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Applied a Dynamic Stochastic General Equilibrium Model to analyse fiscal viability - Case Study of Japan

تطبيق نموذج التوازن العام الديناميكي العشوائي لتحليل الجدوى المالية – دراسة حالة اليابان

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Abstract:

This article aims to studies the fiscal viability of Japan by applying a dynamic stochastic general equilibrium model to the Japanese economy by introducing intermediation costs into the model.

We have explaining the observed relationship between the interest and GDP growth rates, which is crucial in testing for viability.

We conclude that when the projected real growth rate is 2.8%, the average real interest rate becomes 2.68%, and the debt to GDP ratio gradually increases stochastically so that government debt is not sustainable. To recover viability, the primary surplus must be 0.3% of GDP.

Keywords: Dynamic Stochastic General Equilibrium Model (DSGE); Japan; Viability; Fiscal viability; Fiscal policy.

JE Classification Codes: E62 , G12 , H68

ملخص:

يهدف المقال إلى دراسة الجدوى المالية لليابان من خلال تطبيق نموذج التوازن العام الديناميكي العشوائي على الاقتصاد الياباني من خلال إدخال تكاليف الوساطة في النموذج .

تم شرح العلاقة الملحوظة بين أسعار الفائدة ومعدلات نمو الناتج المحلي الإجمالي وهو أمر بالغ الأهمية لاختبار الجدوى.

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خلصت الدراسة إلى أنه عندما يكون معدل النمو الحقيقي المتوقع 2.8٪ ، يصبح متوسط سعر الفائدة الحقيقي 2.68٪ ويزداد معدل الدين إلى الناتج المحلي الإجمالي تدريجيًا بشكل عشوائي ، وبالتالي يصبح الدين العام غير مستدام و بالتالي لاستعادة الاستدامة يجب أن يكون الفائض الأولي 0.3٪ من الناتج المحلي الإجمالي .

كلمات مفتاحية: نموذج التوازن العام الديناميكي العشوائي،اليابان،الجدوى،الجدوى المالية،السياسة المالية.
تصنيفات JEL : E62 ، G12 ، H68

1. INTRODUCTION

The huge budget deficit in recent years has raised great concerns about the long run sustainability of Japanese fiscal stance. Since the beginning of the 1990s, government debt has accumulated so much faster than GDP growth that the outstanding stock of debt as a proportion of GDP amounts to about 1.7 as of 2006. The government, responding to a possible fiscal crisis, proposed a fiscal reform plan entitled “Basic Policies for Economic and Fiscal Policy Management and Structural Reform” in 2006 and released a plan under which it will attain a primarysurplus in fiscal.

At the same time, there is the puzzling fact that the real interest rates on government bonds have remained relatively low and have not reacted sensitively to the recent increasein the debt-to-GDP ratio.

Small gaps between interest rates on government bonds and the GDP growth rate are not specific to Japan. In fact, the average realized real rates of return on government bonds in major OECD countries over the past 30 years have been smaller than the real growth rate (e.g.,Blanchard and Weil, 2001). In investigating the test for fiscal sustainability, it is of extreme importance to understand the relationship between the two rates. (Abel.A.B.N.G Mankiw, 1989)

There are two strands of approaches to explaining low interest rates for government bonds from the viewpoint of the neoclassical growth theory. One approach is to introduce uncertainty into the framework of a complete, frictionless economy. Abel et al. (1989) and Bohn (1995) provide examples of stochastic growth models in which risk premium drives down the safe interest rate, often below the economic growth rate. Their argument, along with that of Zilcha (1992), demonstrates that dynamic efficiency is preserved and that the no-Ponzi condition for the intertemporal government budget constraint holds even if the safe interest rate is below the growth rate. Another approach deviates from complete markets and assumes the presence of financial intermediation costs (e.g., Bohn, 1999). Aiyagari and Gertler (1991) and Heaton and Lucas (1996) introduce inter- mediation costs to resolve the Mehra–Prescott puzzle.

In this paper, we attempt to resolve the issue of low interest rates by extending the Bohn (1999) model with financial intermediation costs to a stochastic environment. Specifically, we provide a dynamic stochastic general equilibrium (DSGE) model of an exchange economy featured by intermediation costs and heterogeneous agents. Interme- diation costs reduce the deposit interest rate and hence the rate of return of the govern- ment bond, a perfect substitute for deposits, and contribute to explaining the relatively low interest rate of government bond. We use this model to investigate whether the Japanese economy can avoid a possible fiscal crisis if the released reform plan to attain a primary surplus in fiscal year 2011 is realized. (Weinstein, 2005)

Our results are summarized as follows. When the targeted growth rate is 2.5%, the average interest rate becomes 2.57% in the presence of significant financial intermedia- tion costs. We report a small gap between the interest and growth rates, which is consistent with the actual data. If the targeted primary surplus is zero on average, the debt-to-GDP ratio gradually increases from the initial level of 1.72 to 1.896 in 100 years, suggesting that the government debt is not sustainable. Sustainability requires the primary surplus to be no less than 0.2% of GDP. Lowering the GDP growth rate to 2%, 1% and 0% and assuming that the government runs a zero primary surplus for each growth rate, we find that the average interest rate of government bonds decreases but the gap between the interest rate and growth rates widens. Therefore, the government faces more difficulty in meeting the sustainability condition. (Yamada, 2007)

This paper belongs to the literature on methodology to test sustainability of fiscal deficits. Hamilton and Flavin (1986) tested sustainability by examining the transversality condition in the inter temporal budget constraint of the government. Bohn (1998) pro- posed a simple and pragmatic test for sustainability under which it is sufficient to ascertain whether the debt-to-GDP ratio displays a mean-reversion property. In their famous paper entitled “Deficit Gamble,” Ball et al. (1998) projected future growth rates and interest rates using past data and calculated the probability under which the debt-to- GDP ratio enters a dangerous zone. What is common in the existing literature is that all studies rely heavily on past data, and so their approaches are of limited use for estimatingthe effect of possible fiscal reforms in periods of fiscal crisis.

This paper is also related to the empirical literature investigating fiscal sustainability in Japan.

Doi and Ihori (2003) take the intertemporal approach following Hamilton and Flavin (1986) and reach a pessimistic conclusion regarding the period of 1965–2000.

A substantial body of literature examines the Bohn’s condition (for example, Ihori et al., 2007) and reports findings against that condition when the sample includes the period since 1990.

This paper is organized as follows. Section 2 introduces the model used in calibration. Section 3 reports the results of this fiscal calibration. Section 4 concludes.

2. The Problem:

How to apply dynamic stochastic general equilibrium model in measuring and estimating fiscal viability in Japan?

3. Literatures Review:

There are several studies that dealt with the issue of financial sustainability we will mention some of them :

we have (Borrell and Duncan 1993; Green World Investor, 2011; Taylor, 2010; Mahadevan, 2008), (Borrell and Duncan 1993; DGCI&S, 2011). (Borrell and Duncan 1993). (Schuele, 1999; Alam, 2006; Kumar and Sheetal, 2012). (Fetscherin & Pillania, 2012)

4. The Model

We construct a DSGE model of an exchange economy with infinitely lived agents to investigate the sustainability of government debt. We assume intermediation costs and heterogeneous agents to provide fiscal implications of low safe interest rates. The devel- oped model is a stochastic version of Bohn (1999). (Liboshi .H, 2006)

The model has an equal number of two types of infinitely lived agents, A and B.

Type A has income $Y_t^A = Y_t$ in even periods (zero otherwise) and type B has income $Y_t^B = Y_t$ in odd periods (zero otherwise).

The growth rate of income, $x_{t+1} \equiv (Y_{t+1}/Y_t) - 1$, is a random variable that follows a Markov process according to a continuous and differentiable probability distribution function $G(x_{t+1}|x_t)$ with a positive density $g(.)$ over the support $[\underline{x}, x]$, with a mean m and $\underline{x} > -1$.

$$u'(C_t) = \beta E_t \tilde{V}1\,(W_t, Y_{t+1}, x_{t+1}) \qquad (1)$$

Using the envelope theorem, we obtain :

$$V_1(B_{t-1}, Y_t, x_t) = -u'(C_t)(1 + R_t^*) \qquad (2)$$

On the other hand, the agent who receives income in period t - 1 maximizes :

$\tilde{V}(W_{t-1}, Y_t, x_t) = \max_{C,B} u(\tilde{C}t) + \beta E_t V(B_t, Y_{t+1}, x_{t+1})$ subject to the budget constraint

$W_{t-1}(1 + R_t) + B_t = \tilde{C}_t$. The F.O.C. for consumption yields

$$u'(\tilde{C}t) + \beta E_t V_1(B_t, Y_{t+1}, x_{t+1}) = 0 \qquad (3)$$

Using the envelope theorem, we obtain

$$\tilde{V}1\,(W_{t-1}, Y_t, x_t) = u'(\tilde{C}t)(1 + R_t) \qquad (4)$$

It follows from (1) and (4) that we derive the Euler equation for the agent who receivesincome in period t:

$$u'(C_t) = \beta E_t \{u'(\tilde{C}t+1)(1 + R_{t+1}) \qquad (5)$$

It follows from (2) and (3) that we derive the Euler equation for the agent who receivesincome in period t - 1:

$$u'(\tilde{C}t) = \beta E_t \{u'(C_{t+1})(1 + R_t^*+1)\} \qquad (6)$$

Hereafter we proceed with the analysis by assuming that agents have identical constant relative risk aversion utility functions,

$u(C_t) = C^{1-\alpha}$ $(1-\alpha)$, where a is the degree of the relative risk aversion and hence the inverse of the elasticity of substitution of consumption between periods.

5. Calibration

5.1 Methodology

To simulate the model, we need dynamic equations for the GDP growth rate, the interest rate on government bond and the debt-to-GDP ratio. We assume that the GDP growth ratefollows an AR(1) process:

$$x_{t+1} = \mu(1-\rho) + \rho x_t + \varepsilon_{t+1},$$

where e_{t+1} is a random shock following an i.i.d. normal distribution with the standard deviation of s. We have the interest rate on the government bond with R_t replaced by r_t:

$$r_{t+1} = r + \alpha[\ln(1+x_{t+1}) - \ln(1+\mu)]$$

where $r = R$ is used. We drive the debt-to-GDP ratio
Under some alternative fiscal policy rules for the process we simulate the model recursively by combining Equations .
Specifically, we take the following steps :

Step 1: We generate a series of random shocks e_{t+1} for 100 time periods.

Step 2: We construct x_{t+1} by substituting x_t and e_{t+1} recursively with the starting value of x_0 =m.

Step 3: We construct r_{t+1} by substituting x_{t+1}

Step 4: We construct d_{t+1} by substituting r_{t+1}, x_{t+1}, and s_t under a particular fiscal policyrule recursively with a starting value of d_0.

Step 5: We repeat Steps 1–4 10,000 times to obtain the distribution of d_{t+1}, and particularly its mean value.

5.2 Parameters:

First, we selected the parameters in the utility function. We set the annual discount factor b at 1/1.02 = 0.9803, a figure often applied to the Japanese economy we choose a sample period from 1981 to 2005 to exclude the period with a regulated interest rate. The estimation result is as follows:

$$\underset{(0.004)}{\hat{r}_t = 0.020} + \underset{(0.089)}{0.668\hat{x}_t}, \quad \text{Adj.}R^2 = 0.696,$$

the numbers in the parentheses are standard errors. Adj.R denotes the coefficientof determination adjusted for degrees of freedom.

we set a at 0.668, or equivalently the elasticity of intertemporal substitution at 1.497.

Next, we chose the parameters of technology. We set the average real GDP growth rate m to 0.025, which is the average growth rate over the period of fiscal years 1981 to 2004.

The mid-term economic outlook published by the Japanese government predicts that the growth rate will gradually accelerate from fiscal year 2006, reaching 2.5% in fiscal year 2011

The parameters in the autoregressive process of the real GDP mainly affect the probability that the debt-to-GDP ratio decreases from the initial level. We estimated the AR(1) process, applying OLS to the annual real GDP growth ratedata over the period of fiscal years 1981 to 2004:

$$x_t = 0.014 + 0.451x_{t-1}, \text{ Adj. R} = 0.166,$$

where x_t is the real GDP growth rate. The estimated value of r is positive and significant, consistent with the model's assumption that the growth rate of income follows a Markov process. We set r to 0.451 and s to 0.01917, where the latter is the root mean squared error of the above regression.

Third, we set the financial intermediation cost, k, to be the interest margin between bank loans and deposits. We calculated the average interest margins of domestic banks by taking differences between the average loan interest rate and the average deposit interest rate reported in their financial statements we obtained 1.88% for 1975–79, 2.28% for 1980–89, 2.08% for 1990–99, and 2.15% for 2000–06. The average interest margins for 1980–2006, when financial liberalization was promoted, were 2.17%. We set k at 0.022. Although the interest margin may reflect a default risk, we interpreted the interest margin as the intermediation cost, because the intermediation cost should include the costs of defaults.

6. Fiscal policy rules

Bohn (1998) proposes a fiscal policy under which the government increases a primary surplus when the debt-to-GDP ratio increases, and vice versa. While he claims that the US experience was consistent with this rule, the Japanese government does not seem to have followed it, at least during the past 30 years. Rather, as is shown by Figure 1, we observe a positive correlation between the primary balance and the GDP growth rate. (K, 2009, pp. 19-35)

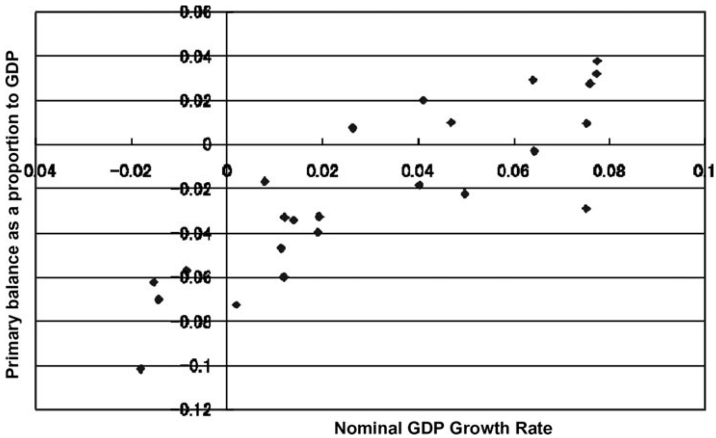
This observation will motivate us to guess that the Japanese primary balance is an increasing function of the GDP growth rate. Regressing the primary balance as a proportion of nominal GDP to the growth rate of nominal GDP over the period of fiscal years 1981–2004, we obtained the following result:

$$s_t = -0.053 + 0.997\hat{x}_t \quad , Adj.R^2 = 0.713.$$
$$(0.006)\ (0.131)$$

Given the high goodness of fit, we can safely say that the primary balance actually depends heavily on the nominal GDP growth rate.

We used the nominal GDP growth rate and not the real one because the government is likely to determine expenditures considering tax revenues that are strongly affected by nominal GDP. In fact, the nominal GDP growth rate provides a better fit than the real GDP growth rate . This policy rule is not necessarily inconsistent with our theoretical .

Fig.1. Primary balance as a proportion to GDP and nominal GDP growth rate



Source: From the researcher's calculations based on the MATLAB program model defined in real terms we assume the following fiscal policy rule:

$s_t = -\eta + 1.0x_t,$

where the intercept h is a free parameter that is intended to capture the government's fiscal stance We set h to 0.025 so that the primary balance becomes zero if the growth rate is 2.5%, considering the government's goal for a fiscal surplus in fiscal year 2011.

Table 1 summarizes the parameters that we use for the baseline calibration.

Column 1 in Table 2 shows the baseline result under the assumption that the primary balance averages zero. Hereafter we evaluate all variables in real terms. The mean interest rate on government debt is 2.57%, slightly higher than the average GDP growth rate. Figure 3a shows that the average debt-to-GDP ratio gradually increases from the initial level of 1.72, reaching 1.896 in 100 years. The probability that the debt-to-GDP ratio reaches a level below the initial value in 100 years is 39.7%. The government debt is not sustainable based on our criterion.

Table 1. Parameters

Preference		Technology			Financial intermediation	Fiscal policy rule		Initial condition
Discount Rate	Inverse of Elasticity of Intertemporal Substitution	Mean Growth Rate	Serial Correlation	Standard Deviation	Intermediation Cost	Coefficient on Growth Rate	Constant Term	Debt/GDP
b	a	M	r	s	k	g	h	d_0
1/1.02	0.668	0.025	0.451	0.01917	0.022	1	0.025	1.72

Source: From the researcher's calculations based on the MATLAB program

Table 2. Calibration results

Average primary surplus-to-GDP Ratio (%)	0	0.1	0.2	0.5	1	1.1
Average real interest rate (%)	2.57	2.57	2.57	2.57	2.57	2.57
Average debt-to-GDP ratio in 100 years	1.896	1.791	1.681	1.362	0.852	0.737
Probability that debt-to-GDP ratio in 100 years is less than its initial value (%)	39.7	47.0	55.6	76.0	94.4	96.3

Source: From the researcher's calculations based on the MATLAB program

We investigate how much primary surplus is necessary to make government debt sustainable. We find that a primary surplus of 0.1% of

GDP raises the average debt-to- GDP ratio to 1.791 in 100 years, but a primary surplus of 0.2% of GDP decreases the average debt-to-GDP ratio, reaching 1.681 in 100 years. In the latter case, the expected debt-to-GDP ratio decreases, although the probability that the debt-to-GDP ratio increases from the initial level is still as high as 44.4%. A primary surplus of 0.2% of GDP makes the government debt sustainable.

We calculate the primary surplus required for decreasing the debt-to-GDP ratio with a probability of 95%. In Figure 3b, increasing the average primary surplus further, we find that if the targeted primary surplus is 1% of GDP, the debt-to-GDP ratio decreases from the initial level with a probability of 94.4%. If the targeted primary surplus is 1.1% of GDP, the debt-to-GDP ratio decreases with a probability of 96.3%. If the government is to achieve a primary surplus of 1% of GDP by raising consumption taxes, it must raisethe tax rate by about 2.5 percentage points given that its expenditure as a proportion of GDP is constant.

7. Results under alternative parameters:

In this section, we make several alternative assumptions to examine changes in thebaseline results .

In Case 1: we set the financial intermediation cost, k, to zero. The average interestrate of the government bond is 3.7%, 1.2 percentage points higher than the GDP growth rate. The real interest rate is so high that the average debt-to-GDP ratio reaches 5.599.

With an almost 100% probability, the debt-to-GDP ratio increases from the initial level. To stabilize the debt-to-GDP ratio below the initial level, the primary surplus as a proportion of GDP must be 2.1%. How can we interpret this result ? .

The average nominal interest rate of long-term government bonds was 5.0% over the period 1981–1998, the period prior to the zero-interest-rate policy, while the average nominal GDP growth rate over the same period was 4.2%, 0.8 percentage points lower than the interest rate (see Figure 1). However, considering the fact that the average funding cost of the government is no more than the long-term interest rate, it does not seem likely that the interest rate of government bond is 1.2 percentage points higher than the GDP growth rate. (Ihori, 2002, pp. 492 - 511)

In Case 2: we set the inverse of the elasticity of intertemporal substitution, a, at 1, which is often assumed in the literature of dynamic stochastic general equilibrium analysis. The average interest rate of government bond is 3.42%, higher than the baseline result of 2.57%. The debt-to-GDP ratio increases rapidly and reaches 4.204 in 100 years. The government debt is not sustainable. This case does not seem likely either, consideringthe past relationship between the interest and growth rates.

We have so far assumed that the Japanese economy achieves a GDP growth rate of 2.5%. Anticipating possible declines in labour force and technological progress due to the future population aging, the growth rate may be lower than 2.5%. To consider this possibility, we set the GDP growth rates at 2%, 1%, and 0% in that order. We also assume that the government achieves a zero primary balance under each growth rate.The results are shown in Cases 3A, 3B and 3C, respectively. The average interest rates of government bonds decrease to 2.24%, 1.57%, and 0.9% as the growth rates decrease to 2%, 1%, and 0%, respectively. The gaps between the interest rate and the growth rate widen to 0.24%, 0.57%, and 0.9%, while it is 0.07% in the benchmark case.

The difference in the results comes from the fact that we set a to 0.668, put differently, the elasticity of intertemporal substitution to be larger than unity. The debt-to-GDP ratios increase from the initial level, reaching 2.206, 3.081 and 4.288 in 100 years, which suggests that the government debt is not sustainable in any case. The primary surpluses necessary to reduce the expected debt-to-GDP ratio from the initial value are 0.5%, 1% and 1.6% of GDP, respectively.

The primary surpluses necessary to reduce the debt-to- GDP ratio from the initial value with a probability of 95% are 1.3%, 1.9% and 2.5% of GDP, respectively.

As the GDP growth rate declines, the gap between the interest and growth rates widens and the primary surplus necessary for the sustainability condition increases. Ihori et al. (2007) make a more pessimistic simulation under the assumptions that the rate of technological progress is 0% and that the labour force declines, as we explain in detail in the next section.

Finally, we consider the possibility that the fiscal policy is featured by a primary surplus that is a nonlinear function of the GDP growth rate. When the GDP growth rate is low, primary balances may worsen extremely because of expansive fiscal policy mea- sures. It may be difficult to restore primary balances by increasing taxes or decreasing government expenditure, which would cause significant redistribution. Progressive income tax may also cause a nonlinear relationship between primary surplus and GDP growth rate. (Ueda, 2007)

Regressing the primary surplus as a proportion of nominal GDP on the nominal GDP growth rate and its squared values, we obtained the following concave equation:

$$s_t = -0.054 + 1.479\hat{x}_t - 7.321{x_t}^2$$

$$(0.006)\;(0.343)\;(4.846) \qquad \text{Adj. } R^2 = 0.729$$

We employ the above fiscal policy rule by adjusting the constant term so that the primary balance becomes zero under a 2.5% real GDP growth rate.

8. Comparisons with previous studies

In this subsection, we compare our calibration results with previous studies on the sustainability of Japanese government debt. Ihori et al. (2007), directly comparable to ours, calculate the interest rate from the growth model of overlapping generations. They project a primary balance that is necessary to maintain the debt-to-GDP ratio. Their estimated primary balance (3.9% of GDP on average) is greater than ours primarily because the gap between the interest and growth rates exceeds almost 3 percentage points, which is much larger than our result. The main reasons for this difference are as follows. First, they do not consider financial intermediation costs. Second, they set the inverse of the elasticity of intertemporal substitution at a higher value than ours. Third, they assume a lower GDP growth rate than ours

Dekle (2005) examines the small-open version of the growth model and finds that the government debt is not sustainable unless the primary surplus increases substantially to almost 5% of GDP over the next decade or so. His projection assumes a wide gap between the interest rate (6%) and the TFP growth rate (1.2%).

Broda and Weinstein (2005) and Doi (2006) make simulations using exogenous pairs of economic growth rates and interest rates. Broda and Weinstein (2005) project that the government revenues as a proportion to GDP must increase moderately.[23] Doi (2006) points out that more government revenues are necessary than Broda and Weinstein's results if financial assets held by the central and local governments are not subtracted from their debt and if we consider the recent financial deterioration. Note that the simulation results of Broda and Weinstein (2005) and Doi (2006) are difficult to compare with our results directly because both of them ignore general equilibrium consideration between growth and interest rates. (Kawade, 2002, pp. 325 - 338)

Oguro (2006) applies the approach of "deficit gamble" (Ball et al., 1998) to the Japanese economy, finding that if the primary deficit is zero, the probability that the debt-to-GDP ratio will fall below its initial value in 100 years is 49.4%, higher than our baseline result (39.7%). His methodology is to estimate the joint distribution ofthe interest rate and the GDP growth rate over the period 1966–2005 and to project the estimated debt-to-GDP ratio to the future. Notably, the sample period includes the high-growth era when the interest rate is lower than the average growth rate. His optimistic prediction appears to come from the chosen sample period.

9. CONCLUSION

To answer the question of whether government debt is sustainable in Japan, we have calibrated a DSGE model. By incorporating financial intermediation costs into the theo- retical model, we have succeeded in explaining the actual relationship between the interest rate and the GDP growth rate observed for the Japanese economy in some consistent manner. Our approach has also made it possible to assume some combinations of the interest rate and the economic growth rate on theoretical grounds. Our approach will remain an effective analytical tool even when the future potential growth rate changes. Our calibration has also enabled us to show the variability of our forecasts.

In investigating the fiscal sustainability by calibrating a DSGE model, it is extremely important to specify the relationship between the interest rate on government bond and the GDP growth rate in a manner that is consistent with the actual data. With parameter sets consistent with the Japanese economy, it makes little difference whether government bonds are treated as safe or risky assets, while it is essential to introduce financial intermediation costs to calibrate the model with realistic interest rates.

Our results can be summarized as follows. When the growth rate is 2.5%, the average interest rate is 2.57% under the assumption that financial intermediation costs remain at the same level as in the past. If the targeted primary surplus averages zero, the debt-to- GDP ratio gradually increases from the initial level of 1.72 to 1.896 in 100 years, suggesting that the government debt is not sustainable. To make it sustainable, the targeted primary surplus must be 0.2% of GDP. Lowering the GDP growth rate to 2, 1, and 0% and assuming that the government runs a zero primary surplus for each growth rate, we find that the average interest rate for government bond decreases but the gap between the interest rate and the growth rate widens, so that the government faces greater difficulty in meeting the sustainability condition.

It should be noted that our calibration results depend on several assumptions. First, we

assume that government outlays as a proportion to GDP are constant. If we consider an increase in social security expenses associated with population aging, we may say that government revenues necessary to meet the sustainability condition will exceed our estimate. Next, we have argued the fiscal sustainability issues under the criterion that the debt-to-GDP ratio decreases from its 2005 level, 1.72. If we consider a decrease in savings rate, which will be inevitable with population aging, we may have to set a more stringent criterion than 1.72. Furthermore, we do not consider the possibility that the interest rate on government bonds incorporates the risk of an increasing debt-to-GDP ratio. If we consider this possibility, the primary balance necessary to meet the sustain- ability condition may be higher than our estimate. The effect of the risk of fiscal insolvency on the interest rate depends on how we model the economy after the fiscal insolvency, which is an important direction for future research. Finally, it should be noted that our model is an exchange economy with growth rates being exogenous. Generally, the accumulation of government debt may deter private capital accumulation and have a negative impact on economic growth.

We must not hastily conclude that a reduction of financial intermediation costs due to financial innovation will raise the interest rate and tighten the government budget. We have employed an exchange economy model without production to present a simple model that consistently explains the actual relationship between the interest rate and the GDP growth rate. The next task is to extend the model to an endogenous growth model with production and to calibrate it to the Japanese economy. In the endogenous growth model, a reduction of financial intermediation costs may possibly raise the economic growth rate, resulting in an increase in tax revenues and a primary surplus.

Our model is a standard asset-pricing model incorporating financial intermediation costs. To incorporate various other extensions that have been tried to explain the safe assetreturn, such as the decoupling of the degree of relative risk aversion and the elasticity of intertemporal substitution (Weil, 1989, among others), is left for future studies.

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