tool for analyzing the Japanese economy in Iiboshi et al. (2006) and Sugo and Ueda (2008), we largely follow these studies in choosing prior distributions and in fixing several parameters that are difficult to identify. Specifically, we set the capital share at $\alpha = 0.3$, the discount rate at $\beta = 0.99$, the depreciation rate at $\delta = 0.06$, the wage markup at $\lambda_w = 0.5$, and the parameter for the elasticity of investment to the price of capital adjustment cost at $\zeta \equiv 1/S'' = 6.32$. The steady-state capital-output ratio and debt-to-output ratio are set at $\bar{K}/\bar{Y} = 2.2$ and $\bar{B}/\bar{P}\bar{Y} = 0.6$, following Iiboshi et al. (2006) and Broda and Weinstein (2004), respectively. We assume that $\bar{C}^R/\bar{Y} = \bar{C}^{NR}/\bar{Y} = \bar{C}/\bar{Y}$ following Galí et al. (2007) and take sample period averages for the steady-state values for the government spending-to-output ratio and consumption, labor, and capital income tax rates.

### 3.2 Estimation Results

Tables 2-3 report the estimated mean parameter values and those of previous DSGE studies for the sake of comparison: Smets and Wouters (2003) (SW), Coenen and Straub
(2005) (CS), and FMS for the euro area, Levin et al. (2006) (LOWW) for the United States, and Iiboshi et al. (2006) (INW) and Sugo and Ueda (2008) (SU) for Japan. The studies listed here, with the exception of FMS, are all variants of the Smets and Wouters (2003) model. Although FMS employs adjustment cost functions for sticky price and wage mechanism, FMS’s other features, such as real rigidities, shocks, and functional forms, share much in common with the studies listed here.

- Insert Table 2 Here -

Overall, the values of posterior mean estimates are not very different from those reported in previous studies. From the viewpoint of fiscal policy effectiveness, structural parameters for the non-Ricardian share, price and wage stickiness, habit persistency, and labor supply elasticity are of particular interest. The estimated mean value of the non-Ricardian share, 0.25, is very much consistent with the Kalman filter estimates of Hatano (2004). Hatano (2004), using a Kalman filter technique, determines that this figure remains between 0.2 and 0.3 throughout the 1980s and the 1990s in Japan.\textsuperscript{10} Compared with other DSGE-based estimates for the euro area and the U.S., the value is somewhat smaller.\textsuperscript{11} The Calvo parameter for wage stickiness is higher, whereas that for price is lower than the INW and SU estimates. They are, however, largely in line with the results of Koga and Nishizaki (2005).\textsuperscript{12} Our estimate of the inverse elasticity of the labor supply is close to those of INW and SU. The parameter value for habit persistency is much smaller than that reported by INW but much larger than that reported by SU. SU conjecture that their small value for habit persistence is due to their assumption of internal habit. This paper assumes that habit is external, as does INW. On the other hand, that our value is smaller than that of INW may be attributable to the inclusion of non-Ricardian households. As Coenen and Straub (2005) note, this has the effect of lowering the estimate of the parameter for habit persistency and raising that for the intertemporal elasticity of substitution. In fact, the value of the estimated intertemporal
elasticity of substitution $1/\sigma_c$ is larger than that of INW. Overall, posterior means for structural parameters do not suggest that the government spending multiplier is large in this model.

Insert Table 3 Here

Turning to the policy parameters, we note that relative to those of INW, the estimated response of monetary policy to inflation is weak, and the estimated response to the output gap is strong. The less aggressive stance of monetary policy towards inflation may reflect the difference in the sample periods.\textsuperscript{13} The posterior mean estimates of tax rule parameters that govern responses of tax instruments to debt-to-output ratio are all positive, although those of consumption and labor income tax rules are not reliably different from zero. The results are quite consistent with those of the OLS estimates of single-equation fiscal rules reported in Table 1, which suggests that capital income taxation contributed to debt stabilization to the largest extent during the 1980s and 1990s in Japan. Although the series of aggregate effective tax rates on capital is treated as a latent variable in the MCMC estimation, we reach the same conclusion as that suggested by the OLS estimation in which capital tax data series is utilized.

4 Assessing the Role of Tax Policy Rules


The size of a coefficient of the debt-to-output ratio of a tax rule determines the speed of fiscal adjustment or debt repayment and accordingly affects the time paths of economic variables such as output, consumption, and investment after a government spending increase. Even more importantly, when one analyzes an economy with different kinds of taxes, the size of the coefficient compared with those of other tax rules also affects
the time paths because different distortionary taxes differ in their disincentive effects on household decisions.

To examine the influence of tax rules on the effect of fiscal stimulus, we consider the sensitivity of the government spending multiplier to changes in the coefficients of tax rules. We begin by comparing the simulation results under the estimated tax rules for Japan 1980:Q1-1998:Q4 with those under parameters that replicate tax rules estimated for the euro area 1980:Q1-2005:Q4 in FMS. Setting the smoothing parameter values to those estimated for Japan, we adjust the policy parameters $\phi_{tcb}$, $\phi_{tlb}$, and $\phi_{tkb}$ for each tax rule so that the coefficients of the debt-to-output ratio become equal to those of the FMS estimates. The adjusted policy parameters and the coefficients are reported in Appendix Table A with those of our estimates and those of FMS's original estimates. The coefficients suggest that debt in Japan is financed largely through capital income taxation, whereas financing in the euro area is instead allocated rather heavily to labor income taxes. In the following exercise, all other parameter values are calibrated to the estimated means of the posterior distributions for the parameters unless otherwise noted.

- Insert Figure 2 Here -

Figure 2 illustrates the dynamic responses of output, consumption, investment, and labor input to a government spending shock equal to one percent of the steady-state output under the estimated tax rules and those under the adjusted FMS tax rules for the euro area. Each dynamic response is depicted as a percentage deviation from the steady state and hence corresponds to the impact multiplier of Mountford and Uhlig (2009). The impact multiplier for output in period $k$ is defined as follows:

$$ \text{Impact Multiplier (} k \text{)} = \frac{\Delta Y_{t+k}}{\Delta G_t}. $$

The output multipliers of the estimated model are larger in the initial periods than those when the adjusted FMS tax rules are employed; greater declines are shown in
later periods. The upper right-hand and lower left-hand panels reveal that the greater output multipliers of the estimated model in the initial periods can be attributable both to the dynamic responses of consumption and to those of investment. A closer look at the patterns of output, consumption, and investment responses indicates that investment serves as a major driving force for the stronger output response under the estimated tax rule. The strong increase in investment reflects the increase in the labor supply, which has a positive impact on the marginal product of capital. It is also traceable to a moderate increase in the interest rate due to the less aggressive monetary policy. In later periods, however, the estimated model exhibits large decreases in consumption, in investment, and thus in output. The decreases are brought about by delayed tax increases in response to debt accumulation. Because the main financing source for the estimated tax rules is capital income taxation, the decline in later periods is significant for investment.

Note that the estimated model delivers a slight but positive consumption response in the initial periods. This is somewhat surprising because none of the estimated values of key structural parameters for fiscal policy effectiveness—such as the non-Ricardian share, price and wage stickiness, habit persistency, or labor supply elasticity—seem to generate the crowding-in effect. In particular, the estimated share of non-Ricardian households in Japan seems to be too small to have precipitated the crowding-in effect as suggested in previous studies (see Coenen and Straub (2005)).

4.2 Policy Experiments

4.2.1 Alternative Financing Schemes

In the following, we examine how different financing schemes affect the effectiveness of fiscal stimulus. We consider three alternative tax-financing schemes: (a) one in which the consumption tax alone adjusts to stabilize debt (a consumption tax-financing scheme),
(b) one in which the labor income tax alone adjusts (a labor tax-financing scheme), and
(c) one in which the capital income tax alone adjusts (a capital tax-financing scheme).

The parameter values for the three tax-financing schemes are set as follows: (a) $\rho_{tc} = 0.6$, $\phi_{tcb} = 0.2/\tau^c$, $\bar{\tau}^c = 0.08$, $\phi_{tlb} = \phi_{tkb} = 0$; (b) $\rho_{tl} = 0.6$, $\phi_{tlb} = 0.2/\tau^l$, $\bar{\tau}^l = 0.31$, $\phi_{tcb} = \phi_{tkb} = 0$; (c) $\rho_{tk} = 0.6$, $\phi_{tkb} = 0.2/\tau^k$, $\bar{\tau}^k = 0.45$, $\phi_{tcb} = \phi_{tlb} = 0$. The responsiveness parameters of three tax rules, $\phi_{tcb}$, $\phi_{tlb}$, and $\phi_{tkb}$, are normalized by their respective steady-state values because $\tau^c_t$, $\tau^l_t$, and $\tau^k_t$ are defined as deviations from their steady-state values. For the sake of simplicity, we assume that government spending does not respond to the output gap ($\phi_{gy} = 0$) in the exercise below. We also consider the following two alternative financing schemes for comparative purposes: (d) a spending reversal and (e) a balanced budget. In the case of a spending reversal, the government spending rule is assumed to take the following form:

$$\dot{G}_t = \rho_g \dot{G}_{t-1} - (1 - \rho_g) \phi_{gb}(\dot{b}_{t-1} - \dot{Y}_{t-1}) + \eta_t^{gb}. \quad (23)$$

where $\phi_{gb}$ captures the degree of future spending cuts based on the debt-to-output ratio. We set $\rho_g = 0.6$ and $\phi_{gb} = 0.2 \times (\dot{C}/\dot{G})$, where $\dot{C}/\dot{G} = 2.5$. For a balanced budget, we assume that the current labor income tax alone adjusts to meet the following period-by-period budget constraint:

$$G_t = \tau^c_t C_t + \tau^l_t w_t L_t + \tau^k_t k_{t-1} + \tau^k_t D_t P_t. \quad (24)$$

### 4.2.2 Short-run Stimulative Effects

Figure 3 displays the impulse responses to a government spending shock under the five alternative financing schemes formulated above. We put the responses under the labor tax-financing scheme in both the right and left panels for comparative purposes. As in Figure 2, the responses correspond to the impact multipliers.
The top two panels show that the stimulative effects of capital tax-financed spending exceed those under other financing schemes in the short term. Fiscal stimulus under the balanced budget scheme shows the smallest output response on impact. Because the balanced budget scheme does not allow any debt finance, the negative wealth effect on consumption becomes quite large. The initial rise in consumption is the largest under the capital tax-financing scheme. It should be noted that the hump-shaped rise in Ricardian consumption caused by the spending reversal occurs from the sixth quarter onward in the model. That is, the observed initial increases in total consumption are brought about by non-Ricardian households. The capital tax-financed spending leads to the strongest initial increases in investment as well, but a large decline occurs as the capital tax increases in later periods. Labor input also shows the strongest increase under the capital tax-financing scheme. Recall that the coefficients of the estimated tax rules for Japan suggest that debt is repaid largely through capital income taxation, whereas its financing in the euro area is allocated rather heavily to labor income tax.

In comparing the responses shown in the left panels of Figure 3 with those in Figure 2, we notice that the response patterns of output, consumption, investment, and labor input under the capital tax-financing scheme all show similar patterns to those under the estimated tax rules for Japan. On the other hand, the response patterns under the labor tax-financing scheme show similar patterns to those under the adjusted FMS tax rules for the euro area.

To assess the quantitative importance of changes in the multipliers brought by alternative tax-financing schemes, we compare the first-year average responses for different tax-financing schemes in Table 4. The responses for different non-Ricardian shares are also presented for capital tax-financed spending.

- Insert Table 4 Here -

As expected, the introduction of non-Ricardian households contributes toward a crowding-
in effect on consumption. The crowding-in effect decreases as the share of non-Ricardian households declines. On the other hand, the investment multipliers become larger as the non-Ricardian share declines because non-Ricardian households do not own capital, and hence, the total investment in the economy increases as the share declines. Note that decreases in Ricardian consumption also become smaller as investment responds strongly. Both consumption and labor tax-financed spending cannot generate the crowding-in effect on consumption with a relatively high non-Ricardian share ($\omega = 0.4$) in this model. In contrast, the stimulative effects of capital tax-financed spending are larger than those of consumption and labor tax-financed spending with a high non-Ricardian share, even when non-Ricardian households do not exist ($\omega = 0.0$). The results here indicate that a choice of tax rules can alter the consequences of a fiscal stimulus program anticipated by the given non-Ricardian share.

### 4.2.3 Inspecting the Mechanism

In a general equilibrium framework, an (irreversible) increase in government spending needs to eventually be financed through a corresponding increase in taxation, even if it is financed by debt initially. Taxation creates a negative wealth effect on consumption and leisure. The decrease in leisure is result of increased labor hours. The increases in labor hours induce capital accumulation because they have a positive impact on the marginal product of capital, making investment more attractive. Therefore, investment tends to rise after a permanent government spending increase in neoclassical models (see Aiyagari et al. (1992); Baxter and King (1993)). The same basic forces apply in the face of a persistent increase in government spending (see Burnside et al. (2004)). In New Keynesian models, however, investment tends to decline because strong monetary policy reactions lead to a rise in the real interest rate (see Linnemann and Schabert (2003); Cogan et al. (2010)).
In our estimated model, fiscal stimulus has persistent effects, and monetary policy does not respond aggressively to inflation. Therefore, investment increases through the above-mentioned neoclassical channel without being hampered by a real rate rise. Because the model allows partial debt finance and three distortionary taxes, debt repayment is to be financed via a split among consumption, labor, and capital income taxes. Regarding the role of different taxes, note that both consumption and labor income taxes have dampening effects on labor hours because the labor supply schedule is related to the utility-maximizing choice between consumption and leisure on an after-tax basis. Hence, debt stabilization via either a consumption tax or a labor income tax limits the initial increase in labor input after fiscal stimulus more than debt stabilization via a capital income tax. Labor input increases greatly under the capital tax-financing scheme, and so does investment. Although capital income taxation is harmful to investment, the speed of fiscal adjustment or debt repayment is slow, and the increase in investment is strong enough to outweigh the distortionary effects of capital taxation in the initial periods. The results here are closely related to the findings presented by Jones (2002), which indicate that labor income taxation has a greater downward effect on labor input—and, accordingly, on output—that capital income taxation does in a neoclassical framework.

Furthermore, in our New Keynesian model, the investment boom pushes up the rental rate on capital, but monetary policy does not react very aggressively to inflation; it allows negative real interest rates, at least for a while. The negative real rate not only further increases investment but also induces Ricardian consumption to rise initially through the intertemporal substitution effect. Hence, both investment and consumption respond positively to the capital tax-financed spending increase. Notice also that as we have seen in Table 4, increases in investment have positive effects on Ricardian consumption.

To illustrate the role of monetary policy in the estimated model, we consider the
sensitivity of the multipliers to changes in parameter values as we did for the tax rules earlier. Setting the interest rate smoothing coefficient to the estimated value for Japan ($\rho_r = 0.93$), we adjust the policy parameters $\phi_{rx}$ and $\phi_{ry}$ of the monetary policy rule so that the coefficients of inflation and the output gap become equal to the corresponding FMS estimates for the euro area. Again, the adjusted policy parameters and the coefficients are reported in Appendix Table A with our estimates and the FMS’s original monetary policy estimates. The adjusted parameter values indicate that the estimated monetary policy for Japan is less aggressive towards inflation than that for the euro area.

Figure 4 shows the impact multipliers for different tax-financing schemes under the adjusted FMS monetary policy rule for the euro area. The responses under the capital tax-financing scheme and the estimated monetary policy for Japan are also shown for comparative purposes. As we have previously seen, consumption rises initially under the capital tax-financing scheme and estimated monetary policy. Under the adjusted FMS monetary policy, however, interest rates are raised more aggressively, thereby weakening intertemporal substitution in consumption. The increase in investment is also hampered by the higher interest rate. As a result, the short-run impact multipliers of capital tax-financed spending are lowered until they become almost equal to those of consumption and of labor income tax-financed spending under the relatively aggressive monetary policy rule.

4.2.4 Medium- and Long-run Consequences

Although this paper aims to address the effect of short-run fiscal stimulus under alternative financing schemes, it is important to remember their medium- and long-run consequences. Mountford and Uhlig (2009) suggest the present-value multiplier as a
summary measure intended to capture the cumulative effects of a fiscal shock along
an entire path up to a particular time. The present-value multiplier for output over a
$k$-period horizon is defined as follows:

\[
\text{Present-Value Multiplier } (k) = \frac{E_t \sum_{s=0}^{k} R^{-s} \Delta Y_{t+s}}{E_t \sum_{s=0}^{k} R^{-s} \Delta G_{t+s}}.
\]

Figure 5 depicts the present-value multipliers for output, consumption, and investment under alternative tax-financing schemes. When capital income tax alone is adjusted to stabilize debt, the present-value multipliers for output are the largest up to a three-year horizon. Over longer horizons, higher capital taxes lower investment, and thereby, the present-value multipliers for investment decrease below those under the consumption and labor tax-financing schemes. The present-value multipliers for consumption become negative within a two-year period, but the decline is smaller than under the consumption and labor tax-financing schemes up to a seven-year horizon.

Table 5 reports the cumulative (horizon=$\infty$) present-value multipliers under alternative tax-financing schemes and under the balanced budget scheme. The capital income tax-financed spending increase has the largest adverse effect on investment, consumption, and output. The cumulative present-value multiplier is slightly positive when the spending increase is consumption tax-financed and slightly negative when it is labor tax-financed. As can be seen in Figure 3, taxation on labor causes a larger decline in labor input than does consumption tax in later periods. Accordingly, the decline in investment is rather prolonged when the spending is financed by labor taxes. These long-run consequences are in line with the widespread consensus: taxes on capital are harmful to growth,\textsuperscript{15} and taxes on consumption are the least distortionary. The cumulative present-value multipliers under the labor-tax financed balanced budget scheme are larger than those when labor income tax is adjusted to stabilize debt through the
feedback rule, although the short-run impact multipliers are smaller, as shown in Figure 3. The reason is that the labor tax feedback rule allows partial debt finance initially, thereby making taxation partly delayed. Delaying the timing of taxation increases output in the short term; however, the output decrease caused by the delayed taxation may be larger than the initial increase (see Trostel (1993)).

- Insert Table 5 Here -

Table 5 also reports the welfare effects of a government spending shock under alternative financing schemes, including a spending reversal. Following Levine et al. (2008), we use a quadratic approximation of the representative household’s utility as the welfare criterion. The change in welfare is expressed as the percentage of steady-state consumption equivalence. Because the utility function is assumed not to be affected by government spending, the overall results are quite similar to those suggested by the cumulative present-value multipliers. The amount of welfare loss is the greatest if spending is financed by capital income taxes. A labor tax-financed spending shock has a larger negative impact on welfare than a consumption tax-financed spending shock does. Welfare loss is the smallest when a future spending reversal is prospected because it does not require an additional tax increase to stabilize debt. The results seem to indicate that a spending reversal policy is the most desirable. However, it should be noted that the results depend critically on the simplifying assumption that government spending is completely wasteful in our model.

The results of this study suggest that output decline and welfare loss are, in the long term, greatest under the capital tax-financing scheme. As previously discussed, a capital tax-financed spending shock induces an investment boom in the initial periods if the speed of fiscal adjustment is slow. This is because capital taxation has the smallest adverse effect on the increase in the labor supply. An accommodative monetary policy plays a critical role in allowing the real interest rate to decline in the short term.
However, as debt is repaid over time, the initial stimulative effects are dominated, in the long term, by the distortional effects of capital taxation. Because capital taxation creates intertemporal wedges, the distortional effects become excessively greater with longer horizons, especially in the presence of imperfect competition (see Judd (2002); Schmitt-Grohé and Uribe (2006)). Thus, it is important when designing fiscal stimulus packages and financing schemes to take into account the long-run costs that arise from future tax burdens. Nevertheless, as Uhlig (2010) notes, the benefits of a faster recovery, as brought about by a fiscal stimulus program, can be greater than their long-run costs depending on the norms at play (for example, how a government will act in a recession). In fact, the central issue in the fiscal stimulus debate among policy-makers most often regards the size of the multiplier in the short term.

5 Concluding Remarks

This paper used an estimated DSGE model of the Japanese economy to study changes in the government spending multiplier under alternative fiscal financing schemes. The results have shown that the government spending multiplier becomes greater in the short term if the spending increase is initially financed by debt and that debt is largely repaid via a gradual increase in capital income tax under an accommodative monetary policy. Capital taxation has the smallest dampening effect on labor input, and the increase in labor input is the key factor contributing to the effectiveness of fiscal stimulus in a general equilibrium framework, as shown by Aiyagari et al. (1992) and Baxter and King (1993). Therefore, to improve the effectiveness of the stimulus, future taxation for debt repayment is better allocated to capital tax instead of labor-dampening taxes, such as consumption and labor income taxes. In light of this paper’s finding that a prospective future financing scheme considerably affects the size of the short-run multiplier, governments are advised to announce both stimulus plans and financing schemes at the same
time to ensure the effects are predictable.

There are some further points regarding the possible extension of this model that should be noted. First, this paper restricts its analysis to the case in which both fiscal and monetary policy rules are stable and linear. However, policy rules are likely to change over time (see e.g. Davig and Leeper (2007); Chung et al. (2007); Davig and Leeper (2011)). Embedding the possibility of a policy regime change in the model is therefore an important avenue to be explored. In addition, the recent crisis highlights the importance of fiscal stimulus when nominal interest rates are at zero, the lower bound (see e.g. Christiano et al. (2009); Erceg and Lindé (2010); Woodford (2011)). It would be interesting to extend our analysis to a “liquidity trap” scenario, in which monetary policy rule cannot be approximated by a linear function. Second, further research could entail incorporating the productivity-enhancing and/or utility-enhancing features of government spending into the model because it is commonly believed that government spending can have a direct effect on the production and utility function (see e.g. Kamps (2004); Linnemann and Schabert (2006); Bouakez and Rebei (2007)). The incorporation of these features may increase the size of the government spending multiplier and provide broader implications to welfare analysis, and therefore deserves high priority in future research.
Notes

1. The aggregate effective tax rates are calculated using the method proposed in Mendoza et al. (1994). The method is intended to construct measures of tax rates that are consistent with the concept of aggregate tax rates at the macro-level. The calculation is based on macroeconomic data, such as tax revenue and national accounts. Their relatively simple methodology is found to be useful in approximating the tax rates faced by the representative agent in DSGE models (see Jones (2002); Forni et al. (2009); Leeper et al. (2010a)).

2. The movements in the effective tax rate on capital broadly reflect the changes in Japan’s statutory corporate tax rate, which was raised in 1981 and 1984, and reduced in 1987, 1989, and 1990.

3. Similar expenditure rules can be found in Leeper and Yang (2008) and Forni et al. (2010).

4. Ludvigson (1996) also finds that a debt-financed government spending increase is expansionary, whereas a distortionary tax-financed increase is contractionary.

5. The non-Ricardian households are usually assumed as liquidity-constrained and hence cannot smooth consumption intertemporally. A government spending shock typically generates a negative wealth effect, which induces forward-looking households to decrease consumption in a general equilibrium framework. On the contrary, empirical studies using a standard VAR approach tend to find that private consumption rises after a government spending shock (see Fatás and Mihov (2001); Blanchard and Perotti (2002); Perotti (2007)). Galí et al. (2007) first introduced the non-Ricardian households to a simple DSGE model and have shown that it is possible to have the crowding-in effect on consumption. Introduction of non-Ricardian households is quite popular among the current workhorse DSGE models at policy institutions (see Kumhof et al. (2010)).

6. A habit is called external if it is affected by the average consumption level of the economy, which is exogenous for each agent. On the other hand, it is called internal if the agent’s habit is directly affected by its past consumption.

7. The series of effective tax rates on capital income is also calculated. The obtained data series is too volatile, however; it is therefore treated as a latent variable whose value cannot be observed directly in the MCMC estimation.

8. The zero lower bound on interest rates requires us to deal with two difficult problems in a DSGE framework: non-linearity and indeterminacy (see Braun and Waki (2006)). Furthermore, non-linearity complicates Bayesian estimations. In evaluating the likelihood function, we need to resort to the particle filter instead of the Kalman filter when the state space representation of the DSGE model is not linear (see Fernández-Villaverde and Rubio-Ramírez (2005); Fernández-Villaverde and Rubio-Ramírez (2007)). Because of these difficulties, most of the existing empirical New Keynesian DSGE
literature on the Japanese economy does not include the zero-interest-rate period (see Iiboshi et al. (2006); Sugo and Ueda (2008); Ichiue et al. (2008); Hirose (2008)). The only exceptions are Yano (2009) and Kitamura (2009). They use the particle filter to estimate New Keynesian DSGE models on Japanese data, which include the zero-interest-rate period.

The Japanese Government adopted the Resolution on Fiscal Consolidation in December 1979 and started its consolidation efforts. To push ahead with the efforts, the Fiscal Structural Reform Act was enacted in 1997, however, the Act was amended and suspended in 1998 to cope with the unanticipated sharp economic downturn. In 2001, aiming at strengthening the Cabinet’s leadership in budgetary process, the Council on Economic and Fiscal Policy was established in the Cabinet Office and the Council started to announce the Basic Policies for Economic and Fiscal Policy Management, which served as guidelines for the budget making during the period 2001-2009. The Basic Policies also functioned as roadmap for fiscal consolidation. For a detailed review of Japan’s experience, see Tanaka (2002) and von Hagen (2006).

The estimation period ranges 1955-1998. Ogawa (1990) is the first paper to adopt a Kalman filter technique to estimate Japan’s non-Ricardian share for the period 1970-1983. It reports that the share stays in the range of 0.4-0.5 in the first half of the 1980s.

As for the euro area, FMS report 0.34 for a case without unions. They also report 0.37 for a case with unions, which are assumed to act as wage setters representing both types of households. Coenen and Straub (2005) report 0.246, 0.249, and 0.370 for different tax specifications. Ratto et al. (2009) report 0.35. As regards the U.S., Bilbiie et al. (2008) report 0.35 and 0.51 for different sample periods.

They estimate Japanese Calvo parameters for wage and price are in the range of 0.7-0.75 and 0.5-0.55 respectively, based on the method of Galí and Gertler (1999).

The estimation period of INW is 1970:Q1 to 1998:Q4, while that is 1980:Q1 to 1998:Q4 in this paper. Ichiue et al. (2008) obtain mean estimates closer to those of this paper ($\rho = 0.85$, $\phi_{\text{per}} = 1.49$, and $\phi_{\text{hyp}} = 0.16$) for a sample period 1981:Q1 to 1995:Q4.

They argue that the value of non-Ricardian share needs to exceed 0.35 to obtain the crowding-in effect in their estimated medium-scale DSGE model of the euro area.

Leeper et al. (2010a) obtain the same results by conducting similar exercises to this paper in a neoclassical framework.

Recall that we assume non-Ricardian households have the same utility function as Ricardian households.

Therefore, most of the literature on welfare effects of fiscal policy assumes utility-enhancing government expenditure (see e.g. Pappa and Vassilatos (2007); Forni et al. (2010)).
Although Uhlig (2010) stresses the necessity of considering the long-run costs of fiscal stimulus, he also notes that initial boost in output may be worth the costs depending on the normative perspectives. From a more empirical point of view, Fatás and Mihov (2009) argue that "the fiscal cost of not stabilizing the economy is likely to be much higher than the cost of a deficit that helps the economy go faster towards a recovery path."

For example, in a recent paper, Christina Romer, Chair of the President’s Council of Economic Advisers, and Jared Bernstein, Chief Economist of the Office of the Vice-President, estimated the effects of a fiscal stimulus package that is planned to create jobs within a period of two years. Cogan et al. (2010) compared the multipliers used in Romer and Bernstein (2009) with those in a standard New Keynesian model over a three-year period. Please also note that literature regarding surveys on multipliers usually report on those up to a two- or three-year horizon (see e.g. Spilimbergo et al. (2009)).
References


_ (2009) ‘Why fiscal stimulus is likely to work.’ International Finance 12(1), 57–73


Kitamura, Tomiyuki (2009) ‘Measuring monetary policy when the nominal short-term interest rate is zero: A dynamic stochastic general equilibrium approach.’ Mimeo


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# Appendix

Table A: Tax and monetary policy rules for Japan and the euro area

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</tr>
<tr>
<td>( 1 - \rho_{tk} )</td>
<td>0.345</td>
<td>0.03</td>
</tr>
<tr>
<td>( \phi_{tbb} )</td>
<td>0.123</td>
<td>0.57</td>
</tr>
<tr>
<td>coeff.</td>
<td>0.043</td>
<td>0.017</td>
</tr>
<tr>
<td>monetary policy rule</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( 1 - \rho_r )</td>
<td>0.066</td>
<td>0.08</td>
</tr>
<tr>
<td>( \phi_{r\pi} )</td>
<td>1.533</td>
<td>1.72</td>
</tr>
<tr>
<td>coeff.</td>
<td>0.102</td>
<td>0.138</td>
</tr>
<tr>
<td>( \phi_{ry} )</td>
<td>0.254</td>
<td>0.13</td>
</tr>
<tr>
<td>coeff.</td>
<td>0.017</td>
<td>0.010</td>
</tr>
</tbody>
</table>
Table 1: Responses of fiscal instruments to debt-to-output ratio for different subsample periods

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumption tax rate</td>
<td>0.0814***</td>
<td>-0.0039</td>
<td>26.302***</td>
</tr>
<tr>
<td></td>
<td>(3.748)</td>
<td>(-1.380)</td>
<td>[0.000]</td>
</tr>
<tr>
<td>Labor income tax rate</td>
<td>0.0894</td>
<td>0.0122*</td>
<td>3.6374***</td>
</tr>
<tr>
<td></td>
<td>(1.384)</td>
<td>(1.869)</td>
<td>[0.030]</td>
</tr>
<tr>
<td>Capital income tax rate</td>
<td>0.2777**</td>
<td>0.0360</td>
<td>2.5196*</td>
</tr>
<tr>
<td></td>
<td>(2.143)</td>
<td>(1.134)</td>
<td>[0.085]</td>
</tr>
<tr>
<td>Gov. spending-to-output ratio</td>
<td>0.0007*</td>
<td>-0.0005***</td>
<td>23.642***</td>
</tr>
<tr>
<td></td>
<td>(1.884)</td>
<td>(-14.42)</td>
<td>[0.000]</td>
</tr>
</tbody>
</table>

Notes: A triple asterisk (***)) denotes significant at the 1 percent level; a double asterisk (**) denotes significant at the 5 percent level; a single asterisk (*) denotes significant at the 10 percent level.

Values in parentheses are t-statistics. Probabilities of the Chow’s breakpoint test are shown in square brackets. Aggregate effective tax rates on consumption, labor and capital income are calculated following the method of Mendoza et al. (1994). Government spending is the sum of government consumption and investment. In calculating debt-to-output ratio, debt held by the government is excluded.
Table 2: Mean estimates of structural parameters compared with those of previous studies

<table>
<thead>
<tr>
<th></th>
<th>Euro Area</th>
<th>U.S.</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SW</td>
<td>CS$\dagger$</td>
<td>FMS$\dagger\ddagger$</td>
</tr>
<tr>
<td>$h$</td>
<td>0.592</td>
<td>0.412</td>
<td>0.73</td>
</tr>
<tr>
<td>$\sigma_c$</td>
<td>1.391</td>
<td>1.101</td>
<td>(1.00)$\ddagger$</td>
</tr>
<tr>
<td>$\sigma_l$</td>
<td>2.503</td>
<td>2.343</td>
<td>2.00</td>
</tr>
<tr>
<td>$1/\zeta$</td>
<td>6.962</td>
<td>7.386</td>
<td>5.30</td>
</tr>
<tr>
<td>$\varphi$</td>
<td>1.417</td>
<td>1.602</td>
<td>n.a.</td>
</tr>
<tr>
<td>$\psi$</td>
<td>0.201</td>
<td>0.219</td>
<td>0.22</td>
</tr>
<tr>
<td>$\xi_w$</td>
<td>0.742</td>
<td>0.747</td>
<td>n.a.</td>
</tr>
<tr>
<td>$\xi_p$</td>
<td>0.905</td>
<td>0.914</td>
<td>n.a.</td>
</tr>
<tr>
<td>$\gamma_w$</td>
<td>0.728</td>
<td>0.724</td>
<td>n.a.</td>
</tr>
<tr>
<td>$\gamma_p$</td>
<td>0.477</td>
<td>0.456</td>
<td>n.a.</td>
</tr>
<tr>
<td>$\omega$</td>
<td>n.a.</td>
<td>0.370</td>
<td>0.34</td>
</tr>
</tbody>
</table>

$\dagger$ Estimates for a case in which time-invariant distortionary taxes are considered.

$\dagger\ddagger$ Baseline estimates (without unions).

$\ddagger$ Values in parentheses are calibrated.
Table 3: Mean estimates of policy parameters compared with those of previous studies

<table>
<thead>
<tr>
<th>Monetary policy parameters</th>
<th>Euro Area</th>
<th>U.S.</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW</td>
<td>CS†</td>
<td>FMS‡</td>
<td>LOWW</td>
</tr>
<tr>
<td>$\rho_r$</td>
<td>0.956</td>
<td>0.964</td>
<td>0.92</td>
</tr>
<tr>
<td>$\phi_{\tau \pi}$</td>
<td>1.688</td>
<td>1.692</td>
<td>1.72</td>
</tr>
<tr>
<td>$\phi_{\tau y}$</td>
<td>0.098</td>
<td>0.103</td>
<td>0.13</td>
</tr>
<tr>
<td>(coeff. on $\Delta \hat{Y}$)</td>
<td>0.151</td>
<td>0.160</td>
<td>0.23</td>
</tr>
<tr>
<td>(coeff. on $\Delta \hat{\pi}$)</td>
<td>0.158</td>
<td>0.153</td>
<td>0.07</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fiscal policy parameters</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho_g$</td>
<td>0.943</td>
<td>0.944</td>
<td>n.a.</td>
</tr>
<tr>
<td>$\phi_{gy}$</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>$\rho_{tc}$</td>
<td>n.a.</td>
<td>n.a.</td>
<td>0.96</td>
</tr>
<tr>
<td>$\phi_{tcb}$</td>
<td>n.a.</td>
<td>n.a.</td>
<td>0.50</td>
</tr>
<tr>
<td>$\rho_{tl}$</td>
<td>n.a.</td>
<td>n.a.</td>
<td>0.91</td>
</tr>
<tr>
<td>$\phi_{tlb}$</td>
<td>n.a.</td>
<td>n.a.</td>
<td>0.28</td>
</tr>
<tr>
<td>$\rho_{tk}$</td>
<td>n.a.</td>
<td>n.a.</td>
<td>0.97</td>
</tr>
<tr>
<td>$\phi_{tkb}$</td>
<td>n.a.</td>
<td>n.a.</td>
<td>0.57</td>
</tr>
</tbody>
</table>

† Estimates for a case in which time-invariant distortionary taxes are considered.

‡ Baseline estimates (without unions).
Table 4: First-year average responses for different tax-financing schemes and non-Ricardian shares

<table>
<thead>
<tr>
<th></th>
<th>$\tau^k$ financing</th>
<th>$\tau^l$ financing</th>
<th>$\tau^c$ financing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\omega = 0.4$</td>
<td>$\omega = 0.2$</td>
<td>$\omega = 0.0$</td>
</tr>
<tr>
<td>$\frac{\Delta Y}{\Delta \omega}$</td>
<td>0.779</td>
<td>0.767</td>
<td>0.757</td>
</tr>
<tr>
<td>$\frac{\Delta C}{\Delta \omega}$</td>
<td>0.091</td>
<td>0.039</td>
<td>-0.004</td>
</tr>
<tr>
<td>$\frac{\Delta C^R}{\Delta \omega}$</td>
<td>-0.074</td>
<td>-0.034</td>
<td>-0.004</td>
</tr>
<tr>
<td>$\frac{\Delta C^{NR}}{\Delta \omega}$</td>
<td>0.337</td>
<td>0.333</td>
<td>-</td>
</tr>
<tr>
<td>$\frac{\Delta I}{\Delta \omega}$</td>
<td>0.369</td>
<td>0.505</td>
<td>0.619</td>
</tr>
</tbody>
</table>
Table 5: Cumulative present-value multipliers and welfare effects of a government spending shock

<table>
<thead>
<tr>
<th></th>
<th>$\tau^h$ financing</th>
<th>$\tau^l$ financing</th>
<th>$\tau^c$ financing</th>
<th>Balanced bdg.</th>
<th>Spending rev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\frac{PV(\Delta Y)}{PV(\Delta G)}$ (horizon=$\infty$)</td>
<td>-1.903</td>
<td>-0.020</td>
<td>0.095</td>
<td>0.093</td>
<td>-</td>
</tr>
<tr>
<td>$\frac{PV(\Delta C)}{PV(\Delta G)}$ (horizon=$\infty$)</td>
<td>-2.470</td>
<td>-1.446</td>
<td>-1.424</td>
<td>-1.274</td>
<td>-</td>
</tr>
<tr>
<td>$\frac{PV(\Delta I)}{PV(\Delta G)}$ (horizon=$\infty$)</td>
<td>-8.601</td>
<td>-2.423</td>
<td>-1.344</td>
<td>-2.247</td>
<td>-</td>
</tr>
<tr>
<td>Welfare loss$^\dagger$</td>
<td>-1.686</td>
<td>-0.374</td>
<td>-0.293</td>
<td>-0.326</td>
<td>-0.156</td>
</tr>
</tbody>
</table>

$^\dagger$ Expressed by the change in certainty-equivalent consumption in percentage of its steady state level.
**Figure 1:** Cross-country comparison of aggregate effective tax rates on capital income

*Notes:* Capital income tax rates are taken from “Mendoza-Razin-Tesar effective tax rates updated through 1996,” which is available at [http://econ-server.umd.edu/~mendoza/](http://econ-server.umd.edu/~mendoza/). In calculating Japan’s debt-to-output ratio, debt held by the government is excluded.
Figure 2: Impact multipliers for different tax rules

Figure 3: Impact multipliers for different financing schemes

Notes: Solid lines—capital tax-financing; dashed lines—labor tax-financing; dotted lines—consumption tax-financing; dash-dotted lines—spending reversal; dash-double dotted lines—balanced budget.
Figure 4: Impact multipliers for different tax-financing schemes under the adjusted FMS monetary policy for the euro area

Notes: Solid lines—capital tax-financing; dashed lines—labor tax-financing; dotted lines—consumption tax-financing; dash-dotted lines—capital tax-financing under the estimated monetary policy in Japan.
Figure 5: Present-value multipliers for different tax-financing schemes

Notes: Solid lines—capital tax-financing; dashed lines—labor tax-financing; dotted lines—consumption tax-financing.