Reconsideration of the "Domar condition" to check sustainability of budget deficit*

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Abstract

The Japanese economy is faced with the highest debt to GDP ratio due to the aging population. COVID-19 made the government spend huge amounts of money on medical expenses, cash transfers to SMEs, and so on. Budget deficits increased in many regions in the world. Fiscal sustainability is quite important not only among developed countries but also developing countries.

As a condition for examining the financial stabilization "Domar condition" is commonly used. The Domar conditions compares "the interest rate" and "the economic growth rate." If the former is smaller than the latter, the budget deficits will converge and the government deficits will be stabilized. Recently, the Central Bank of Japan started to purchase huge amounts of government bonds from the market and achieved "negative" interest rate. Paul Krugman says that Japan's fiscal stability can be maintained if the central bank keeps interest rates negative, which is lower than the growth rate of the economy.

In this paper, we explain that the Domar condition is derived by focusing only on the supply of government bonds and not considering the demand for government bonds. Next, including the demand for government bonds in the model, it will be shown that "outstanding stock of government bonds" and the interest rate sensitivity of the demand for government bonds should be compared by taking into account of both supply and demand for government bonds. The condition is applied to the case of Greece and Japan. This condition validates the national bankruptcy of Greece. It also shows why Japan is still sustained.

The Domar condition applied is only to the U.S. where her currency is an international currency. In case of crisis, demand for government bonds will become larger and larger in the U.S. because demand comes from all over the world. On the other hand, many other counties face a decline in the demand for domestic currencies when facing a crisis. The sustainability of the government bond market should be checked by applying the condition shown in this paper to various countries including Japan.

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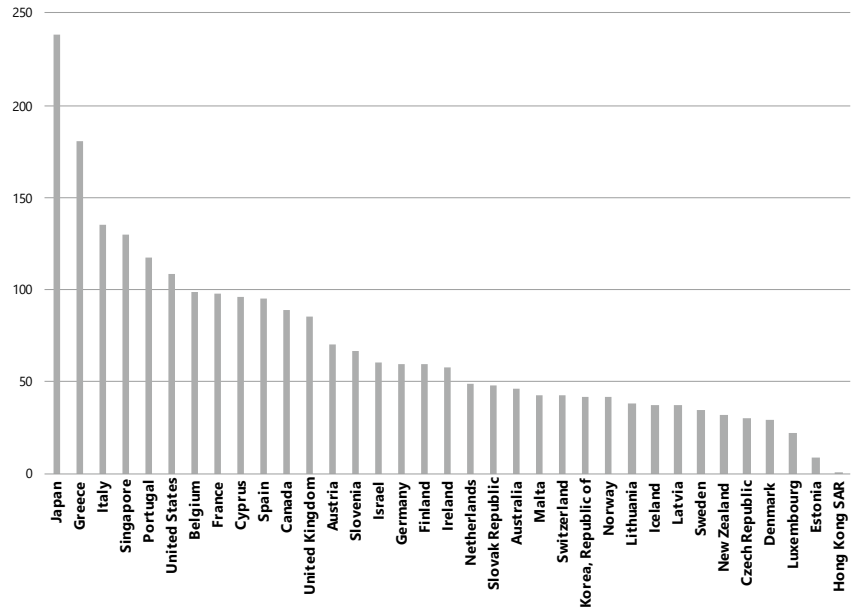
I. Introduction

The new coronavirus infection forced the government to support affected sectors and individuals through cash transfers, credit guarantees and others. As a result, the budget deficits climbed up to an unprecedented scale in Japan. Table 1 shows that Japan's debt to GDP ratio is the highest followed by Greece and Italy. In order to finance large government spending, the government has to issue enormous amounts of government bonds due to slower increase of tax revenues. Japan's general government debt in 2019 was about 1300 trillion yen, which is about 240% of the GDP. The reasons for rapid increase in Japanese government debt is the increase in social security costs due to the aging of the population and the decrease in tax revenue due to the secular stagnation of the economy. The corona crisis has been worsening Japan's fiscal situation. The deterioration of fiscal deficits are seen in many Asian countries. The discussions on fiscal sustainability are urgently needed in order to restore accumulated government budget deficits without hurting economic activities.

A common use in examining fiscal sustainability is the "Domar condition." It compares the interest rate and economic growth rate in order to examine financial sustainability. If the

Figure 1. International Comparison of Debt/GDP ratio (2019)



Source: IMF

interest rate is lower than the economic growth rate, fiscal stability is maintained. Conversely, if the interest rate exceeds the economic growth rate, it will lead to financial collapse.

In recent years, using the Domar condition, Krugman (2020) states that Japan's budget deficits will be sustained since the monetary policy of the Bank of Japan set the interest rate to negative. The Domar condition of comparison between rate of interest and growth rate of the economy will be maintained, which will lead the Japanese government budget situation in a stable direction.

However, the Domar condition is derived from the government's budget constraint, which looks only from the supply side of government bonds. The actual government bond market is derived from the equilibrium between the supply of government bonds and the demand for government bonds. Therefore, the stability of the government bond market cannot be judged only by the supply side of the government bond where the Domar condition is obtained. In particular, unlike the United States, Greece had collapsed in the past. The United States is the only country which attracts lots of demand in case of a crisis due to its thick bond market and key currency. All other countries except for the United States cannot create a large amount of demand for government bonds from all over the world in a crisis period. Therefore, the discussion of the stability of the government bond market (= fiscal stabilization) must consider the government budget constraint formula (= government bond supply formula) and the demand for government bonds.

In this paper, we derive the stability condition of the government bond market from the supply and demand of government bonds. A new condition for the stability of the government budget consists of the outstanding stock of government bonds compared with the interest elasticity of demand for government bonds. The new condition is applied to both Greece and Japan. It shows that Greece meets the conditions of financial collapse. On the other hand, Japanese data shows fiscal stability by use of new conditions proposed in this paper.

In the future, in all countries will be recommended to apply our new fiscal sustainability condition instead of using the Domar condition. The new fiscal stabilization condition derived in this paper (= the condition that the budget deficit will expand and the issuance of government bonds will continue to increase and the government will collapse) will be used to check if the country is not a key currency and capital market is not thick enough to attract foreign investors.

II. Domar condition (comparison between interest rate and economic growth rate)

When discussing fiscal stabilization, the Domar condition derived from the government's budget constraint formula is often used in the literature. The Domar condition compares the interest rate and the economic growth rate, and if the interest rate is lower than the economic growth rate, the budget deficits will be sustained and will head toward stabilization of the budget. On the other hand, if the interest rate is higher than the economic growth rate, it will lead to fiscal explosion. The Domar condition is an important condition for checking fiscal sustainability. In Japan, the Domar condition has been used in the debate

over whether or not the public finances will collapse. In this section, we explain how the Domar condition is derived.

The Domar condition is derived from the government budget constraint:

$$G_t + r_t^B B_{t-1} = \Delta B_t + T_t. \tag{1}$$

Total government expenditures on the left hand consists of government spending (G_t) and interest payment on government bonds ($r_t^B B_{t-1}$), where r is the interest rate of government bonds and B is the stock of government debt. The right-hand side of equation (1) shows how they are financed. T_t stands for tax revenues and B_t stands for new issue of government bonds. Dividing both hands of equation (1) by GDP (Y) and rearranging the equation, we obtain equation (2).

$$b_t - b_{t-1} = g_t - t_t + \frac{r_t - \eta_t}{1+\eta_t} b_{t-1}, \tag{2}$$

where $b_t \equiv B_t/Y_t$, $g_t \equiv G_t/Y_t$, $t_t \equiv T_t/Y_t$, and $\eta_t \equiv \Delta Y_t/Y_t$. Differentiating equation (2) with respect to b_{t-1}, namely, differentiating Δb_t with respect to b_{t-1}, we obtain equation (3) as follows:

$$\frac{\partial \Delta b_t}{\partial b_{t-1}} = \frac{r_t - \eta_t}{1+\eta_t}. \tag{3}$$

Since the denominator of equation (3) is greater than 1 in normal cases (i.e. $1 + \eta_t > 0$), numerator ($r_t - \eta_t$) determines the sign of equation (3). When $r_t > \eta_t$ (the interest rate > the growth rate of the economy), budget deficits will keep on rising and the government budget deficits will explode. When $r_t < \eta_t$ (interest rate < growth rate of the economy), the budget deficits will converge and the government budget deficits will be sustained.

In comparing the rate of interest (r_t) and the growth rate of the economy (η_t) either real value or nominal value can be used. Namely, real interest rate in comparison to real growth rate of the economy or nominal interest rate in comparison to nominal growth rate of the economy can both be used. This is because the real interest rate is obtained by subtracting the inflation rate from the nominal interest rate, and the real GDP growth rate is obtained by subtracting the inflation rate from the nominal GDP growth rate.

III. Derivation of government bond demand

In order to obtain the demand for government bonds, a simple portfolio theory can be applied. The investors will choose safe assets (namely, government bonds) and risky assets whose risks are shown by σ. As shown in Yoshino, Tahgizadeh-Hesary and Otsuka (2021), the fund manager (investor) determines the portfolio of government bonds and risk assets, so as to maximize the utility while comparing the risks and returns. The investor utility function is given as follows:

$$U(r_t, \sigma_t) = r_t - \beta \sigma_t^2. \tag{4}$$

Equation (4) states that the utility of investors depend on (i) rate of return (r) and (ii) risk (σ) where the relative weight of risk (σ) in comparison to rate of return (r) is β. If β is larger than 1, investors are sensitive to risks much more than rate of return. On the other hand, lower value of β will show that investors are not so much concerned about their risks com-

pared to the return.

Investors allocate their assets into government bonds (*B*) and risk assets (*I*). *a*% of total assets is allocated to government bonds (*B*) and (1-*a*)% of their assets are allocated to risky assets (*I*). Then, the total rate of return is expressed as

$$r_t = ar_t^B + (1-\alpha) r_t^I. \tag{5}$$

The aggregate risk (variance) is

$$\sigma_t^2 = \alpha^2 (\sigma_t^B)^2 + (1-\alpha)^2 (\sigma_t^I)^2 + 2\alpha(1-\alpha)\sigma_t^{BI}, \tag{6}$$

where σ^B shows the risk of investing into government bonds. As a matter of fact, in the case of Greece, investing into Greece government bonds is risky during a crisis period. σ^I is the risk in investing assets *I*. σ^{BI} is covariance between government bond (*B*) and risky assets (*I*). Investors maximize their utility (equation (4)) based on two constraints namely equation (5) and equation (6). The optimal allocation of total assets into government bonds (*B*) and risky assets (*I*) can be obtained as follows.

$$\alpha^* = \frac{\frac{1}{\beta}(r_t^B - r_t^I) + (\sigma_t^I)^2 + 2\sigma_t^{BI}}{2(\sigma_t^B)^2 + 2(\sigma_t^I)^2 - 4\sigma_t^{BI}}. \tag{7}$$

Equation (7) describes that the demand for government bonds depends on the rate of return on government bonds and risky assets ($r_t^B - r_t^I$), risks of each asset (σ^B, σ^I) and covariance of government bonds and risky assets (σ^{BI}), Therefore, the demand for government bonds by domestic investors can be written as

$$\Delta B_t^d = b_0 + b_1 (\sigma_t^B, \sigma_t^I)(r_t^B - r_t^I). \tag{8}$$

Likewise the demand by foreign investors in government bonds can be written as follows, by taking into consideration of the interest rate parity condition.

$$\Delta B_t^f = f_0 + f_1(\sigma_t^B, \sigma_t^f)\left[r_t^B - \left\{r_t^f + \frac{(e_t^e - e_t)}{e_t}\right\}\right], \tag{9}$$

where f_0 stands for the shift parameter by foreign investors and f_1 is interest rate sensitivity of demand for government bonds.

Demand for government bonds by domestic investors and foreign investors can be added together, which will lead to the following total demand for government bonds.

$$\Delta B_t^D = (b_0 + f_0) + f_1(\sigma_t^B, \sigma_t^f)\left[r_t^B - \left\{r_t^f + \frac{(e_t^e - e_t)}{e_t}\right\}\right] + b_1(\sigma_t^B, \sigma_t^I)(r_t^B - r_t^I). \tag{10}$$

IV. Simultaneous equation system of supply and demand for government bonds

Consider a government budget constraint, which takes into account the central bank purchase of government bonds from the market (Christ, 1979). The government budget constraint can be written as

$$G_t + r_t^B B_{t-1} = \Delta B_t^S + T_t + \Delta M_t, \tag{11}$$

where ΔM_t is the supply of money that is printed when government bonds are purchased from the market in an open market operation.

Putting the supply of government bonds into the left hand, equation (11) can be arranged

as follows

$$\Delta B_t = (G_t - T_t) + r_t^B \times B_{t-1} - \Delta M_t. \tag{12}$$

From equation (10) and equation (12), the equilibrium interest rate on the government bond will be obtained as follow:

$$r_t^{B^*} = \frac{(G_t - T_t) - \Delta M_t - (b_0 + f_0) + f_1\left(r_t^f + \dfrac{e_t^e - e_t}{e_t}\right) + b_1 r_t^I}{(b_1 + f_1) - B_{t-1}}. \tag{13}$$

The equilibrium interest rate on the government bond in obtained at the intersection of supply and demand for government bonds shown in Figure 2 in Section V. The following can be said about equation (13).

(i). An increase in government spending will increase government bond issuance, which will shift the supply of government bonds in Figure 2 to the right, and lead to an increase in the interest rate on government bonds.

(ii). The Bank of Japan uses open market operations to increase the money supply through an increased purchase of government bonds, which will shift the demand for government bonds by the Central Bank of Japan, and shift the demand curve to the right (Figure 5), which will lower the rate of interest on government bonds.

(iii). An increase in demand for government bonds by banks, insurance companies, pensions, etc., will shift the demand curve for government bonds to the right (Figure 5), which will reduce the interest rate on government bonds.

(iv). An increase in the outstanding amount of government bonds will increase the interest payment cost of government bonds, forcing further issuance of government bonds by increasing the supply of government bonds. It will raise the interest rate on government bonds as is shown in Figure 5.

(v). If a foreigner sells Greece government bonds and shifts to overseas government bonds, the demand for Greece government bonds will decrease. The interest rate on government bonds will rise (Figure 5).

V. Fiscal stabilization conditions that replace the Domar conditions derived from the simultaneous equations of government bond demand and government bond supply

Substituting the equilibrium interest rate of government bonds (r^{B^*}) in equation (13) into the government bond supply equation (12), we have

$$\Delta B_t = (G_t - T_t) + r_t^{B^*} \times B_{t-1} - \Delta M_t. \tag{14}$$

From equation (14), one can check whether fiscal is sustainable or fiscal explosion occurs. By differentiating equation (14) with respect to B_{t-1}, we have

$$\frac{\partial \Delta B_t}{\partial B_{t-1}} = \frac{\partial r_t^{B^*}}{\partial B_{t-1}} B_{t-1} + r_t^{B^*}, \tag{15}$$

where

$$\frac{\partial r_t^{B^*}}{\partial B_{t-1}} = \frac{(G_t - T_t) - \Delta M_t - (b_0 + f_0) + f_1\left(r_t^f + \dfrac{e_t^e - e_t}{e_t}\right) + b_1 r_t^I}{[(b_1 + f_1) - B_{t-1}]^2} = \frac{r_t^{B^*}}{[((b_1 + f_1) - B_{t-1})]}.$$

If equation (15) is positive, the budget deficits will keep on rising, which will lead to explosion of government budget. On the other hand, if equation (15) is negative, the budget deficits will shrink, which will lead to sustainable situation of government budget deficits.

Equation (15) can be rewritten as follows:

$$\frac{\partial \Delta B_t}{\partial B_{t-1}} = \left(\frac{1}{1 - \dfrac{B_{t-1}}{b_1 + f_1}}\right) r_t^{B^*}. \tag{16}$$

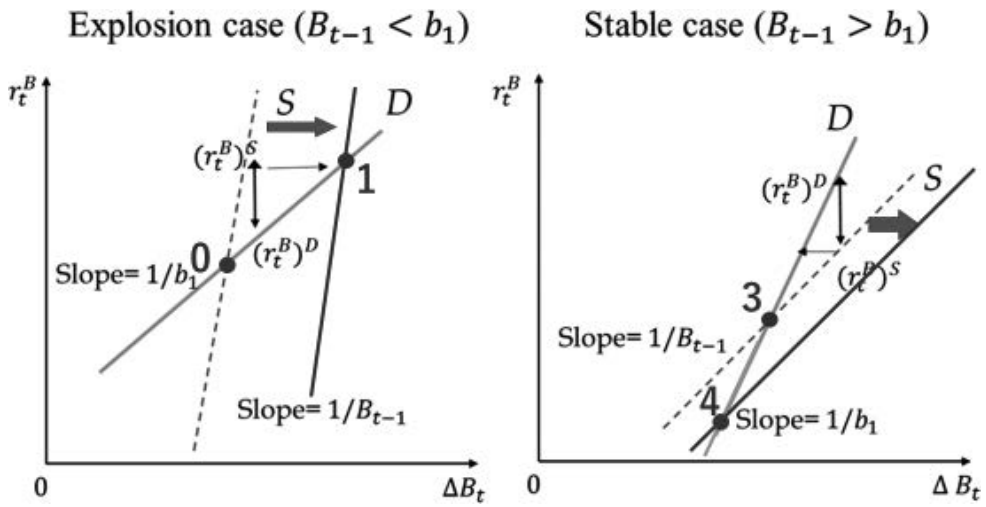
This implies

$$\frac{\partial \Delta B_t}{\partial B_{t-1}} \gtreqless 0 \Leftrightarrow 1 \gtreqless \frac{B_{t-1}}{b_1 + f_1}. \tag{17}$$

The equation (17) is an alternative to the Domar condition, which is a fiscal stabilization condition when both the supply and demand of government bonds are taken into consideration. From equation (17), whether or not the budget deficits will be stabilized depends on the "outstanding stock of government bonds (B_{t-1})" in comparison to the interest rate sensitivity of demand for government bonds ($b_1 + f_1$) where both domestic investors (b_1) and foreign investors (f_1) are taken into consideration.

An intuitive explanation of equation (17) is as follows. The numerator of equation (17) is the outstanding government debt. If the interest rate increases 1%, the interest payment on government bonds will rise by $1 \times B_{t-1}$. The denominator is speed of sales of government bonds both by domestic investors and foreign investors in facing a crisis. If the denominator is larger than the numerators, the speed of escape from the country's government bond mar-

Figure 2. Diagram of Fiscal sustainability condition



ket whose sensitivity in interest rate exceeds the additional interest burden of the government is faster than an increase of government bond supply. Thus, it will lead to instability of government budget deficits. Equation (17) can be explained by Figure 2. The left chart of Figure 2 is the case of fiscal explosion where the interest rate on government bonds will keep on rising. The right chart of Figure 2 is the case where the interest rate goes down and fiscal sustainability is achieved. Figure 2 shows whether shift of the supply curve will lead to higher interest rate on government bonds or lowering interest rate on government bonds.

VI. Comparison of Greece and Japan using fiscal stabilization conditions that take into account the supply and demand of government bonds

In this section, we empirically examine the validity of the fiscal stabilization conditions derived above by looking at the cases of Japan and Greece. Here we pick up Japan and Greece, as the debt to GDP ratios of these two countries are the top two among various countries listed by IMF in Figure 1. Greece went into bankruptcy in fiscal year 2012, whereas Japan's fiscal balance is still sustainable. We compare the value of $b_1 + f_1$ and B_{t-1} for these two countries.

For simplicity, to estimate the value of $b_1 + f_1$ the following linear model is considered.

$$\Delta B_{t-1} = (b_0 + f_0) + (b_1 + f_1) r_t^b + e_t. \tag{18}$$

The demand for government bonds is explained by interest rate of bonds and e_t which represents error term. Quarterly data on government bond interest rates and government debt balances are used for estimation. The sample period was the longest data available in each country. In Greece's case, the sample period is 2001Q1-2019Q3. In the case of Japan, it is 1988Q1-2019Q4. The data was obtained from the Bank of Japan, the Ministry of Finance and Euro Stat. In addition, in order to measure the parameter fluctuations in the time series of the estimation results, a rolling estimation is performed in which the sample is fixed at eight years and the estimation period is shifted.

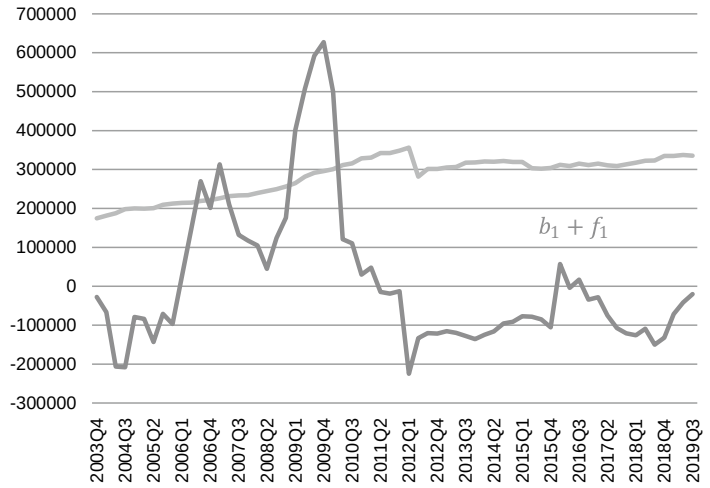
Figure 3 shows the case of Greece and figure 4 depicts the case of Japan. We first look at Figure 3. In the 2006 and 2009-2010 periods, $b_1 + f_1$ exceeded B_{t-1}. Namely higher interest of Greek bonds led foreign investors to reduce their holdings of Greece government bonds compared with increased interest burden for Greece's government.

Figure 4 shows B_{t-1} is always larger than $b_1 + f_1$ where the demand for Japanese government bonds are much more stable against various shocks in the market. Sensitivity of interest rates on the demand for government bonds are much smaller than the case of Greece, which made the Japanese government bond market much more stable than the Greece market.

VII. Differences between Greece and Japan in demand for government bonds

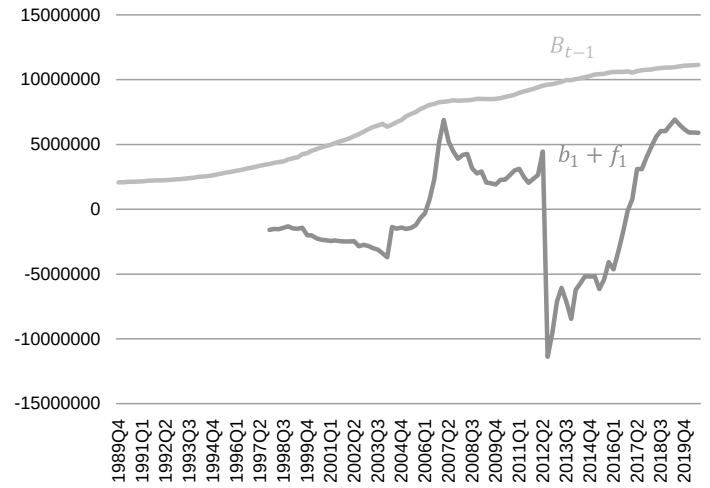
Why is there a difference in fiscal sustainability between Greece and Japan despite their high debt to GDP ratio? The key to this is the breakdown of government bond holdings. Table 1 compares the demand for government bonds in Greece and Japan in 2012. In the

Figure 3. Greek case (Comparison between B_{t-1} and $b_1 + f_1$)



Source: Estimated by the authors

Figure 4. Japanese case (Comparison between B_{t-1} and $b_1 + f_1$)



Source: Estimated by the authors

case of Greece, more than 2/3 of government bonds were held by overseas' investors. On the other hand, 93.3% of Japanese government bonds were held by domestic investors such as commercial banks, insurance and pension funds. By the way, in 2020 overseas' holders proportion of Japanese government bonds was 12.8%, still much lower than Greece.

Figure 5 is the difference of foreign ownership ratio of government bonds demand, is an illustration of how they affect the government bond market.

The left chart of Figure 5 is the case of Greece and right chart is the case of Japan. The chart compares the shift parameters of $b_0 + f_0$ in equation (10).

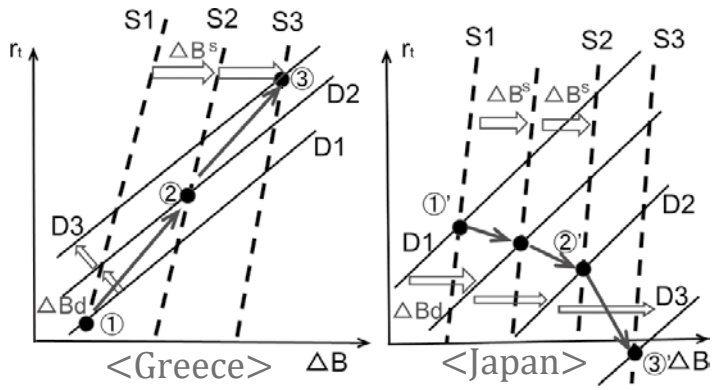
The vertical dotted line shows the supply of government bonds. If the interest rate rises,

Table 1. Holders of Japanese and Greek Government bonds

Holders of Japanese Government bonds	*% of total*	*Holders of Greek Government bonds*	*% of total*
Bank and postal savings	45	Overseas investors	33
Life and non-life insurance	20	Domestic investors	21
Public pension funds	10	European Central Bank	18
Private pension funds	4	Bilateral loans	14
Bank of Japan	8	Social pension funds	6
Overseas investors	5	International Monetary Fund	5
Households	5	Greek domestic funds	3
Others	3		

Note: In Greece, 70% of debt is held by overseas investors, compared with 5% for Japan.
Data are for 2011.

Figure 5. Supply and Demand for Government bonds (Greece and Japan)

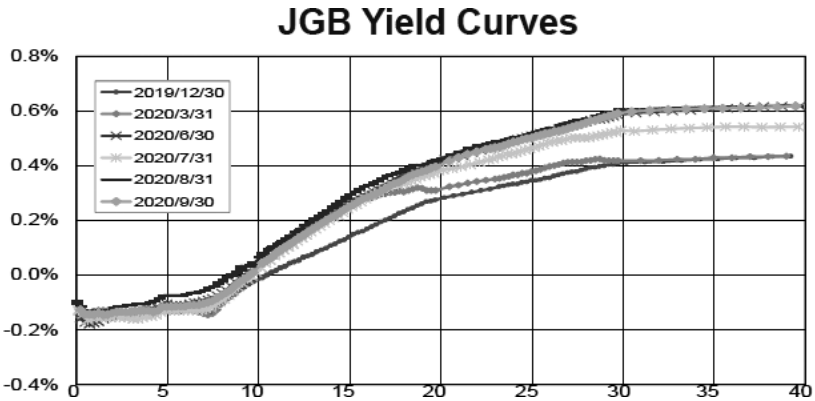


Source: Yoshino, Mizoguchi and Taghizadeh-Hesary (2019)

the interest payment of government bonds will rise, which will increase new issuances of government bonds. Therefore, the supply curve of government bonds is shown as rising to the right. The demand for government bonds by both domestic and foreign investors show upward sloping since the higher the interest rate the greater the demand for government bonds rises. In this diagram, the shift parameter denoted by $b_0 + f_0$ in equation (10) explains the case of Greece in comparison to Japan. In the case of Greece, when it faced a crisis, foreign investors sold Greek bonds and flew away to other markets. Foreign investors feared that Greece might not be able to return their principle and interest on government bonds to investors. The demand for Greek bonds declined especially from foreign investors significantly. The demand for Greek bonds shifted to the left by the decline in f_0. Figure 5 shows that the interest rate of Greek bonds rose from ①, ② and ③. Increased interest rate further pushed Greece's spending on interest payment on government bonds much higher. The budget deficits kept on rising which lead into bankruptcy for Greece. Mathematically, equation

(20) shows that the decline of f_0 (decline in demand by foreign investors) will push interest rates upward, which led Greece to pay very high interest to bond holders, which forced Greece into bankruptcy. On the other hand, Japanese demand for government bonds are dominated by domestic investors and the bond market of Japan was not hit by a crisis. Domestic investors kept on purchasing JGB (Japanese Government bonds) without hesitation. Most recently, the Central Bank of Japan purchased JGB from the market. Figure 5 shows the large shift of demand for JGB from D2 to D3 and turned Japanese interest rates to negative. The yield curve of JGB in Figure 6 shows negative interest rates between short terms up to 10 year JGB. It is called un-conventional monetary policy by targeting JGB interest rate to lead to negative territory.

Figure 6. Term Structure of Interest Rate



Source: Japan Bond Trading Co., Ltd.

It confirms that the stability of the government bond market must be explained by both supply of bonds and the demand for government bonds including the behavior of foreign investors.

VIII. Conclusion

The budget deficit in Japan and other countries are rising due to the corona disaster. Fiscal sustainability is an important issue. A recent book from the World Bank uses Domar condition to check sustainability of budget deficits in Asian countries. Domar condition is obtained from the supply of government bonds, namely by use of government budget constraints. Domar condition compares the interest rate and growth rate of the economy. If the interest rate is lower than the growth rate of the economy, the budget deficits will become smaller and sustainable. However, this paper shows that both supply and demand for government bonds determine the stability of the fiscal budget. Outstanding amount of government bonds in comparison to interest rate sensitivity of demand will be the criteria for sustainability of budget deficits. If interest rate sensitivity is very high, investors leave from the

government bond market by selling their bonds, which will lead to very high rate of interest and bring further increase of interest payments. In the case of Greece, large share of foreign investors in demand for government bond shifted their demand from the Greece market to other foreign markets, which lead Greece to bankruptcy. All the countries except for the U.S. have to watch both supply and demand for government bonds. The U.S. will be the only country who need not worry about demand for government bonds. The currency of U.S. is an international key currency where demand for the US dollar will come from everywhere in the case of crisis. The U.S. attracts lots of demand even in crisis. On the other hand, other countries whose currency is not an international vehicle currency must pay attention to demand and supply of government bonds where our new condition must be applied.

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