

Defying Gravity: How Long Will Japanese Government Bond Prices Remain High?¹

Takeo Hoshi² and Takatoshi Ito³

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Abstract

Recent studies have shown that the Japanese debt situation is not sustainable. The puzzle is that there is no warning sign such as rising interest rate. The paper identifies three conditions that have supported the high indebtedness without a rising interest rate of Japan so far. Those are (1) large amount of domestic savings with an extreme home bias, (2) a stagnant economy that depresses the rate of return in every sector, and (3) expectation of future fiscal consolidation. Any substantial change in any of these conditions can lead to a debt crisis. Without any substantial changes in fiscal consolidation efforts, the debt is expected to hit the ceiling of the private sector financial assets soon. There is also downside risk, which brings the ultimate crisis earlier. Economic recovery may raise the interest rates and make it harder for the government to roll over the debt. Finally, the expectations can change without warning. Failure in passing the bill to raise the consumption tax, for example, may change the public perception on realization of tax increases. When the crisis happens, the Japanese financial institutions that holds large amount of government bonds sustain losses and the economy will suffer from fiscal austerity and financial instability. There may be negative spillovers for trading partners. If Japan wants to avoid such crisis, the government has to make a credible commitment and quick implementation of fiscal consolidation. IMF could help by issuing a strong early warning.

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² Professor, IR/PS, University of California at San Diego, thoshi@ucsd.edu.

³ Professor, Graduate School of Economics and Graduate School of Public Policy, University of Tokyo, tito@e.u-tokyo.ac.jp.

1. Introduction

It is well-known that Japan has the highest debt-GDP ratio among OECD countries. Yet, the yields for long-term government bonds have been low for many years. Many business reports, especially originating outside Japan, have alerted significant risk of holding JGBs (Japanese Government Bonds) in the past decade. Indeed, in some occasions, the yield on the 10-year JGB sometime jumped by 100 basis points in a few months (1998 and 2003), but it came back down to low level (below 2 percent) in the following several months. Many academic papers written in the last decade have concluded that the current Japanese government deficits and debts are not sustainable. But, anyone who had thought the sovereign crisis would come to Japan has been proven wrong so far.⁴ Downgrades by credit rating companies in the last thirteen years did not bring down Japanese bond prices. Even in the most recent sovereign debt crisis and scare in Europe and the United States has not rattled the JGB yields. Japanese government bond prices appear to defy the law of gravity.

This paper shows that there are rational explanations for the low and stable yields on the Japanese government bonds, but argues that there is an absolute saturation point beyond which the debt cannot be absorbed without drastically changing yields. It is when the total amount of government debt reaches too close to the sum of all the private sector financial assets. Foreign investors have already shied away from the JGB market, as 95% of JGBs are held domestically. When the domestic financial assets are all Japanese government debt, it is the absolute dead end. If the dead end is close enough to be visible, even Japanese investors will try avoiding accumulating more JGBs.

The economy is stagnating, so that household income is not rising. With rapid aging in Japan, household in aggregate will start spending down financial assets rather than further accumulating them. The total household financial assets peaked at 1,566 trillion yen in March 2007, and have already declined to 1,476 trillion yen by March 2011. (The net financial assets, after deducting mortgages and other liabilities, are about 1,110 trillion yen.) If this pace of decline continues, the household financial assets will be about 1,340 trillion by 2016. The outstanding amount of Japanese government bonds (JGB) in March 2011 was 943 trillion yen, up from 674 trillion yen in 2007. If the pace of increase continues in the future, the JGB outstanding will be 1,350 trillion yen, for the first time exceeding the household assets, in 2016. So, according to this simple calculation, Japan would be insolvent as a nation in 2016.

Of course, this is a simplistic calculation. There are many factors for more debt-absorbing factors: The public sector of Japan owns financial assets, including JGBs, so that the net liabilities, rather than gross JGBs should be considered in such a calculation. The four years from 2008 to 2011 have been exceptional in running large fiscal deficits in response to the global

⁴ We do not claim an original credit for the analogy of Japanese debts to defying gravity. From serious press to financial newsletters, descriptions like “Mt. Fuji” of Japanese government bonds and government bonds “defy gravity” have been very popular.

financial crisis, so that the debt may not increase such rapidly in the future. On the other hand, there are other factors that may move Japan to the saturation point even faster. Other than JGBs, there are other public sector liabilities, such as the bonds issued by local governments and future liabilities in the national pension system and the healthcare and long-term care systems. Reconstruction after the earthquake/tsunami disaster will cost the government. The decreasing working-age population may continue to depress the economic growth. The increasing retired population will raise the social security benefit payments.

If borrowing from abroad for already high government liabilities is unlikely (without paying a prohibitively high interest rate), the amount of private sector financial assets will represent the wall that the net government liabilities cannot go over. In this paper, we examine several scenarios on the growth rate, the interest rate, and the pace of fiscal consolidation for Japan and see if Japan can avoid crashing into the wall.

The rest of the paper is organized as follows. Section 2 reviews the basic facts on the Japanese debt situation and the recent literature. Section 3 describes and then explains the low and stable JGB interest rates. Section 4 examines possible triggers for a fiscal crisis. Section 5 examines the issue of financing reconstruction cost of the earthquake/tsunami damages. Section 6 discusses likely consequences of the crisis, and Section 7 discusses what the government can do in managing the crisis once it happens. Section 8 describes what role the International Monetary Fund can play in giving early warning signals without triggering the crisis. Section 9 concludes.

2. Sustainability of fiscal policy in Japan

There have been many studies on the subject of the sustainability of the Japanese fiscal policy because Japanese government debt-to-GDP ratio has been the highest among advanced countries, as shown in Figure 1. This section briefly reviews the recent research on the subject. We find all the papers point to the same conclusion: the current course of fiscal debt dynamics in Japan is “not sustainable” and a drastic adjustment will be necessary in the near future.

<Figure 1. Gross-Government Debt to GDP ratio>

One of the first attempts to examine the sustainability of Japanese fiscal policy in this century (in English) was by Broda and Weinstein (2005), who applied the approach originally developed by Blanchard et al. (1990) to examine the sustainability of the Japanese fiscal policy. Broda and Weinstein first calculate the net debt-to-GDP ratio, by subtracting the financial assets that the government owns from the gross debt. The net debt of Japan is substantially lower than the gross debt primarily because the government and entities in the public sector, such as the national pension fund, hold substantial financial assets that include government bonds. Figure 2 shows the time series of net debt for major countries.

<Figure 2. Net Government Debt to GDP ratio>

The approach of Broda and Weinstein (2005) calculates the constant tax rate that is necessary to bring down the debt to GDP ratio at some distant future to the current level given the future path of government consumption and transfer payments, the (constant) interest rate and the (constant) long-run GDP growth rate. Strictly speaking, this approach does not test the sustainability. It calculates the minimum (constant) tax rate to achieve the stability and judges whether such tax rate is realistic (economically as well as politically). Using the numbers at the end of the fiscal year 2002 (March 2003), they find if Japan raises the tax revenues to about 32%-37% of GDP (depending on the assumed interest rate and the GDP growth rate) the debt to GDP ratio can be stabilized. The required tax revenue to GDP ratio was comparable to the actual figures for the U.S., which led Broda and Weinstein (2005) to conclude that the tax increase to achieve the sustainability is not unrealistically high. Indeed the social security reform of 2004 has already achieved the tax rate that exceeds the low end of the range of the sustainable tax rates that they found.

Doi (2009) replicated the calculation of Broda and Weinstein (2005) using new estimates of future government expenditures and transfers (which reflect the social security reform of 2004) and the initial value of debt to GDP ratio as of March 2007. He found the range of required tax rates increased by about 5% from 37% to 42%, compared to Broda and Weinstein. Doi, Hoshi, and Okimoto (2011) updated the calculation to March 2010. They found the range shifted up by another 2% from 42% to 44%. The range implies the tax revenue must be increased by 6% to 13% of GDP on top of the current government revenue (about 33% of GDP) to stabilize the debt. If such an increase is to be achieved by only consumption tax increase, the tax rate must be raised from the current 5% to somewhere between 17% and 31% (using a widely used estimate that the marginal increase of consumption tax rate by 1% leads to tax revenue increase of 0.5% of GDP). They conclude such drastic tax increase would be political impossible, considering that the government is having an extreme difficulty in raising the consumption tax rate only by 5%.

Many calculations along the line of Broda and Weinstein (2005) assume certain long-run growth rate and interest rate, and calculate the tax rate that is required for the sustainability. Imrohoroğlu and Sudo (2011) instead assume the current tax rate (and expected future government expenditures) and calculates what kind of economic growth would achieve the sustainability. They calibrate a neo-classical growth model so that the interest rate is determined endogenously. They find that the debt to GDP ratio becomes sustainable when the TFP growth rate for the next 10 years is assumed to jump to 4% (and going back to the benchmark case of 2% growth thereafter). Since the sustained TFP growth of 4% for 10 years is highly unlikely for Japan (and any developed economy), their finding suggests that the growth alone cannot stabilize the Japanese debt to GDP ratio. In other words, the current fiscal policy is not sustainable.

Hosono and Sakuragawa (2011) also make the interest rate endogenous by building a dynamic stochastic general equilibrium (DSGE) model. They show that when there is a substantial intermediation cost in financial contracting in the private sector, the interest rate on the government bond can be quite low. Even with the very low interest rates generated from the model, however, they find the current fiscal policy of the Japanese government is not sustainable.

Immediate and permanent tax increase considered in Broda and Weinstein (2005) approach is not the only way to stabilize the debt to GDP ratio in the long run. Less drastic policies could stabilize the debt eventually. Bohn (1998) showed that if the primary surplus responds sufficiently positively to increases in the debt to GDP ratio, the debt is eventually stabilized. It is sufficient for the response rate to be greater than the difference between the safe interest rate and the GDP growth rate to stabilize the debt to GDP ratio. Bohn (1998) found the condition is satisfied for a long time series in the U.S.

Doi and Ihori (2009) applied the analysis of Bohn (1998) to the Japanese data from 1956 to 2000. They find the primary surplus responded either negatively or not at all to increases in the debt to GDP ratio. Thus, the Japanese government did not act in the way that stabilizes the debt to GDP ratio.

Ito (2011) considers the possibility that the response of the primary surplus to the debt to GDP ratio is time-dependent. Using the data from 1970 to 2009, he calculates the response coefficient by recursive OLS (Ordinary Least Squares) estimation. He finds that the debt dynamics may have been stable in the earlier part of the sample (up to the mid 1990s), but it became definitely unsustainable toward the end of the sample period.

Doi, Hoshi and Okimoto (2011) consider the possibility that the response is state dependent, possibly changing from one policy regime to another. Using the data from 1980 to 2010, they find the evidence that the response is indeed state dependent and there are two different policy regimes. In one policy regime, the response is significantly negative, implying the primary surplus actually falls (deficit widens) when the debt to GDP ratio increases. In the other policy regime, the primary surplus does not respond to the debt to GDP ratio. Thus, they find the fiscal policy unsustainable.

Ito, Watanabe, and Yabu (2011) estimate a similar model of the debt dynamics with possible regime changes. Looking at a longer sample period (1885-2004), they find the Japanese fiscal policy is overall stable. In the periods 1885-1925 and 1950-1970, the primary surplus responded substantially positively to an increase in the debt. One can interpret their result to imply that the Japanese fiscal policy would be sustainable if Japan could go back to the policy regime in 1885-1925 (roughly under the gold standard) and in 1950-1970 (effective balanced budget legislation) with high probability. Without such drastic changes, the fiscal policy is unsustainable.

Ostry et al. (2010) measure “fiscal space,” which is defined to be the distance to the maximum level of the debt that can be sustained, for 23 countries. They start by estimating the cubic equation version of the regression model à la Bohn (1998) of the primary surplus (as a proportion to GDP) on the debt to GDP ratio for a panel of countries. Combining the coefficient estimates (common to all the countries) with the assumed interest rate and the GDP growth rate (for each country), they calculate the level of debt above which the primary surplus is not sufficient to offset the debt growth coming from interest payment ((interest rate minus growth rate) times the debt to GDP ratio). If the debt to GDP ratio exceeds this limit, the debt to GDP ratio is expected to increase without bound if the response of the primary surplus to the debt level is governed by the historical policy rule. The authors calculate the fiscal space as the distance of the current level of the debt to GDP ratio from this limit. Their calculation for Japan shows that Japan has already exceeded this limit in all likelihood.

Gagnon (2011) forecasts the net debt to GDP ratios for both advanced economies and emerging economies from 2015 to 2035. He assumes the interest rate on the government debt is equal to the GDP growth rate in 2015 and increases by 3.5 basis points for every one percentage point increase in the debt to GDP ratio above its 2015 level. For advanced economies including Japan, he shows that the net debts are expected to increase very rapidly. For Japan, the net debt to GDP ratio is projected to increase from 153% in 2015 to 386% in the baseline case. Even in the optimistic growth scenario, the Japanese net debt is expected to increase to 335% of GDP by 2035.

Adjusting the primary surplus is not the only way to satisfy the government budget constraint. Monetary policy, by changing the inflation rate and the real value of the government debt, can influence the fiscal sustainability. In a series of papers including Leeper (1991) and Davig and Leeper (2007), Eric Leeper examined the interaction between fiscal policy and monetary policy extensively. Leeper (1991) distinguishes between “active” and “passive” policies. An “active” policy authority “pays no attention to the state of government debt and is free to set its control variable as it sees fit” (Leeper 1991, p.130). He shows that the government budget constraint is violated when both fiscal and monetary policies are active. Even when the fiscal policy is active, however, the government budget constraint still holds if the monetary policy is passive. By estimating policy functions with Markov switching for the U.S. data, Davig and Leeper (2007) find the fiscal policy alternates between the active phase and the passive phase, and the monetary policy also alternates between the two regimes. Both policies can become active at the same time but such explosive combination does not last long, making the U.S. debt process sustainable overall.

Doi, Hoshi and Okimoto (2011) estimate fiscal policy and monetary policy rules for Japan (with potential regime changes) following Davig and Leeper (2007). They find the evidence of two distinct regimes for both fiscal and monetary policies in Japan. In contrast to the findings for the U.S., however, they find the fiscal policy is active in both regimes and the monetary policy is passive in both regimes. This suggests the possibility that the government

budget constraint for Japan has been supported by passive monetary policy. If that is the case, adjustments to restore the budget constraint are more likely to happen in the monetary policy than in the fiscal policy.

The fiscal problem of Japan has been highlighted by the IMF as well. For example, IMF (2011) reports “stabilizing the net debt ratio by 2016 and reducing it to around 135% of GDP by 2020 would require a reduction of the primary fiscal deficit by 10 percent of GDP over a 10 year horizon” (IMF 2011, p.11). Without such substantial adjustment, the net debt to GDP ratio is predicted to grow without bound exceeding 200% by 2023. In summary, all the recent studies on the sustainability of the Japanese fiscal policy point to the same conclusion: the Japanese debt dynamics is not sustainable unless the government implements fiscal consolidation of unprecedented magnitude. As recent as 2003, Broda and Weinstein (2005) was able to find a “happy news” for the Japanese fiscal situation. Continued deterioration of the government financing in the late 2000s, however, has now made the situation clearly unsustainable. So the question on the Japanese government debt is not whether it runs into a problem. The question is when and how the Japanese policy is forced to adjust.

Novelty of our paper is three-fold: First, we introduce the maximum debt that Japan can hold at a time. The maximum debt that we consider is the sum of the household financial assets (minus the equity holding) and cash and deposits held by corporations. Even if it looks possible to bring down the debt-to-GDP ratio to a sustainable level in several decades, the debt-to-GDP ratio can hit the maximum debt ratio along the way. At that point, the Japanese government would have to sell bonds to foreigners and the higher interest rate demanded by foreigners could make the debt dynamics unsustainable: in other words “game over.” Second, future expected demographic change is taken into account for setting a scenario for future growth. Many scenarios used in fiscal sustainability calculations assume a constant growth rate of GDP. However, in light of declining working-age population, a constant growth rate is difficult to achieve unless per-worker productivities accelerate dramatically. Given the negative demographic dividends, arising from the declining working-age population ratio, the growth rate assumption should be placed on the productivity growth of GDP per-working-age population. Under the constant labor productivity growth assumption, as the demographic dividends fall, the growth rate of GDP becomes much lower than those assumed in many other calculations.⁵ Third, we assume that the spread between the interest rate and the growth rate becomes wider as the debt-to-GDP ratio goes up. This assumption is realistic since during the fiscal crisis, the interest rate rises due to risk premium and the higher interest rate makes it more difficult to maintain high level of debt.

⁵ Of course, Japan could take policies to mitigate the problem by allowing immigration into Japan; promotes women to participate in the labor market more, and promote old-age people to continue workings by increasing the retirement age for pension purpose. However, the government has not made much progress in either of these mitigation measures in recent years.

Before proceeding to the analysis, it is helpful to clarify various definitions of Japanese government debt. First, there is “JGB including Zaito bonds”—which is the central government long-term bonds. This amounts to about 750 trillion yen (about 150% of GDP) as of the end of fiscal 2010. In addition, the central government has liability in the form of borrowings of about 60 trillion yen and short-term Financing Bills (FBs) of about 110 trillion yen. The government also guarantees bonds issued by some independent administrative agencies, such as the Deposit Insurance Corporation, the Development Bank of Japan, and Japan Highway Corporation. The total guaranteed liabilities amounts to about 45 trillion yen. Adding them altogether, the central government has 970 trillion yen of bonds and other liabilities as of the end of fiscal 2010.

Second, the government also publishes “the general government long-term liabilities.” This definition excludes the Zaito bonds (or FILP bonds in English), FBs, and contingent liabilities from the definition above and adds local government long-term debts. The general government long-term liabilities as of the end of fiscal 2010 were about 890 trillion yen.

Table 1 shows several different definitions of the Japanese government liabilities including JGBs and others. There are a few items that need attention. Financing Bills (FBs) are issued primarily to fund the foreign reserves that are held in the special account of the government. They are rolled over every 3 months, and considered to be short-term liabilities that have offsetting entries on the asset side of the balance sheet (foreign reserves). The FBs are excluded from long-term liabilities and from “net” government liabilities. However, FB rollovers may become costly if and when the Japanese short-term interest rate rises above the US short-term interest rate.

Another category that is included in some and excluded in other definitions is FILP (Fiscal Investment and Loan Program) bonds. The bonds are the JGBs, but the revenues are earmarked for financing the government agencies covered by the FILP, which includes the Japan Finance Corporation, the Urban Renaissance Agency and others. The local governments are also major recipients of the FILP funds. Before the FILP reform of 2001, the FILP was financed by the Trust Funds Bureau of the Ministry of Finance that collected funds from the postal saving and the national pension funds in the form of deposits. After the reform of 2001, the postal saving and the national pension funds are no longer required to deposit their funds to the Ministry of Finance. The agencies in the FILP are encouraged to raise the funds in the market by issuing FILP Agency Bonds, but the agencies that have trouble raising sufficient funds in the market can rely on the Fiscal Loan Funds (created by reorganizing the Trust Fund Bureau) that is funded by FILP Bonds. Japan Post Bank (inherited postal saving business after the postal privatization of 2007) does not have to purchase the FILP bonds, but they do anyway. The distinction between the regular JGBs and the FILP JGBs is purely accounting. They are indistinguishable in the market. Yet, FILP bonds are excluded in some definition, based on the

idea that they will be redeemed by future proceeds from investment rather than tax revenues. The validity of this argument depends on profitability of the FILP agencies, which is questionable.⁶

<Table 1>

3. Why is the JGB yield so low?

Most of the papers reviewed in Section 2 find the Japanese fiscal situation to be “unsustainable”—that is, there is a high probability that the debt-to-GDP ratio would continue to rise under a reasonable set of assumptions on the demographic transition, the growth rate and the future paths of taxes and expenditure. This assessment is also shared by many international financial institutions, credit rating agencies, and private-sector analysts. Yet, the JGB interest rate has been low and stable. The 10-year JGB rate has been below 2% since 1999, and between 1% and 1.5% in the last few years. The rate is much lower than the bond rate of other advanced countries. This is despite the fact that Japan has higher debt to GDP ratio than the European countries that have suffered from sovereign debt crises in the last two years—Greece, Ireland, Portugal, Spain, Italy. Apparently, the correlation between the debt-to-GDP ratio and the bond yield is broken down for Japan. Even the downgrading of the JGB in the past did not rattle the market. The low JGB interest rate with the backdrop of the very high and rising debt-to-GDP ratio is apparently a major puzzle.

Several factors have been pointed out as contributing factors to the low and stable JGB interest rate (see Ito (2011), for example). Here we stress three sets of factors that seem most important in explaining low JGB yields: (i) high private saving and the home bias of Japanese investors, (ii) low opportunity cost of holding JGBs, and (iii) expectation of drastic future fiscal consolidation.

First, the national saving (sum of savings of household, corporate, and the government) of Japan has been positive for the last 35 years. In the 1960s and 1970s, the huge household surplus financed corporate borrowing, while the government was only slightly in deficit. The household saving rate precipitously declined in the 1980s and 1990s, but the corporate saving started to increase and more than offset the decline in household saving. Together the private saving (sum of household and corporate savings) has continued to finance the government deficits, which started to grow in the 1990s, without help from the foreign sector.

Table 2 shows the distribution of JGB ownership by different type of investors from 2005 to 2010. The largest share (39%) is owned by banks, including the Post Bank. The insurance companies hold about 20% of the total. The other private-sector financial institutions own about 10%. The government social security fund (Government Pension Insurance Fund or GPIF) also owns about 10%. The Bank of Japan holds about 8%. Additional 5% is held by the households directly and about 3% is held by other domestic investors. Thus, more than 95% of JGBs are

⁶ For more details of the FILP, its 2001 reform, and the profitability of the program, see Doi and Hoshi (2003). MOF (2010) is the government disclosure about the current status of the FILP.

owned by domestic residents. This implies that the Japanese government bond rate was determined solely by domestic factors and free from the volatility of external factors, such as long term interest rates of other major countries or foreigners' sentiment. Sudden capital inflows and outflows or exchange rate concerns (either appreciation or depreciation) do not spill over to the JGB market.

<Table 2. Ownership of JGBs>

The large amount of the private saving does not necessarily implies that it has to be used to purchase low yielding domestic government bonds. The saving could chase higher returns and flow abroad, but this has not happened for Japan. We observe strong home bias in Japanese institutional and retail investors. The proportion of the yen-denominated domestic assets for Japan is extremely high, compared to investors in other advanced countries.

The Japanese households are known to be risk-averse, not willing to take foreign exchange or credit risk. The bank deposits are most favored financial assets of households. The proportion of equities in the portfolio of a typical household is very low. Starting in the 1990s, many Japanese corporations have paid down their borrowings and have accumulated cash reserves. This reflects the lack of many profitable investment opportunities. They have not been pressured to increase dividends or wages, either. The motivation behind the large cash reserves may be the preparation for future investment opportunities or looking after takeover threats in the future, but the important point here is that the corporate saving, too, flows into the banking sector in the form of deposits.

A large proportion of household and corporate savings are deposited into banks. Banks in turn find the JGBs attractive because the investment does not involve currency risk, which has been historically high for foreign bonds. The capital adequacy requirements (Basle I, II, and III) also make JGBs desirable for banks: JGBs (and sovereign debts of advanced countries) are assigned zero weights in calculating the risk-weighted assets that determines the minimum amount of capital banks must hold. Pension funds and insurance companies seem to be also content with holding a large amount of long-term JGBs because their liabilities are also in the yen.

Second, the returns from the investments alternative to the JGBs have been mostly low as the Japanese economy stagnated for the most of the last couple of decade. For example, the lack of loan demand made banks invest their additional deposits into JGBs. In addition, the sustained near-zero interest rate policy of the Bank of Japan has kept the yield curve down and flat. The policy rate (overnight call rate) of the Bank of Japan has been at or below 0.5% since 1995. The continued deflation also reduced the return from real investments relative to JGB. The Japanese Consumer Price Index (CPI) has been falling most of the time in the last 15 years. This means that the real yields of JGBs for Japanese consumers have been higher than the nominal yields.

Finally, Japanese investors seem to have more faith in the government's willingness and leadership to restore fiscal balance in the future than many economists that we cited in Section 2. The studies on the sustainability of Japanese fiscal policy suggest that the debt to GDP ratio would grow without bound unless an unprecedented fiscal reform is implemented. If the investors believe that a future government will take such an unprecedented action to avert a crisis, we can understand the low yields on the JGBs.

A source of such expectation may be the fact that the total tax burden to GDP ratio for Japan is still very low at around 33% (including payment into the social security system). If Japan takes actions to raise tax revenue, the current level of fiscal deficits may be eliminated easily. For example, the deficit of the central government was 44 trillion yen in Fiscal 2011. Using the widely used estimate that a marginal 1% increase in the consumption tax rate brings in additional revenue of 0.5% of GDP (about 2.5 trillion yen), 18% increase in the consumption tax rate would increase the government revenue by 45 trillion yen. Thus, if the Japanese consumption tax rate is raised from the current 5% to 23%, the entire deficit can be eliminated. Most European countries have the VAT rate more than 15% and some as high as 25% (e.g., Sweden), so the 23% consumption tax may not be outrageous. Japan has a huge room for increasing VAT rate to the European norm.

The empirical study of Tokuoka (2010) confirms that some of these factors are indeed important in explaining apparently too low yields on JGBs. He starts out by pointing out that the yield on government bonds tend to rise as the deficit or the debt increases for many advanced economies, but such a relation is not observed for Japan. Figure 3 shows that JGB yield actually fell as the Japanese debt-to-GDP ratio increased in the 1990s and 2000s. Tokuoka (2010) examines what factors contributed to keep the JGB yields low when the amount of debt increased. Table 3 shows a representative regression result.

<Figure 3. JGB outstanding and yield>

<Table 3. Explaining JGB yield >

The result shows that higher household and corporate net savings result in lower JGB yield. It means that more private saving lowers the JGB yield, because they increase demand for JGBs. The regression result also shows that higher foreign ownership raises the bond yield. Foreign investors seem to demand higher risk premium both for interest rate risk and for currency risk. These suggest that the first factor that we list (private saving and home bias) is indeed important in explaining low JGB yield. It is worth noting that increase in the stock of JGB indeed increases the bond yield after controlling for these additional factors. The regression suggests that the bond yield rises by 2 basis points for each 1 percentage point increase in the debt to GDP ratio.

There is no guarantee that these factors continue to exist to hide the positive relation between the debt and the interest rate. For example, household savings may start to decline due

to the aging society. Corporate savings, which has increased so far, would not keep increasing forever. The share of foreigners also matter, if JGB had to be sold to foreigners as domestic investors' total assets go down, then the foreigners would demand a higher risk premium on JGB. What would happen when some of these factors disappear and the JGB yield starts to rise reflecting high indebtedness of the Japanese government? This is the question that we now turn to.

4. What would trigger a crisis?

In a typical fiscal crisis, the interest rate starts to increase when the debt-GDP ratio and fiscal deficits to GDP ratio increase sharply. The higher interest rate makes the rollover and new issues of government bonds difficult at a reasonable level of interest rate. The government has to either issue at higher rates, which will worsen the debt situation by adding more debt, or adjust revenues and expenditures so that they can do without new debt issues. Changing a budget takes time, however, and raising revenues (presumably through tax increase) would be politically difficult.

When some of the conditions that have supported the low JGB yield, the interest rate can start to rise and trigger a crisis. Depending on which condition changes first, we can identify three types of triggers. We call those (1) saving trigger, (2) fundamental trigger, and (3) expectation trigger.

(1) Saving trigger

Almost all JGBs are held by the Japanese residents. If the growth of the private savings decelerates, and the government debt continues to increase, the amount of the government debt may eventually exceed the amount of private savings. At that point, even mobilizing all the private sector financial assets to hold the JGBs, leaving nothing for the corporate sector credit, would not be sufficient. Thus, it is unlikely that the economy ever reaches that point. As soon as the market sees that the extrapolation of the current course eventually would lead to such extreme situation, the government will have trouble selling new JGBs. This will lead to a crisis. If Japan needed to rely on foreign investors to buy JGB at that point, the interest rate would rise. According to Tokuoka (2010)'s regression, one percentage point increase of foreign ownership of JGBs pushes up the yield by 11 basis points.

There is a good reason to believe that household saving rate will decline, which will slow down the growth of the private sector financial assets. The baby boomer generation will retire in the next ten years, and they will most likely start consuming out of their financial assets. The working-age population is expected to decline by 8% in ten years from 2011 to 2021.

To get an idea about when the government debt is expected to catch up with the private savings in the absent of fiscal reform, we carry out the following calculation. The government debt is assumed to follow a similar dynamics.

$$b_{t+1} = \frac{1+r_t}{1+\eta_t} b_t + g_t - \tau_t \quad (1)$$

where b_t is the government debt to GDP ratio at the beginning of period t , r_t is the real interest rate, η_t is the real GDP growth rate, g_t is the government expenditures including transfers divided by GDP in period t , and τ_t is the tax rate (relative to GDP). For the initial value of the debt to GDP ratio, we use 153%, which is the amount of adjusted net debt calculated by Doi, Hoshi, and Okimoto (2011). The future government expenditure series also come from Doi, Hoshi, and Okimoto (2011). The series is based on the 2008 estimates of healthcare and long-term care expenditures by the National Congress on Social Security and the 2009 estimates of social security related expenditures by the Ministry of Health, Labor, and Welfare and assumes no drastic future reform. The sum of total tax revenues and social security contribution is assumed to stay at 30% of GDP, the approximate level for fiscal 2010.⁷

We consider three alternative assumptions for the interest rate.

R1: Interest rate is equal to the largest of the growth rate (η_t) or the level at 2010 (1.3%).

R2: Interest rate rises by 2 basis points for every one percentage point that the debt to GDP ratio at the beginning of the period exceeds the 2010 level (153%) ($r_t = 1.3\% + 0.02*(b_t - 1.53)$).

R3: Interest rate rises by 3.5 basis points for every one percentage point that the debt to GDP ratio at the beginning of the period exceeds the 2010 level (153%) ($r_t = 1.3\% + 0.035*(b_t - 1.53)$).

R1 is motivated by the fact that the average yield on 10 year JGBs over the last several years has been about the same as the GDP growth rate during the same time interval, but constrains the interest rate to be much lower than the current rate even when the GDP growth declines further. R2 and R3 assume that the interest rate rises as the government accumulates more debt. Many empirical studies have demonstrated such relation. R2 (2.0 basis points increase) uses the finding of Tokuoka (2010) for Japan. R3 (3.5 basis points increase) assumes the coefficient estimate used by Gagnon (2010). It is the median estimate from studies of various advanced economies.

The debt calculated by (1) is compared to the amount of domestic private financial assets that can be potentially used to finance government debt. As the measure of such domestic private savings, we consider:

⁷ The national taxes amount to about 40 trillion yen; the local taxes amount to 34 trillion yen, and the social security contribution amount to about 58 trillion yen. GDP was 480 trillion. The ratio was 28%.

Net financial assets of the household sector – Value of shares and other equities held by the household sector + Cash, deposits, government bonds, and public corporation bonds held by the private nonfinancial sector

The private savings thus defined was 261.3% of GDP at the end of fiscal year 2010.⁸

Starting from this initial value of the private financial assets, we assume the future private financial assets will evolve according to the following equation.

$$a_{t+1} = \frac{1+r_t}{1+\eta_t} b_t + \max(a_t - b_t, 0) + s_t \quad (1)$$

where a_t is the private savings to GDP ratio at the beginning of time t , s_t is the (flow) saving divided by GDP in year t . The dynamics assumes that all the government debt is held by the private sector and that portion of the private financial assets grows at the rate of the interest rate on the government debt. The rest of the private financial assets is assumed to grow at the rate of GDP growth.

The aggregate saving rate is a function of the demography. Appendix 1 describes how we estimate the aggregate saving rate from 2010 to 2050. The result is shown in Figure 4. The saving rate starts out above 3% in 2010 but quickly goes below 2% by 2017. It then holds steady and start to decline again in the 2030s and falls almost to -3% by the end of the 2040s.

<Figure 4. Aggregate Saving to GDP Ratio: 2010-2050>

The upper-bound for the debt to GDP ratio is defined as the level when the new issue of government bonds exceeds the total (flow) saving of that year and the amount of the private sector financial assets that are not in the form of the government debt yet. Thus, in order to avoid the upper bound, the debt to GDP ratio must satisfy the following constraint.

$$B_t - B_{t-1} \leq S_{t-1} + (A_{t-1} - B_{t-1}) \quad (1)$$

Or rewriting this in terms of the ratios to GDP,

$$b_t \leq \frac{s_{t-1} + a_{t-1}}{1 + \eta_{t-1}} \quad (1)$$

We consider several different future growth rate series. We start by a simple although unrealistically optimistic assumption that the Japanese GDP will grow at 2% annually for the next 40 years. This is an assumption often used by the Japanese government for future economic projections. Figure 5 shows the path of the debt to GDP ratio under the alternative scenarios on the interest rate. The series DebtX (X=1, 2, 3) is the path of the debt to GDP ratio under the

⁸ The data on the financial assets are taken from the Bank of Japan Flow of Funds Data.

interest rate scenario RX. The figure also shows the right hand side of the constraint (4) as MaxDebtX (X=1, 2, 3). For every scenario on the interest rate, the figure shows that the inequality is violated in 2023 at the latest.

<Figure 5 . Government Debt and Private Sector Financial Assets: 2010-2050>

The assumption of 2% real GDP growth indefinitely is probably too optimistic. The assumption ignores the tremendous shift in demography, namely shrinking working age population. A more reasonable assumption may be that GDP per working population rather than GDP itself will grow at a constant rate.

Note that

$$rGDP = POP * \frac{wPOP}{POP} * \frac{rGDP}{wPOP}, \quad (1)$$

where rGDP is the (level) of real Gross Domestic Population, POP is total population, and wPOP is the working age population. In terms of the growth rate, we have:

$$\Delta rGDP = \Delta POP + \Delta \frac{wPOP}{POP} + \Delta \frac{rGDP}{wPOP}, \quad (1)$$

where Δ is the growth rate operator, $\Delta x = \{x(t) - x(t-1)\} / x(t-1)$. Real GDP growth rate, $\Delta rGDP$, is the sum of the population growth rate, ΔPOP ; the growth rate of the ratio of working-age population to population, $\Delta(wPOP/POP)$; and the growth rate of GDP per working-age person, $\Delta(rGDP/wPOP)$. The last term, the growth rate of GDP per working-age person, can be roughly regarded as a rate of increase in labor productivity. Thus, we refer to this term as the labor productivity growth for short.⁹ Table 4 demonstrates this demographic growth decomposition for 1955 to 2010. The working-age population is defined to be ages 20 to 64.

<Table 4: Demographic Dividend>

During the rapid growth period from 1955 to 1970, the average annual growth rate was 9.7%. This is the left-hand side of equation (6). The right hand side of equation (6) breaks down contribution as follows; high population growth (1%), increase in the proportion of working-age population (1.0%), and very high growth rate of GDP per working-age person (7.7%). The boost in the overall growth rate by the population factor is called demographic dividend.¹⁰ The overall growth rate fell over time as all of these factors that contributed to the growth declined. The

⁹ The number of actual workers who engage in production activities is the working-age population times the labor participation rate, plus anyone who may be working in the retired age group (age 65 and over). The decline in working age population can be alleviated if the participation rate, especially that of women, increases, or more elderly people participate in the labor market. Either possibility is not considered in this paper.

¹⁰ For demographic dividend in general, see Bloom, Canning, and Sevilla (2003), and for application of demographic dividend to Japan, see Komine and Kabe (2009).

growth rate of GDP per working-age person, however, seems to have stabilized around the 1990s. Although the GDP growth rate dropped from 1.1% during the 1990s to 0.7% in the 2000s, much of it can be explained by the drop in the working population ratio (from +0.1% to -0.5%). The growth rate of GDP per working-age person indeed increased from 0.7% in the 1990s to 1.1% in the 2000s.

Future projection of demographic growth decomposition requires the expected future demographic changes as inputs. We take the (mid-point) future projection of the total population and working-age population from the National Institute of Population and Social Security Research (IPSS).¹¹ This produces the first two terms of the right-hand-side of equation (6).

There are two ways to generate the future economic growth rate, which is an important input for simulation of debt-to-GDP ratio. First, we can just assume a constant GDP growth rate. This will imply a path of future growth rates of GDP per working-age population. Alternatively we can assume a constant growth rate of GDP per working-age population and derive an implied path of the GDP growth rate. For Japan, the first method turns out to imply a path of growth of GDP per working-age population that are unrealistically high. The second method implies GDP growth rates that are somewhat lower than the ones used in other sustainability calculations.

Let us first calculate how much growth increase of GDP per working-age person is necessary to maintain the overall GDP growth rate of 2%. Table 5 shows the result. The 2% economic growth (of real GDP) in fact implies that the growth rate of GDP per working-age person must be at roughly 3% in the next twenty years (2011-2030) and at 3.5% for the following twenty years (2031-50). The productivity growth rate of 3 percent and above has not been seen since 1980s. It seems implausible that the Japanese economy can repeat the miraculous growth of the 1970s and 1980s in the next 40 years.

<Table 5. Implications of 2% growth>

A more reasonable scenario is to assume the growth rate of GDP per-working-age person (or an increase in labor productivity) to be similar to that of the 1990s and 2000s. We consider two alternative growth rates per-working-age population. The low growth scenario is that the increase in labor productivity at 1.05% (average of 1994-2010) and the high growth scenario is at 2.09% (average of 2001-2007, the “Koizumi years”).¹² Table 6 shows the growth decomposition on the assumption of the 1.05% growth rate of GDP per-working-age person.

<Table 6. Per worker productivity growth of 1.05%>

¹¹ For the IPSS population forecasts, see <http://www.ipss.go.jp/pp-newest/e/ppfj02/top.html>. Our

¹² Mr. Junichiro Koizumi became Prime Minister in April 2001. He resigned as Prime Minister in September 2006, succeeded by Mr. Shizo Abe, who was widely regarded as a protégé of Koizumi. Prime Minister Abe lasted only one year to 2007. The Koizumi years here are taken from 2001 to 2007, counting in the Abe year.

The results are reported in Figure 6, which shows a result similar to the one in Figure 5. The upper bound for the debt accumulation is reached by 2024 at the latest.

<Figure 6. Government Debt and Private Sector Financial Assets: 2010-2050 (1.05% GDP per worker growth)>

Assuming that the growth rate of GDP per working-age person grows at the 1994-2010 average may be too pessimistic. After all the period is sometimes called “lost two decades.” Alternatively, let us assume that the growth rate will grow at a rate that was observed during the years that Mr. Koizumi was Prime Minister, when Japan seemed to have finally regained a robust growth. The average growth rate from 2001 to 2007 was 2.09%. Assuming that the growth rate of GDP per-working-age person will remain constant in the future, we can calculate the growth rate of real GDP as in Table 7. The growth rate will be close to 1% in the next twenty years, until 2030, then falls to 0.6% in the 2030s and the 2040s.

<Table 7. Per-worker productivity growth of 2.09%>

The result of the dynamics for government debt and private sector saving, Figure 7, again is pretty much the same as the one in the previous Figure. The Japanese government is expected to run out of the room to place more bonds domestically by 2024 at the latest.

< Figure 7. Government Debt and Private Sector Financial Assets: 2010-2050 (2.09% GDP per worker growth) >

In the calculations for Figures 6 and 7, we use future GDP growth rates that are different from the government projection of 2% per year. The future government expenditure to GDP ratios, however, are still based on the government projection of 2% GDP growth. This procedure is correct if the government expenditure falls at the same rate as GDP when the GDP growth rate falls below 2%. If the government expenditure does not fall as much, our procedure results in underestimation of future government expenditure to GDP ratio. To see the impact of this potential misspecification, we calculated the dynamics for government debt under an alternative extreme assumption: the level of government expenditure does not depend on the GDP growth rate, so that the government expenditure to GDP ratio at year t when the GDP growth rate is x ($x < 2\%$) is given by (the government estimates under 2% growth assumption) $\times (1.02) / (1+x)$. The results (not reported here) show that the government debt can exceed the MaxDebt sooner but not by more than one year.

The results in Figures 5 through 7 suggest that the year when the Japanese debt would exceed the private financial assets does not depend very much on the growth rate, which is adversely affected by the aging of Japanese population. This does not mean that the population dynamics does not matter for the sustainability of fiscal situation. On the contrary, expected increase in social security related spending in the future as a result of aging, which is embedded in all the simulations above, is at the heart of the sustainability problem.

Appendix 2 provides a simple example that shows the power of population dynamics that could make a previously appropriate pay-as-you-go pension system unsustainable. The appendix considers a simple two-period-life overlapping generation model. The young is endowed with income W and the old is endowed with none. The government offers government bond that carries the interest rate r to the young, to mature in the next period (when the young becomes the old). The young also has an access to the storage technology that can transform one unit of endowment in this period to one unit of consumption in the next period. Each agent has a lifetime utility function which is the sum of the two one-period concave utility functions. The population grows at the rate $g > 0$. Then, by setting $r = g$, the government can establish a pay-as-you-go pension system that is sustainable as long as the population growth rate remains at g . By offering the government bond of an amount of $(1 - \tau)W$, where $\tau \leq 1$, one can show that such pension scheme can improve the welfare of every generation as long as τ is not too large.

Now suppose that the population growth rate suddenly goes to zero, after generation j . If the government tries to honor the bond rate r despite the fundamental change, they have to collect more from generation $j+1$ by increasing τ . Then, in order to honor the same promised rate of return to generation $j+1$, the government has to raise τ even more on generation $j+2$, and so on. Sooner or later, τ exceeds 1, which means that the young is asked to pay more than the endowment, which is impossible. Thus, the existing pension system becomes unsustainable.

Appendix 2 provides more detailed treatment of this example. It also contains a numerical example that shows how quickly τ would have to increase. The example provides a simple metaphor for the current Japanese situation, where the government finances, especially the social security system, have not adjusted to the reality of declining population.

(2). Fundamental trigger

The private saving ceiling is the absolute maximum of the domestic demand for the government debt, but the demand for JGBs will start falling well before the saving ceiling is ever reached. One potential trigger for such a change is that the financial institutions find alternative and more lucrative ways to invest the funds. In general, when the economic environment changes to increase the returns from alternatives to the JGBs, the interest rate on JGBs may start to increase. If this suddenly happens, this can trigger a crisis. Increases in the rate of returns may be caused by favorable changes in the economic growth prospect. The end of deflation and the zero interest rate policy would also lead to higher interest rates.

Alternatively, the change may be caused by some shocks that are unfavorable for the Japanese growth as well. For example, continued economic stagnation and political uncertainty may convince more Japanese manufacturing firms to shift their production abroad. The corporations then draw down their saving to invest abroad.

The reconstruction boom that is likely to happen following the earthquake and the tsunami that hit Japan may be another potential trigger. The reconstruction may create so large loan demand for banks that they need to reduce the JGB purchases. Signs of the reconstruction boom have now started to be observed. The new construction starts have increased in many affected areas. In December 2011, the loans outstanding at six major banks marked an increase over the past year for the first time in 27 months.¹³

A crisis may be triggered by an increase in the perceived risk for the financial institutions to hold JGB. There were a few instances in the past that suggest the potential importance of this type of trigger. In 1998, some confusion on how much the Fiscal Investment and Loan Program (FILP) of the government (using the fund collected through the postal savings) would buy government bonds made the yield to jump by more 100 basis points in less than three months. Another incidence occurred in the mid-2003, often called “VaR Shock” among the Japanese market participant. Over the summer of 2003, the price of JGB suddenly dropped. The yield went up from 0.5% in June to 1.6% in September. A sudden price decline raised the VaR (value at risk) of JGB and many financial institutions sold JGBs to reduce the risk. This behavior, which was individually prudent, depressed the JGB price further. The first incidence shows that the credibility of public sector support for the JGB is important. The appetite of the private sector alone was not enough to absorb increasing JGB issues at low interest rates even back in the late 1990s. The second incidence shows that once the price of JGB is destabilized downward, there is a reinforcing mechanism to send the prices further down. Both incidences demonstrated that the yield could move by 100 basis points easily in three months.

The relationship between the interest rate and growth rate has been a subject of contention both in theoretical models and public policy debates. In the standard neo-classical growth model, the steady state level of consumption is maximized when the interest rate (which is equal to the marginal product of capital in equilibrium) is the same as the steady state growth rate of output. The level of capital that achieves this is called the golden rule level of capital. If the level of capital is higher than the golden rule of capital, the interest rate (marginal product of capital) is lower than the steady state growth rate. In this case, lowering the level of capital (by increasing consumption) today increases the steady state level of consumption, making not only the current generation but also all the future generations better off. Thus, the interest rate higher than the growth rate suggests that the level of capital is inefficiently high. The situation is often termed “dynamically inefficient.”¹⁴

In policy debates, the relation between the interest rate and the growth rate is a key in deciding the level of primary surplus necessary to stabilize the debt to GDP ratio. If the interest

¹³ Japanese Bankers Association (2012) *Zenkoku Ginkō Yokin Kashidashikin Sokuhō: Heisei 24 nen 1 gatsu-matsu (Express Report on Deposits and Loans at All Banks: End of January 2012)*.

http://www.zenginkyo.or.jp/stats/month1_01/entryitems/yokashi02211.pdf

¹⁴ See Abel, Mankiw, Summers and Zeckhauser (1989) for a full treatment of the discussions on the dynamic inefficiency.

rate is equal to the steady state growth rate, it is possible to stabilize the debt-GDP ratio without any primary surpluses ever. However, if the interest rate exceeds the growth rate, it is necessary to run primary surplus sometime in the future to keep the debt-GDP ratio from exploding.¹⁵

Figure 8 shows the time-series of the real GDP growth rate (4 quarter moving average of year-on-year growth rate of quarterly real GDP) and the *ex post* real 10 year JGB rate calculated using the year-on-year CPI inflation rate in Japan. During the first half of the 1980s and again in the first half of the 1990s, the interest rate tended to be higher than the growth rate. During the long stagnation from the mid-1990s to present, the two rates are on average very much the same except for the occasional recessions (periods with negative growth rates). For most of the time, the interest rate and the growth rate seem to be correlated positively. In the aftermath of global financial crisis, however, the growth rate sharply dipped into the negative territory, while the interest rate increased, showing a negative correlation.

<Figure 8>

To see dynamic interactions between the interest rate and the growth rate, a two-variable VAR (vector autoregression) model was estimated for the 1975-2011 period and two sub-periods: 1975-1993 and 1993-2011. Impacts of an unanticipated shock (one standard deviation) of each variable on the two variables in the following quarters are evaluated using the impulse response functions in Figures 9, 10, and 11. An own shock has a long declining influence for each variable as expected. The impact of an unanticipated change (innovation) of the interest rate on the growth rate is not significantly different from zero in the first half, but it becomes negative and significant in the second half. A higher than expected interest rate has been bad news for the growth during the long stagnant period in Japan. This may suggest that a negative supply shock or the monetary (LM) shock was more important than the fiscal (IS) shock during this period. A shock to growth produces the positive response in the interest rate suggesting that the surprise pick-up in growth will raise the interest rate in the subsequent quarters.

<Figures 9-11>

How much increase in the interest rate would put Japanese sovereign debt into a crisis? We explore the answer to this question by looking at the impact of interest rate shocks on the interest payments implied by the simulations conducted above. We calculate the increase in the interest rate that would push the interest payment above 35% of the total government revenue. The 35% number is arbitrary, but it is consistent with the range of the numbers that we observed during the recent cases of sovereign defaults. Figure 12 shows the increase in the interest rate

¹⁵ The policy debate over a question of the relative magnitude of the interest rate and the growth rate took place in 2006 between then Minister Heizo Takenaka (Fiscal and Economic Affairs) and Professor Hiroshi Yoshikawa who was a member of the Prime Minister's Council of Economic and Fiscal Policy. Professor Yoshikawa argued that the interest rate tends to be higher than the growth rate in a mature economy so that primary surpluses must be a fiscal policy goal. Minister Takenaka countered that interest rate can be below the economic growth rate so that the primary surplus is not necessary to stabilize the debt.

that would make the interest payment exceed the 35% of the total revenue for each year under each scenario. The series *deltaiX* (X=1, 2, 3) shows such necessary interest rate increase under the interest rate assumption RX. *deltai* is calculated as follows:

$$deltai_t = \frac{0.35 * \tau_t}{b_t} - r_t \quad (2)$$

0% means that the interest payment is already at or above the 35% of the total revenue. For the assumption R2 (interest rate increases by 2 basis points for each 1% increase in the debt to GDP ratio) and the assumption R3 (interest rate increases by 3.5 basis points for each 1% increase in the debt to GDP ratio), the interest payment exceeds 35% of the total government revenue by 2020 and 2018 respectively. Only under the assumption R1 (interest rate stays at 1.3% or the growth rate whichever is higher), the interest payment remains below 35% of the total revenue for the next 50 years. Even then, the interest payment would exceed 35% of the revenue if the interest rate jumps by 2% or more after 2026.

< Figure 12 >

(3) Expectation trigger

To the extent that the current low JGB yield is backed by the public's expectation that the Japanese government will restore fiscal balance eventually, any event that disturbs the belief can precipitates a crisis. For example, the Japanese government is about to submit the bill for "integrated reform of social security and tax systems" to the Diet as of this writing (February 2012). The bill proposes a consumption tax rate increase from current 5% to 8% in April 2014 and another rate increase to 10% in October 2015. If the bill fails to pass the Diet, the public may conclude that the government is less likely to achieve fiscal consolidation than they expected, which may lead to a crisis.

We can use the simple simulation model that we used above to see what kind of future tax rates would make the fiscal situation sustainable. We start from the expected tax rate for the next several years that are implied by the latest plan for the integrated reform of social security and tax systems. One percentage point increase of the consumption tax rate is estimated to increase the tax revenue by 0.5% of GDP. Thus, the tax rate increase by 3% that is planned for April 2014 would raise the tax revenue to GDP ratio in fiscal 2014 from current 30% to 31.5%. For fiscal 2015, the planned mid-year increase of consumption tax rate of 2% would increase the tax revenue by another 0.5% to 32% of GDP. The tax revenue to GDP ratio for fiscal 2016 would be 32.5%.

For each assumption about the interest rate R1, R2, and R3, we try to find a path for the future tax rates that starts with these and eventually brings down the debt to GDP ratio to 153%

(the initial value at 2010). Such path is not unique, but Figure 13 shows one possible path for each interest rate assumption that makes the debt process sustainable. Here the growth rate of GDP divided by working-age person is assumed to be 1.05% (the average for 1994-2010).

Under R1, the tax rate increases from 32% in 2015 to 33% in 2016, and increases by 1% a year till it reaches 46% in 2029. The tax rate stays at 46% till 2070 and then gradually falls to 43%. This tax rate policy is shown to bring the debt to GDP ratio down to 153.9% by 2100 as Figure 14 shows.

Under R2 or R3, the 1% tax rate increase each year would take the tax rates to unrealistically high level before the debt to GDP ratio starts falling. Looking at the tax and social security collection to GDP ratio across OECD countries, no country has the ratio above 50%. The largest rate observed in the late 2010s is 49% for Belgium (check and add the reference). Thus, we search for a tax rate path that does not go over 50%. For R2, this implies that the tax rate needs to increase by 3% a year from 2016 to 2020. The tax rate reaches 50% in 2023 and stays there for 3 years. Then, the tax rate can gradually fall to 47% by 2100. Figure 14 shows that the tax policy brings the debt to GDP ratio down to 153.5% by 2100.

The sustainable tax policy under R3 jumps by 9% in 2016 and another 8% in 2017. The tax rate reaches 50% as early as 2018 and stays there for 24 years (till 2041). Eventually the tax rate falls gradually to 47% by 2100. The tax policy brings the debt to GDP ratio down to 153.4% by 2100 as Figure 14 shows.

Figure 15 provides another way to look at the debt dynamics under the sustainable policies. The figure shows the path of the ratio of government debt to the maximum amount of government debt that the private sector can absorb by using the current financial assets and the new saving (what we call MaxDebt) for each interest rate scenario. For all interest rate scenarios, the ratio never exceeds 100%, suggesting that the amount of government debt never breach the limit imposed by the private sector financial assets.

<Figures 13, 14, 15>

If the market participants expect such future tax increases as the ones in Figure 13, we can understand why we have not yet observed high yields on JGB. We know, however, the market expectation can change quickly. If the market changes the expectation and suddenly sees such tax increases unlikely, such a change in expectation can trigger a crisis.

A potential trigger to change the market expectation is a downgrade by credit rating agencies. Downgrading signals an expert opinion to investors at large. Investors may revise their assessment of bonds and re-balance portfolio based on (unexpected) changes in credit rating.

Credit rating may also react to developments in the market rather than providing information independent of the market sentiment. In that case, downgrades and crisis (exchange rate depreciation or bond price decline in the market) may reinforce each other. For example, a four-notch downgrade of Korean sovereign debt came in the middle of its currency crisis in 1997. It did not trigger the crisis but it certainly intensified it. Similarly, Moody's downgrade of Greek government bonds by four notches from A3 to Ba1 on June 14, 2010 came well after Greece went into the crisis: the Greek solvency problem was widely discussed as early as October 2009, and the IMF-EU package was arranged in May 2010. Sovereign downgrades of other European sovereign debts (Ireland, Portugal, Spain, and Italy in 2010-11) also happened when the crisis was already unfolding.

The past experience suggests, however, that the credit rating agencies are not likely to trigger a crisis for the Japanese government bonds as we discuss below. The JGB has already undergone a series of downgrading by both Moody's and S&P in the late 1990s to the beginning of 2000s. Looking back these experiences, we can judge the likelihood that credit rating agencies pull the trigger for the Japanese sovereign debt crisis. The history of the above mentioned changes in credit rating is summarized in Table 8 and Figure 16.

<Table 8 and Figure 16>

Moody's put Japanese JGB on negative watch in July 1998, and actually downgraded from Aaa to Aa1 in November. In February 2000, Moody's put the JGB on negative watch again. Actual downgrade came in September 2000. S&P downgraded Japanese JGB for the first time in February 2001 to AA+, and the second time to AA in November 2001. The third downgrade by Moody's came in December 2002, shortly after it was put on negative watch in September.

In 2002, a series of downgrade continued with intensity. In February, Moody's put JGB on negative watch, while S&P downgraded for the third time to AA- in April. When Moody's actually downgraded JGB by two notches in May 2002, the Ministry of Finance sent an open letter to the three credit rating agencies—Moody's, S&P and Fitch—to question their judgments. The letter from the Ministry, dated May 2, 2002, pointed out the following strengths of the Japanese fiscal situation.¹⁶

- a) From a macro-economic viewpoint, Japan has the largest savings surplus in the world.
- b) The above enables us to finance most of the debt domestically and stay at very low interest rate.
- c) Japan has the largest current account surplus, is the creditor country, and the largest foreign exchange reserves in the world.

¹⁶ Opinions of the Ministry of Finance in a series of exchanges between the Ministry of Finance and the credit rating agencies are found in http://www.mof.go.jp/about_mof/other/other/rating/index.htm.

The ratings A2 by Moody's and AA- by S&P continued for about 5 years till 2007. During the 5 years, the economy started to grow faster, and the fiscal deficit started to shrink. This development was noticed by Moody's and the JGB was put on positive outlook in July 2007, followed by actual upgrading to A1. S&P upgraded JGB to AA in April. Moody's upgraded JGB to Aa3 in June 2008 and to Aa2 in May 2009. In January 2011, S&P downgraded JGB to AA-. This became the first downgrade since the upgrade of 2007. The S&P noted that there was no coherent strategy on the part of the government to tackle the fiscal problems.

If a downgrading of JGB influences the expectations of investors and makes them more reluctant to hold JGBs, we should expect the bond yield to rise, the yen to depreciate, and the stock prices to decline. However, we do not find evidence that any of these happened when JGB was downgraded.

Figure 16 shows the result of an event analysis that we carried out to see whether there is a systematic market reactions to the rating changes. There are no clear, consistent reactions in the bond yield, the yen, and the stock prices in the days leading into downgrade or days following the downgrade. If we observe that the bond yield got higher toward the announcement date, that is, positive $r(t)-r(t-j)$, it means that the content of bad news to bonds was expected. If the credit rating decision (or content) has a surprise element, then the bond yield should go up: $r(t+j)-r(t)$ should be positive. Here we consider several event windows: $j=1,5,25,75,150$ business days. When the downgrade events and negative watch issuance are chosen for S&P (panel 1) and Moody's (Panel 2), the change in the bond yield is hardly positive. If anything, downgrade seems to produce declining bond yield, a bit of a puzzle. However, when "upgrade" events are included with opposite sign (Panel 3), then the changes become slightly positive. This means that the magnitude of decline in the bond yield was much larger for upgrades than for downgrades. This fits the theoretical prediction.

<Figure 16>

Similarly, Figure 16, Panels 4 and 5 show that downgrade is associated with yen appreciation, but Panel 6 shows that upgrades are associated with much larger yen appreciation, so that the total symmetrical effects show that bad (good) news in credit rating changes produce yen appreciation (much more yen appreciation). With respect to stock price Figure 16 (Panels 7,8 and 9), downgrades produces stock price declines, before and after the credit rating changes. We also find upgrades actually lead to even larger stock price, which is a bit puzzling.

The most dramatic downgrade so far was the 2-notch downgrade of May 31, 2002. Although the Ministry of Finance was quite upset and wrote an open letter questioning the judgment, the market was calm, sending the yield slightly lower. Judging from these experiences, it seems safe to conclude that credit rating agencies are not likely to trigger a crisis or to be able to provide early warnings at least for Japan. This assessment has been confirmed by what followed the most recent downgrading of the JGB by Moody's on August 24, 2011.

The downgrading was more or less expected and the JGB yield did not change at all following the announcement.

Another possible trigger may be a hike in the Credit Default Swap (CDS) spread. As Figure 17 shows, the CDS spread has been showing an upward trend since late 2007. It peaked at around 100 basis points (bp) after the Lehman failure. Although it went down to about 40 bp in mid-2009, it started to climb again to 90 bp in 2011. It spiked up again immediately after the March 11 earthquake/tsunami. The CDS spread is a reflection of default assessment among investors. Figure 17 suggests that the environment for JGB has changed in the last three years from zero probability of default to some probability of default. Although the level of spread for Japan is still small compared to some European countries that have experienced fiscal crises in 2010-11, the upward trend is obviously visible. Just for comparison, CDS spreads for Spain and Italy were at around 100 bp in November/December 2009, before it would become constantly higher than 100 in 2010, and then rose above 300 in the summer of 2011.

<Fig 17, CDS>

5. Implications of the earthquake/tsunami

The strong earthquake and tsunami that hit Japan in early 2011 can turn out to be important, because it can affect some potential triggers of the fiscal crisis. The loss of wealth implies that the private financial assets will decline somewhat, for example. The reconstruction boom will increase the upward pressure on the interest rates. Finally, how the government finances the reconstruction expenditure may critically influence the public's expectation about the likelihood of future fiscal consolidation.

The Great East Japan Earthquake on March 11, 2011 caused large damages in the regions northeast of Tokyo. The direct damages to social infrastructure and private structures caused by the Earthquake are estimated at around 16-25 trillion yen.¹⁷ In addition to this cost of direct damages, the Japanese manufacturing sector suffered production stoppage due to lack of parts and semi-finished goods that are produced in the tsunami affected area. One company in Sendai had a large global share in automobile engine controlling computer chip, and many automakers, Japanese and foreign, had to curtail production for several months. The damage of the broken supply chain on the economy outside the affected areas is estimated to have been as much as 0.25% of GDP.

The additional costs from the disaster are due to the accident of the Fukushima Daiichi Nuclear Power plant. Although the precise details of the events are still unknown and will

¹⁷ The numbers on the cost of the earthquake/tsunami comes from METI (2011) unless otherwise noted.

continue to be uncertain for years, we now know at least the followings. The nuclear fuel rods in a couple of reactors were completely melted down within a few days after the earthquake and tsunami destroyed the cooling mechanism of the reactors. The containment vessel was also damaged, and a large amount of radioactive substances has escaped to the environment. In terms of the amount of radioactive materials released to the environment, the Fukushima accident now exceeds the infamous Chernobyl accident that happened in the former Soviet Union in 1987. The Tokyo Electric Power Company (TEPCO) has been trying to restore the cooling capacity of the reactors and stop the leakage of the radioactive substances to the environment, but the progress has been slow.

After the nuclear accident, the residents in the immediate neighborhood of the nuclear plants were forced to evacuate. Agricultural products in larger areas were damaged. Many foreign tourists started to avoid not only the affected areas but Japan entirely. All of these impose substantial cost to the economy, but the amount will not be known for several years.

Nuclear power plants in Japan are now under much more intense scrutiny. As power plants undergo a two-month regular maintenance shutdown after regular operations of 13 months, at any point of time there are a number of reactors that are not operating. It is a regular procedure to get consent from neighboring municipalities to start reactors after regular maintenance. After the Fukushima accident, the residents around the nuclear power plants have become reluctant in restarting the reactors when they are supposed to come out of maintenance. Residents around the reactor demand safety standard set by the government and the government as well as the power companies guarantees the safety of any reactors in operation. If no nuclear power plants can be restarted after maintenance, all nuclear power plants in Japan will be shut down by the spring of 2012. That would severely constrain the electricity supply (the share of the electricity generated by nuclear power was 30% before the disaster) all over Japan.

Facing the immediate power shortage in the TEPCO area, the government ordered May 2011 that customers of TEPCO should introduce across-the-board power usage cut by 15% compared to the previous year. The order was issued by the Minister of Economy, Industry and Trade (METI) based on the Electricity Business Act of 1964. It had been invoked once in 1974 in the wake of the First Oil Crisis. This time the Minister imposed a restriction of 15% cut in usage of electricity over the last year for the peak usage time (weekday, afternoon) on large customers. The violators are fined (although we are not aware of any reported violations). Small customers are asked to cut electricity consumption voluntarily.

The electricity saving order has achieved its goal of motivating companies to avoid weekday afternoon for operations, so that the government and TEPCO avoided a catastrophic power outage. However, economists pointed out that this planned economy type policy has a

major deficiency in resource allocation. The cap and trade type framework would have achieved a better solution.¹⁸

After the nuclear accident at Fukushima, the safety of other nuclear power plants against large earthquakes and tsunami was reevaluated. On May 6, Prime Minister Kan “requested” that the Chubu Electric Power to shut down the Hamaoka Nuclear Power Plant, because it is on the earthquake fault line. Then in July, Prime Minister abruptly declared that Japan would go completely off the nuclear power in the future, putting the future of nuclear power and the power industry in Japan into huge uncertainty.

Thus, the nuclear accident can be quite damaging to the Japanese economy. If the government was to compensate for the losses of the evacuees and the farmers, that would add to the future government liabilities that are already too large to be sustainable. The cost will be added to the reconstruction cost that the government already plans to spend in the next several years.

The government has started to issue Reconstruction Bonds to finance the reconstruction. The Third Supplementary Budget for Fiscal 2011 included the issue of 11.6 trillion yen (about 2.4% of GDP) of Reconstruction Bonds. According to the government plan, additional 12.7 trillion (about 2.6% of GDP) yen of Reconstruction Bonds are slated to be issued in Fiscal 2012. Although the Reconstruction Bonds are supposed to be redeemed using the revenues from income tax surcharge for 25 years, they add to the government debt at least for a while. In addition to these, some estimate that decontamination of nuclear substances and compensations for businesses and evacuees that resulted from the nuclear accident can cost the government as much as 20-30 trillion yen (about 4-6% of GDP).¹⁹

Although these are large expenditures, the amounts are relatively small compared with more than 1,000 trillion yen of debt Japan already has. Doi, Hoshi, and Okimoto (2011) calculate the impact of adding 19 trillion yen (the amount that the government specified in the Basic Policy on Earthquake Reconstruction of July 2011) to the government debt on the magnitude of the tax rate increase that is required for the sustainability. They find the additional debt increases the required tax rate only by 0.05% to 0.20%.

We can use a simple simulation model considered in the last section to examine the impacts of the reconstruction financing on the debt dynamics. For the interest rate scenario, we consider R2 here. Let us start from the sustainable debt path in Figure 15. The path assumes the tax rates shown in Figure 13. Figure 18 shows the debt to GDP ratio divided by the MaxDebt

¹⁸ See T. Ito, et al., “Proposal of Three Principles for Recovery,” published in *Japan Echo* which is a set of recommendation by 113 economists. It is available in http://www.tito.e.u-tokyo.ac.jp/j_fukkou2011.htm

¹⁹ Estimates widely vary depending on how much coverage one may consider. The 30 trillion estimate includes compensation for those households affected in the 20-30km radius; businesses that were affected by the accident; and costs to decommission the reactors at the Fukushima Daiichi. See a Japanese article in *Diamond*: <http://diamond.jp/articles/-/12436>

under this scenario as the series named “sustainable”. Note that the ratio is well below 100%, which suggests the private savings ceiling is never reached under the “sustainable” policy. To see the impact of the Reconstruction Bonds, the series “With Reconstruction Expenses” gives the path of the debt to MaxDebt ratio when the government expenditure is increased by 2.4% of GDP in 2011 and 2.6% of GDP in 2012. The ratio still stays well under 100%. Thus, we confirm that additional debt of a few percentage of GDP does not change the sustainability condition very much.

<Figure 18>

An important assumption here is that the tax increase proceeds as it has been expected. If the tax increase is delayed during the reconstruction period, the debt dynamics can change substantially. The debt path “With Reconstruction and Delayed Tax Increase” in Figure 18 shows what happens if the start of the tax increase was delayed by five years from 2014 to 2019 (in addition to increased bond issues during the three years). The debt to MaxDebt ratio comes dangerously close to 100% in the early 2020s.

Figure 19 repeats the same exercise by adding 1% of GDP as additional expenses each year from 2012 to 2015 to clean up the aftermath of the nuclear accident and to compensate for victims. With these additional costs, the delay becomes critical. In 2023, the debt exceeds the MaxDebt even with the tax policy that used to be sufficient to achieve the sustainability.

Thus, how to finance the reconstruction can be important. It could become either the last straw to large debts that break the back of the Japanese economy or the first step toward the right direction.

If the government finances all the additional spending by just adding to the debt and delays the necessary tax increases, it may shutter the confidence that the government debt is stabilized before it is too late. The year 2012 is expected to be a boom year supported by the reconstruction demand. The people will reason that if the government was not willing to raise taxes in a boom year, it may never raise taxes. As we argued above, the loss of this confidence can trigger a crisis.

Alternatively, if the government starts the necessary fiscal consolidation process by financing a substantial portion of the reconstruction expenditure in the form of taxes, this will boost the confidence that the government is serious about the long-term fiscal health and equitable intergenerational burden sharing. Then, Japan may have a chance of avoiding a fiscal crisis.

6. Consequences of a crisis

How the crisis unfolds will somewhat depend on what triggers the crisis. If the crisis is started by a fundamental trigger such as investment boom and strong growth, this will raise the opportunity cost of holding JGBs, reduce the demand for JGB, and result in higher yield for JGB. If the crisis is triggered by the expected shortage of domestic financial assets to absorb the debt, then the market starts requiring higher yield for JGB. Finally, the crisis may be triggered by changes in the expectations. Unexpected increase in new JGB issues to fill a major gap in government revenues and expenditures, for example, can cause such an expectation change. The public suddenly realizes that the government debt is not sustainable and may start asking for higher yield to compensate for the risk.

Since all these scenarios involve higher interest rates on new issues of JGBs, let us start out by tracing the expected impacts of higher government borrowing rate on the Japanese economy and the rest of the world.

First, the rise in JGB yields will raise other interest rates, such as mortgage rate and corporate bond rate, and increase the cost of fund for households, firms and banks. This will reduce the consumption of non-durables and durables at least temporarily, and hurt the corporate investment. The magnitude of the impacts on consumption and investment, however, may not be large. Muellbauer and Murata (2011), for example, find that the consumption in Japan did not increase at all when the interest rate fell during the 1990s and the 2000s. They even find the consumption responded positively to a rise in the interest rate in some specifications. Similarly, many large corporations have substantial corporate saving (internal funds) and do not feel constrained by cost of funds. Small and medium firms that have been helped by the low interest rate environment and forgiving lending attitude by banks under the Act to Facilitate Financing for SMEs may suffer from higher cost of fund.

The impact on financial institutions, however, will be large, because the majority of long-term government bonds are held by Japanese banks and insurance companies. When the interest rate rises, they suffer the valuation losses. For example, Japanese banks collectively hold about 142 trillion yen of the central and local government bonds as of the end of March 2010. This is compared to 32% of the total bank loans. The interest rate risk is large, too. According to Bank of Japan (2010), 100 basis points increase in JGB yields is estimated to cause about 4.7 trillion yen of losses for Japanese banks collectively (BOJ 2010, Chart 3-2-3, p.39). This is about 11.7% of the Tier I capital at the end of March 2010 and about twice as much as the income before tax for the accounting year ending on March 31, 2010. The interest rate risk as of March 2008 was estimated to be around 3.5 trillion yen. This may not reduce the regulatory capital immediately because the banks are not required to mark all the securities to the market, but many will none the less tighten their credit provision.

Second, the impact of higher JGB yield on the yen depends on a particular scenario. If the high rate is a result of a strong economy, then it would apply pressure for the yen to appreciate, holding other factors, including the future equilibrium exchange rate, constant. However, if the

high rate is a result of capital flight, then it will cause yen depreciation. As we will discuss below, the crisis is likely to include high inflation that would depreciate the yen in the equilibrium.

An extreme case of the high interest rate is the scenario where the Japanese government fails to roll over the debt at any interest rate. Such a liquidity crisis will have substantial impacts on the economy.

Fiscal crisis may be accompanied by “fiscal” inflation, which adjusts the market value of government debt to its fundamental level. Cochrane (2010) describes how such inflation will look like for the U.S. We apply his approach to Japan and consider what kind of inflation we should expect when the fiscal crisis happens.

Cochrane (2010) starts with the following valuation equation for nominal government debt (which is more popularly known as the government budget constraint) when there are long-term government bonds with different maturities.

$$\int_{j=0}^{\infty} e^{-rj} E_t \left[\frac{1}{P_{t+j}} \right] B_t^{(j)} dj = \int_{\tau=0}^{\infty} e^{-r\tau} E_t [s_{t+\tau}] d\tau \quad (2)$$

Here, r is the constant real interest rate, $B_t^{(j)}$ is the (nominal) government bond that matures in j years, P_t is the price level at time t , s_t is the primary surplus at time t , and E_t is the conditional expectation operator given the information set at time t . The equation implies when the presented value of the future primary surpluses change, the real value of government debt must be changed by changes in the price levels.

For example, when a fiscal crisis is caused by a change in the expectation of the future fiscal policy, the right hand side of the equation changes accordingly, and this causes the expected price level path on the left hand side to change. As Cochrane (2010) shows, for a given change of Δ (measured in the percentage term) of the present discount value of the future primary surpluses (right hand side of the equation), there are multiple path of $\{P_{t+j}\}$ that are consistent with the equation. Every such path satisfies:

$$\int_{j=0}^{\infty} \left(\frac{P_{t+j}^0}{P_{t+j}} - 1 \right) W_t^{(j)} dj = \Delta, \quad (2)$$

where P_{t+j}^0 is the expected price level just before the crisis, $W_t^{(j)}$ is the fraction of the market value of government debt with maturity j . Note that the price level path $\{P_{t+j}\}$ that satisfies the equation (9) is not unique. For example, an immediate increase of the price level at time t by Δ followed by no further price level changes would be sufficient. There are also other paths where the inflation of less than Δ continues for several years.

We use this framework to get an idea about how much inflation we should expect to see when a fiscal crisis happens in Japan. For this analysis, we assume the constant real interest rate of 1.5%. As the benchmark case, let us assume the market expectation of the future fiscal policy before the crisis is given by the sustainable policy under the interest rate assumption R2 in Figure 13. Now suppose the reconstruction efforts add additional deficit of 2.4% of GDP and 2.6% of GDP for 2011 and 2012 respectively, and the market expects that the start of the tax increase will be delayed by five years to 2015. For this expectation change, Δ (the percentage change in the present discount value of the future surpluses) turns out to be about -20%.

If the price level jumps by 20%, the necessary adjustment is complete. More moderate inflation can last longer to achieve the adjustment as well. For example, let us assume that the inflation starts immediately after the crisis and stays constant till all the government bonds currently outstanding are paid off. The fraction of the market value of government debt with each maturity is approximated using the data on the distribution of government bonds outstanding by remaining maturity reported in MOF (2011, p. 101). We assume $P_{t+j}^0 = P_t$ for all j . Given the current maturity structure, we find the expected inflation of 4.3% per year for the next 20 some years will adjust the market value of government debt to the new fundamental level.

Bank of Japan could help rolling over the government debt by purchasing JGBs directly from the government. The Bank of Japan, or any other central bank with legal independence, has been clear that they do not endorse such a monetization policy because it undermines the fiscal discipline. However, at the time of crisis, the central bank may find it as the option that is least destructive to the financial system. If such money financing is used to respond to the liquidity crisis, this will create high inflation.

The prospect for high inflation will depreciate yen. This will partially stimulate the economy via export boom, provided that Japan does not suffer a major banking crisis at the same time.

An unexpected inflation will result in redistribution of wealth from the lenders to the borrowers. This is also redistribution from the old generations to the young generations, since the older generation has much higher financial assets whose value might decline, or would not rise at the same pace with inflation rate. This may not have such detrimental impacts on the economy, since many who participate in production and innovation (corporations and entrepreneurs) are borrowers rather than lenders. This is also in the direction toward correcting the intergenerational imbalance that currently exists in the public transfers. For example, Keen, Pradhan, Kang, and de Mooij (2011) find “those over age 60 in 2005 are expected to receive about 100 million yen more in *net* social benefits over their lifetime than are those not yet born” (p.16).

If the short-term interest rate rises sharply, along with the long-term bond rate, then this would cause another serious problem. The foreign exchange special account is where most of

foreign reserves are held. On the asset side of the special account, US Treasuries are held as international foreign reserves; and on the liability side of the special account, short-term government securities (FBs) are issued to the market. In the last 20 years, the interest rate of the US treasuries exceeded the short-term yen interest rate. However, if the yen interest rate becomes higher than the US interest rate, the difference incurs the cash flow from the regular budget to the special account. Ito (2003) showed how much profits the Japanese authority made from the interest rate differential between the U.S. and Japan. The size of FBs outstanding is about 110 trillion yen. If the yen interest rate becomes higher than the dollar interest rate by 2 percentage point, it would require 2 trillion yen of interest income subsidy from the general account to the special account. This will be quasi-fiscal cost.

If the rise in the interest rate rise is accompanied by a strong economy and yen appreciation, then selling foreign reserves to help reduce the cost of maintaining the large loss-incurring position is counterproductive, since the intervention to sell US treasuries and convert them back to Japanese yen would likely to appreciate that yen, and hurting the economy. However, if the interest hike is caused by capital flight, then the yen will be depreciating. Then intervention to prevent the sharp depreciation from turning into a currency crisis would have both trading realized gains (sell the dollar high) and reducing the balance of cash-flow loss making positions.

7. Managing the crisis

The Japanese debt crisis, when it happens, is likely to have serious impacts on the Japanese economy and the rest of the world. This section considers what can be done to manage the crisis so that the damage to the economy can be minimized and to help the recovery process.

To manage the crisis, we need to identify the trigger of the crisis. The increases in the interest rate may be caused by good news, bad news or a sudden shift in expectation. First, when the economy becomes strong and regains vitality, the economic growth rate will go up and the interest rate will increase. This is certainly good news for the government, which can expect large tax revenues. However, the increase of the interest rate may outpace the economic growth rate. Then we will see the budget deficit actually worsen as the interest payments on government bonds increase. Thus, too good news may end up in triggering a crisis.

Second, a bad news on tax revenues or expenditures may trigger a crisis. Once portfolio investors in financial institutions see the bad news, they interpret that to suggest the amount of government bonds is likely to come dangerously close to the ceiling of private financial assets. They will raise the required risk premium to hold additional government bonds.

Third, expectation about a future course of fiscal policy could change suddenly. Suppose that investors had believed that the government would take actions of raising taxes and cutting

unnecessary expenditures in time for regaining sustainability. The expectation shift could be triggered by unexpected outlays (response to a natural disaster, for example) that would exceed the ability to pay by the government. Another possibility is that the Diet votes down a serious fiscal reform bill, leaving the huge hole in the budget for some time to come. Investors will react negatively by demanding a large risk premium.

Once the crisis starts, the policy has to shift to crisis management. As we saw above, the crisis is likely to impair the financial system and slow down consumption and investment. Thus, the government faces a difficult tradeoff. If it tries to achieve a fiscal balance by reducing the expenditures and raising the taxes, the economy will sink further into a recession. If it intervenes by expansionary fiscal policy and financial support for the financial system, that would make the fiscal crisis more serious. This is a well-known dilemma for the government that is hit by debt crisis.

Given negative consequences of fiscal austerity on the economy, use of *de facto*, if not outright, monetization of bonds becomes more attractive. The problem here, however, is money financing leads to higher inflation, which further pushes up the interest rate on the government borrowing and exacerbate the fiscal problem. *De facto* monetization would be to buy a large amount of government bonds in the market to keep the market rate down, while outright monetization would be to purchase new government bonds issued either to roll over the maturing bonds or to finance the current budget deficit.

At the height of the crisis, investors may refuse to agree to rollovers or to purchase newly issued government bonds. Then bond issues are undersubscribed. At that point, the government would face with only two options, *de facto* default or purchase of government bonds to make up for the amount of under-subscription by the central bank.

If the central bank refuses to monetize bonds, and if market participants refuses to purchase rollover and new issues of bonds, then the government may be forced to default on interest payments and/or redeeming maturing bonds. However, default, and possibly hair cut on the outstanding amount will not lessen the burden of the government or help economic recovery. Default of government bonds would not help Japan very much, unlike the countries whose debts are held by foreign residents, because Japanese government debt holders are predominantly Japanese residents, primarily Japanese financial institutions and to lesser extent households and corporations. Outright (partial) default would just reduce the value of financial assets held by the residents and hurt the economy. The financial institutions would be further impaired. If the government is to help financial institutions by injecting capital, that would need issuing more debts. If not helped by the government, the banking system will be destroyed, and the economy will further fall into a crisis. Rational depositors will flee from deposits in Japanese banks to cash, foreign assets or gold.

It is also worth noting one time default does not fix the fiscal problem. The majority part of the problem for Japan (similarly to other developed countries) is caused by the future government expenditures that are expected to exceed the future tax revenues. Default of the existing debt does not solve this problem coming from the future deficits. Crisis would continue for many years, unless future liabilities are reduced somehow.

Thus, managing the debt crisis must include a credible plan to reduce the future deficits as well as closing the current revenue-expenditure gap. The typical policy of this kind is to reduce social security retirement benefits, so that subsidies from tax revenue would be reduced. Another policy would be to raise the consumption tax (VAT) rate, which would raise tax revenues without harming incentives to work and incentive to employ more investment in Japan. The package looks like the same as the policy aimed at avoiding the crisis to start with. After the crisis, the correct policy becomes difficult to adopt because the government is forced to act on it in the middle of recession.

An absolute nightmare scenario at that point would be that the tax rate quickly approaches the point where further tax rate increase would not raise total revenues, as many seek to avoid the taxation. The tax revenues would be zero at both zero tax rate and the 100% tax rate (the activities that generate tax liabilities would stop or go underground). There would be a tax rate that maximizes the revenue. This is the classical Laffer curve. If the tax rate is already at the top of the Laffer curve, tax rate hike would become undesirable. Tax revenues cannot increase and the options for the government will be extremely limited.

It may be helpful if an international organization such as IMF can provide financial help so that the government can buy time. The most recent European sovereign debt crisis offers some guidance to what the IMF can offer to Japan, if Japan falls into a fiscal crisis. The IMF programs tend to include fiscal austerity (tax increase and expenditure cut) and privatization (selling government real assets) in order to help the immediate need for cash. The IMF is likely to insist on structural reform to increase the growth rate in order to reduce a risk of severe recession.

8. Roles of IMF

The IMF surveillance of the advanced countries is often said to be less effective.²⁰ The large countries in quota can just ignore what the Fund advice on that country, without fear of being sanctioned or shamed in any form. On the contrary, the large countries can express unhappiness about a report and advice in the Executive Board meeting. Thus, the Fund tends to be hesitant to issue strongly-worded warnings to advanced countries. This was also evident in missing opportunities to warn the risks of financial vulnerabilities that led to the global financial crisis of 2007-2009: "It finds that the IMF provided few clear warnings about the risks and vulnerabilities

²⁰ See Independent Evaluation Office of the IMF (2009), especially its companion paper, "IMF interaction with Advanced countries." , "IMF Interaction with Member Countries," 2009

associated with the impending crisis before its outbreak.” (Independent Evaluation Office of the IMF, 2011, p.1).

It is important for IMF to warn Japan over the high probability of the coming fiscal crisis, unless fiscal consolidation starts very soon. This should be done with careful preparation of data, discussion of risk scenarios, and recommendations. The analysis and recommendation has to be tailored for Japan, since its fiscal situation is quite different from European sovereign debt crisis. If the consolidation starts immediately there is a chance to avoid a crisis, but if the current fiscal policy continues, a crisis will be inevitable. The early warning is a key, since time is running out quickly.

The different options—moderate inflation, tax increases, expenditure cut—should be presented with pros and cons. There is a tendency on the part of the government to seek a painless way out of the difficulty, in this case a hope for accelerated growth without raising taxes or cutting expenditures. If it was achieved, that would be the best. However, the Fund should play a harsh arbiter to point out that probability that Japan achieves high enough growth to solve the problem is extremely low. Fiscal policy should be prudent: it should prepare for the worst.

In order to issue a serious early warning, the special team should be assembled involving different departments, RES, MCM, FAD in addition to APD, and do thorough research. Article IV mission should be fortified with knowledge of the economy, political reality and economic theory.

The early warning should include credible scare stories and comparison of national welfare under different scenarios. As this paper finds, the earlier the fiscal consolidation starts, the better off will be the future generation.

Of course, there is possibility that the warning is ignored, and a crisis happens. In that case, the Fund should cooperate with the Japanese authorities to minimize the damage to the economy and to minimize spillovers to other countries. Since foreign ownership is low for JGB, there may not be direct hit to financial institutions outside Japan. But, there will be other channels of contagion. Given the size of the economy, the trade channel will be important. Many trading partners will suffer. It is also likely to see the Japanese yen to depreciate due to the crisis, which would help Japan’s recovery from the crisis by encouraging exports. A recovery through exports due to depreciation is a normal reaction. The process of recovery should be clearly explained by the Fund in order to avoid an unnecessary and disruptive competitive depreciation.

9. Concluding remarks

This paper started by analyzing likely trajectories of the Japanese fiscal situation. It was shown that, the government debt would hit the ceiling of private sector financial assets soon if no

adjustments are made. Rollovers and new issues of government bonds will become impossible. Under different scenarios on the growth rate and the interest rate, we estimated how quickly Japan is moving toward this absolute upper-bound for the government debt. If the current fiscal stance continues, the limit would be reached in the late 2020s. In this limiting case, all the private sector financial assets are used to finance the government debt with nothing left for (domestic) credit for the corporate sector. As such, the absolute upper-bound will not be reached in reality. As soon as the market finds out that Japan is likely to be on this collision course, the government will have difficulty rolling over the debt and a crisis will happen. We also showed that it is not too late to avoid the crisis, if the government embarks on a substantial fiscal consolidation (around 8 percentage points in tax payment to GDP ratio).

A crisis will happen if the government ignores the current fiscal situation or fails to act. Then, the crisis forces the government to choose from two options. First, the Japanese government may default on JGBs. Second, the Bank of Japan may monetize debts. The first option would not have much benefit because bond holders are almost all domestic. Monetization is the second option. Although that may result in high inflation, monetization may be the least disruptive scenario.

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Appendix 1. Estimation of aggregate saving rate: 2010-2050

Let s_{it} be the saving per capita in year t for the generation who were born at year i . The aggregate saving in year t is given by:

$$S_t = \sum_{i=0}^t N_{it} s_{it} ,$$

where N_{it} is the number of people who were born at year i . Thus, the aggregate saving to GDP ratio is:

$$\frac{S_t}{Y_t} = \frac{\sum_{i=0}^t \frac{N_{it}}{N_t} s_{it}}{Y_t / N_t} = \sum_{i=0}^t \frac{N_{it}}{N_t} \theta_{it} , \text{ where } \theta_{it} \equiv \frac{s_{it}}{Y_t / N_t}$$

Thus, the aggregate saving rate is the weighted average of the generational saving rate measured as the saving per capita divided by GDP per capita, which we denote as θ_{it} . If we have θ_{it} and N_{it}/N_t , we can calculate the aggregate saving rate for year t .

We use the data from *Family Income and Expenditure Survey* to calculate the saving rate for each age bracket. The survey reports the income and expenditure for 11 age brackets according to the age of the head of the household: 24 or younger, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70 or older. The survey covers a sample of households with two or more members. Thus the survey does not cover single households. The income and expenditure items are collected for the sample of households whose heads are employees, but only expenditure items are collected for all other households, which include not only retirees but also self-employed. Using the tabulation for all the households and another tabulation for the employee households only, we construct the saving rate in the following way.

First, we estimate the number of households headed by retirees and the number of households headed by non-employees (self-employed, farmers, etc.). We have the following information from the survey for each age bracket.

- N_T : Total number of all types of households in the sample
- H_T : Average number of household members for all types of households
- W_T : Average number of household members who earn income for all types of households
- N_E : Total number of employee households in the sample
- H_E : Average number of household members for employee households
- W_E : Average number of household members who earn income for employee households

Let N_R be the number of retiree households and N_S be the number of the other households (self-employed and others). Assuming the proportion of the household members who earn income is

the same for both employee households and other households, but zero for retiree households, we know:

$$(N_E + N_S) \frac{W_E}{H_E} = N_T \frac{W_T}{H_T}, \text{ and}$$

$$N_E + N_S + N_R = N_T$$

By solving these, we can calculate N_S and N_R .

Next, we calculate the per capita income for each generation by multiplying the average household income for employee households by $N_E + N_S$. The assumption here is that the average income is the same for both employee households and other non-retiree households. The consumption for each generation is calculated by multiplying the average consumption for all households by the number of all sample households.

Finally, the saving is calculated by subtracting consumption from income for each age bracket. We estimate the number of people covered by the survey by multiplying the number of all households and the average number of household members. The saving per capita is calculated by dividing the saving by this estimated number of people in the survey. The saving rate relative to GDP per capita is calculated by dividing the saving for each age bracket by the average income per capita. Figure A1 shows the saving rate for each age bracket calculated in this way for each year from 2000 to 2010. The number for each age bracket did not change very much over the decade. We take the average saving rate for each age bracket over 2000-2010 interval and use that as θ_{it} for $t \in [2010, 2050]$.

<Figure A1>

The population weight for each generation is calculated from the mid-point projection by the National Institute of Population and Social Security Research (IPSS). Figure A2 shows the population distribution for 2010, 2020, 2030, 2040, and 2050. We can see that the Japanese population is expected to age rapidly.

<Figure A2>

Appendix 2. A simple overlapping generation model with an unexpected shift in the population growth rate

We consider a pure endowment economy. A consumer lives for two periods. The consumer receives endowment W when young, and nothing when old. The amount of endowment does not change over time (no economic growth). The consumer has an access to the storage technology that transforms one unit of endowment this period to one unit of consumption goods in the next period.

Let $C(t,1)$ and $C(t,2)$ denote the consumption when young and when old respectively of a consumer who was born at the beginning of the period t . The lifetime utility function is assumed to be $U = u(C(t,1)) + u(C(t,2))$. The function is concave and there is no time preference: $u' > 0$, $u'' < 0$. Population of generation j , denoted by $P(j)$, is assumed to grow at rate g : $P(j+1) = (1+g)P(j)$.

(1) No intergenerational transfer

Without any government pension program, one can show that the following is the equilibrium consumption pattern.

$$C(t,1) = C(t,2) = W/2 \text{ for all } t.$$

The consumer consumes one-half in the first period, saves the rest and consumes it in the second period. The equilibrium lifetime utility is:

$$U^* = u(W/2) + u(W/2)$$

(2) Government social security program

The government imposes the tax τ on the endowment to the young with a promise to pay the social security benefit $(1+r)\tau$ when they retire. The τ can be considered as either social security tax or the offer of government bonds. The system is Pay-as-you-go (PAYGO): all the tax revenues from (or bond sales to) generation t will be distributed to the retired generation $t-1$. This government budget constraint implies $(1+g)\tau = (1+r)\tau$, or $r=g$.

The budget constraint for an individual consumer who was born at the beginning of the period t is:

$$C(t, 1) + C(t, 2) = (1 - \tau)W + (1+g) \tau W$$

$$= (1 + \tau g) W$$

$$\text{Saving is } S(t, 1) = (1 - \tau)W - C(t, 1)$$

The optimal consumption pattern for the individual consumer is calculated by maximizing the lifetime utility with respect to the consumption pattern subject to the following two constraints.

$$C(t, 1) + C(t, 2) = (1 + \tau g) W \quad (\text{Individual budget constraint})$$

$C(t, 1) \leq (1 - \tau)W$ (Financial constraint, an individual cannot borrow against the future government transfer)

Given τ and g , the optimal individual consumption pattern is:

$$(A) C(t, 1) = C(t, 2) = ((1 + \tau g)W)/2, \quad \text{if } (1 + \tau g)/2 \leq (1 - \tau);$$

$$(B) C(t, 1) = (1 - \tau)W \text{ and } C(t, 2) = (1 + r) \tau W, \quad \text{if } (1 + \tau g)/2 > (1 - \tau)$$

So, given g , the complete consumption smoothing (A) is possible if and only if $\tau \leq 1/(2 + g)$. If τ is too large, an individual ends up spending more when old than when young, but the consumer cannot borrow against the future transfer. There is a resource constraint for the economy as a whole: the government cannot collect more than the endowment. Thus, $\tau \leq 1$.

Note that the lifetime wealth for an individual consumer is increasing in τ . This implies that higher τ increases the lifetime utility as long as it is not too large to prevent complete consumption smoothing. Thus, if the government wants to maximize the lifetime utility of every generation, it is optimal to set $\tau = 1/(2+g)$.

Numerical Example:

Suppose $\tau = 0.3$, $g = r = 0.5$. Disposable income $(1 - \tau)W = 0.7W$. The equilibrium consumption is $C(t, 1) = C(t, 2) = 0.575W$, and private saving is $(1 - \tau)W - C(t, 1) = 0.125W$. This can be sustained forever, and every generation is better off than an original situation of no social security ($C(t, 1) = C(t, 2) = 0.5W$).

(3) Social security going wrong when population stops growing

To get an idea about what happens when the population growth rate declines as in Japan and the government does not adjust the social security system that was introduced by assuming high population growth, suppose that at generation $t = T$, the population growth suddenly stops:

$g_0 > 0$ for $t = 0, 1, 2, \dots, T$, and $P(t) = (1+g)P(t-1)$,

$g_1 = 0$, for $t = T+1, T+2, \dots$; that is, the $P(t) = P(t-1) = P(T)$.

At time T , the government keeps the promise to generation $T-1$, to pay $r=g_0$ by adjusting τ for generation T : τ_0 for $t = 0, 1, 2, \dots, T$. Then, the government has to adjust the tax rate on generation T to

$$\tau_1 = (1+g_0) \tau_0,$$

with a promise that they will also receive $\tau_1(1+g_0)$. To do that, the government has to adjust the tax rate on generation $T+1$ to:

$$\tau_2 = (1+g_0) \tau_1 = (1+g_0)^2 \tau_0$$

The tax rate has to continue increasing to keep the promise, until $\tau > 1$, hitting the wall of the resource constraint.

Numerical Example:

We start from the sustainable example that we calculated above. $\tau = 0.3$, $g = 0.5$. Disposable income $(1-\tau)W = 0.7W$. The equilibrium consumption is $C(t,1) = C(t,2) = 0.575W$ and private saving is $(1-\tau)W - C(t,1) = 0.125W$.

Now at $T+1$, population growth goes to zero, but the government will keep $r=0.5$. The tax rate for generation $T+1$ has to be:

$$\tau_1 = 0.3 \times (1 + 0.5) = 0.45.$$

The rate continues to increase to keep the untenable promise to the previous generation.

$$\tau_2 = 0.45 \times (1 + 0.5) = 0.675$$

$$\tau_3 = 0.675 \times (1 + 0.5) > 1$$

And the social security system will become absolutely unsustainable.

Fig 1. Gross Debt-GDP ratio

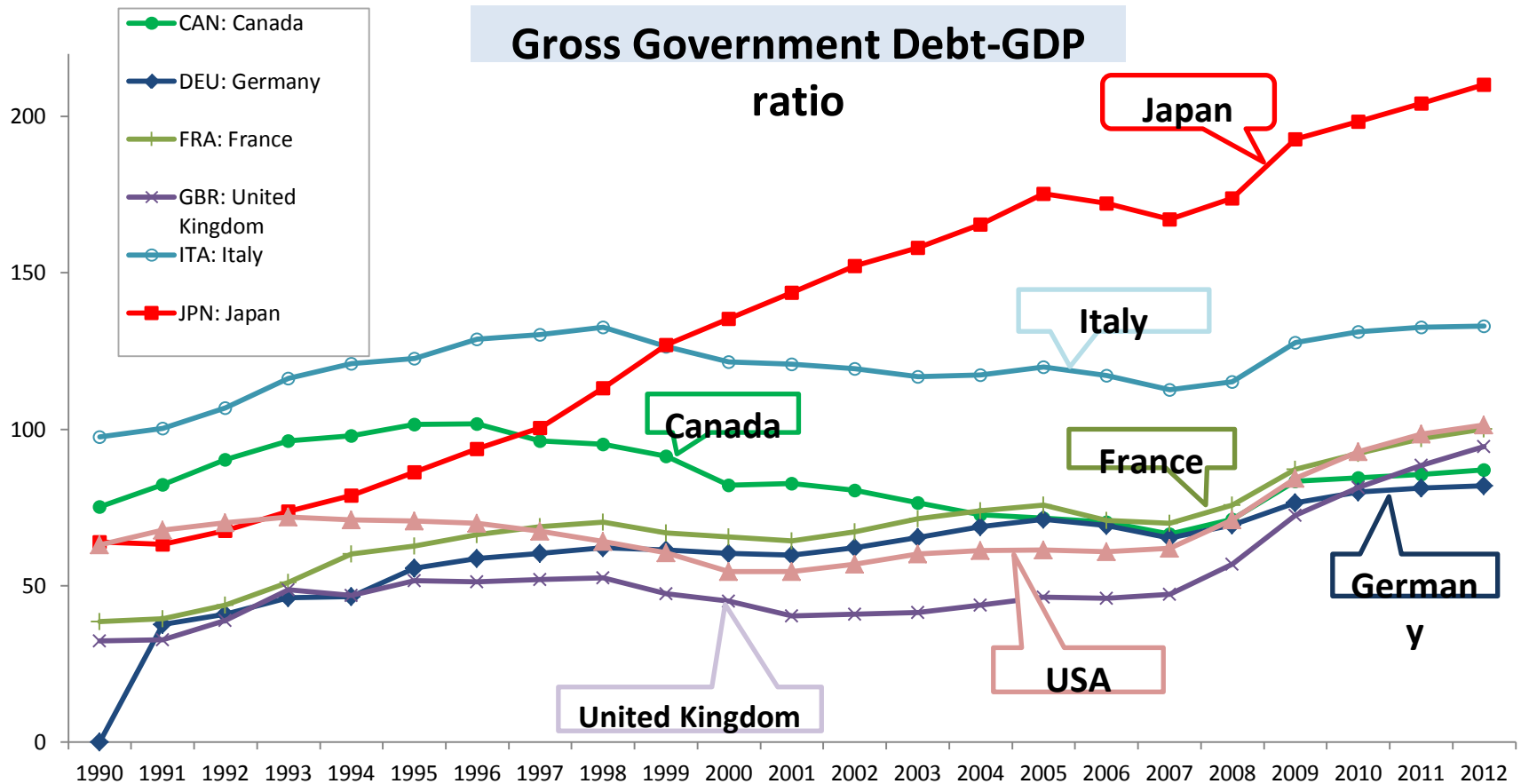


Fig. 2. Net Debt-GDP ratio

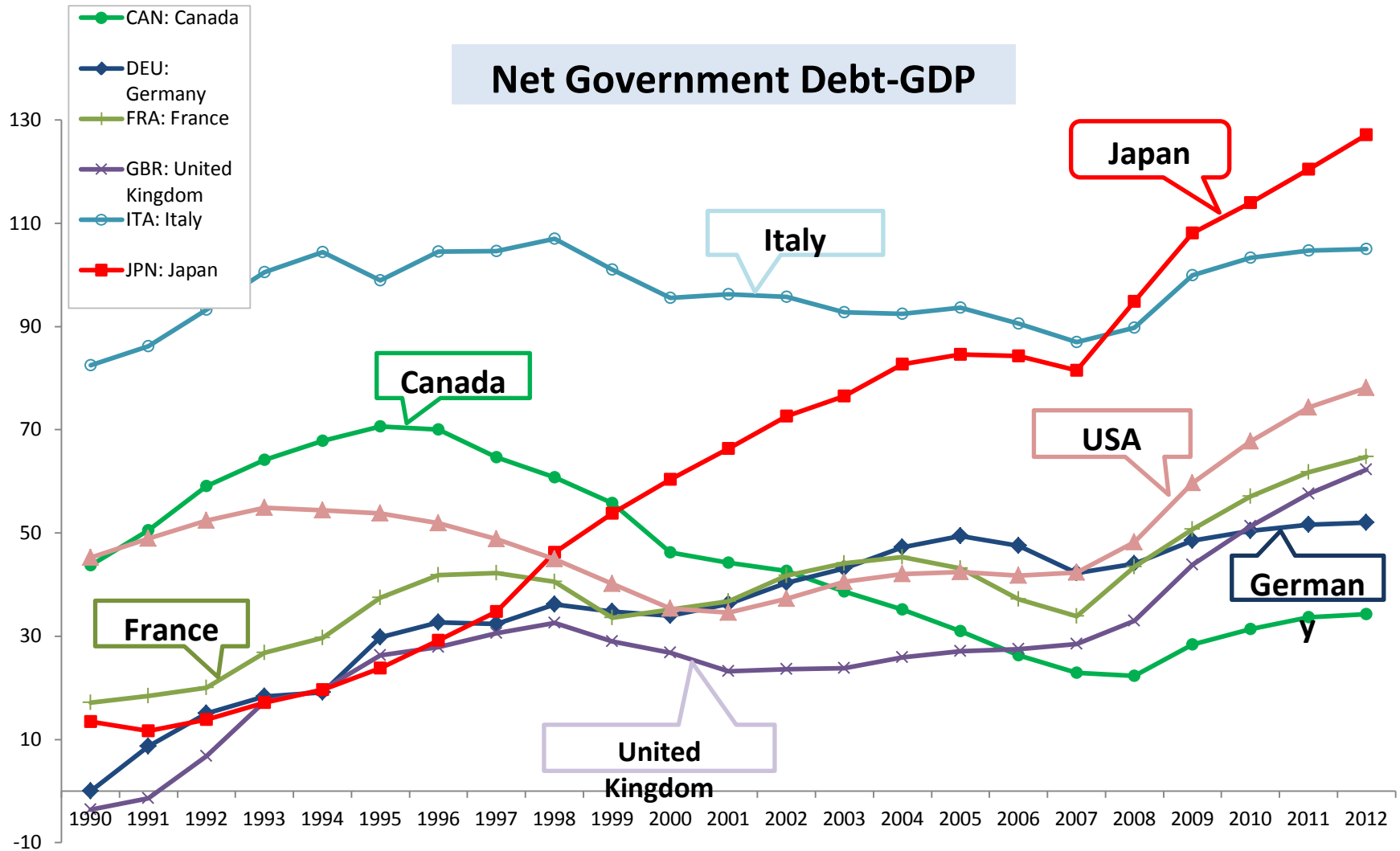


Table 1. Different concepts of Government liabilities

National Liabilities: JGB, Borrowings and Guarantees as reported to IMF			National and Local Government Longterm liability (to be redeemed by mainly future			General Government Gross Liability (National Account concept)		
At the end of March 2011	(Trillion yen)	ratio to GDP	Forecast for March 2012	(Trillion yen)	ratio to GDP	End of March 2000	(Trillion yen)	ratio to GDP
Longterm Liability of National Government			Longterm Liability of National Government			National Government Liabilities		
JGB	636.3		JGB	668.0		JGB (+)	559	
Zaito Bonds	118.2		Zaito Bonds (**)	Not included		Zaito Bonds	Not included	
Others(*)	59.1		Others (*)	24.0		Others (*)	63	
Financing Bills (**)	110.8		Financing Bills (**)	Not included		Financing Bills and Discount Bonds(+)	149	
Government guarantee	44.7		Government Guarantee	Not included		Government Guarantee (**)	54	
Total	969.1	202%	Local, Long-term liabil	200.0		Local liabilities	183	
GDP(2010)	479.0		Total	892.0	186%	Liabilities in Social Security Fund	15	
						Total	1,023	214%
(Source) The Ministry of Finance, homepage http://www.mof.go.jp/jgbs/reference/gbb/data.htm			(Source) The Ministry of Finance, homepage http://www.mof.go.jp/jgbs/reference/gbb/data.htm			(Source) Cabinet Office, Economic and Social Research Institute, http://www.esri.cao.go.jp/jp/sna/kakuhou/kekka/h21_kaku/h21_kaku_top.html#c1		
(*) Others includes government bonds that are issues as capital of public entities (Kofu Kokusai) and borrowings			(*) Borrowings for accounts to be distributed to local governments (Kofu tax), about 34 trillion yen, is categorized in the local liabilities instead of National government liabilities			(+) Short-term discount bonds are excluded from JGB and included in Financing bills and discount bonds		
(**) Financing Bills are issued primarily to fund the foreign reserves that are held in the special account of the government. They are rolled over every 3 months, and considered to be short-term liabilities that have assets, that is foreign reserves, to match the liabilities. FBs should be excluded from long-term liabilities, and from "net" government liabilities.			(**) Zaito bonds are not included because they are in theory repaid from income from government investment; Financing bills are not included because they are short-term, and also they are backed by assets (foreign reserves); and gouarantee is not included because they are only contingent liabilities.			(**) Government guarantee includes liabilities at the public agencies (Dokuritsu Gyosei Hojin)		

Table 2. JGB holders

	2005 ^{March} h		2006March		2007March		2008March		2009 ^{March} h		2010March		2010Dec	
	tril. Yen	(%)	tril. Yen	(%)	tril. Yen	(%)	tril. Yen	(%)	tril. Yen	(%)	tril. Yen	(%)	tril. Yen	(%)
General Government	2	0.3%	7.4	1.1%	3.6	0.5%	2.5	0.4%	2.5	0.4%	1.9	0.3%	2.3	0.3%
Public Pension	57.6	9.0%	61.5	9.2%	68.3	10.1%	78.1	11.2%	80.1	11.8%	76.3	11.2%	74.8	10.3%
FILP	48.8	7.6%	39.4	5.9%	23.9	3.6%	10.9	1.6%	1.2	0.2%	0.8	0.1%	0.8	0.1%
Postal Saving	109.7	17.1%	126.2	18.9%	140	20.8%	—	—	—	—	—	—	—	—
Postal Insurance	55.1	8.6%	57	8.5%	61	9.1%	—	—	—	—	—	—	—	—
Bank of Japan	92.1	14.3%	86.7	13.0%	71	10.6%	63.7	9.2%	55.9	8.2%	51.2	7.5%	58.1	8.0%
Private Financial Institutions	218.6	34.1%	218.5	32.7%	216.1	32.1%	439.7	63.3%	441.6	64.9%	464.5	68.1%	502.6	69.1%
banks	111.6	17.4%	114.5	17.2%	101.6	15.1%	246.4	35.5%	246.2	36.2%	258.7	37.9%	282.7	38.9%
insurance	54.8	8.5%	58.4	8.7%	61.8	9.2%	129.2	18.6%	135.1	19.8%	139.9	20.5%	147	20.2%
private pension funds	21.3	3.3%	24	3.6%	26.2	3.9%	26.8	3.9%	25.6	3.8%	28	4.1%	28.2	3.9%
others	31	4.8%	21.6	3.2%	26.5	3.9%	37.3	5.4%	34.7	5.1%	37.9	5.6%	44.7	6.1%
Overseas	26.4	4.1%	30.2	4.5%	40.2	6.0%	47.4	6.8%	43.9	6.5%	31.6	4.6%	35.1	4.8%
Household	21.8	3.4%	28	4.2%	33.4	5.0%	36.3	5.2%	36	5.3%	34.4	5.0%	33	4.5%
Others	9.6	1.5%	12.4	1.9%	15.2	2.3%	16.5	2.4%	19.6	2.9%	21.4	3.1%	20.5	2.8%
Total	641.8	100.0%	667.3	100.0%	672.7	100.0%	695	100.0%	680.9	100.0%	682.1	100.0%	727.1	100.0%

Figure 3. JGB stock and yield

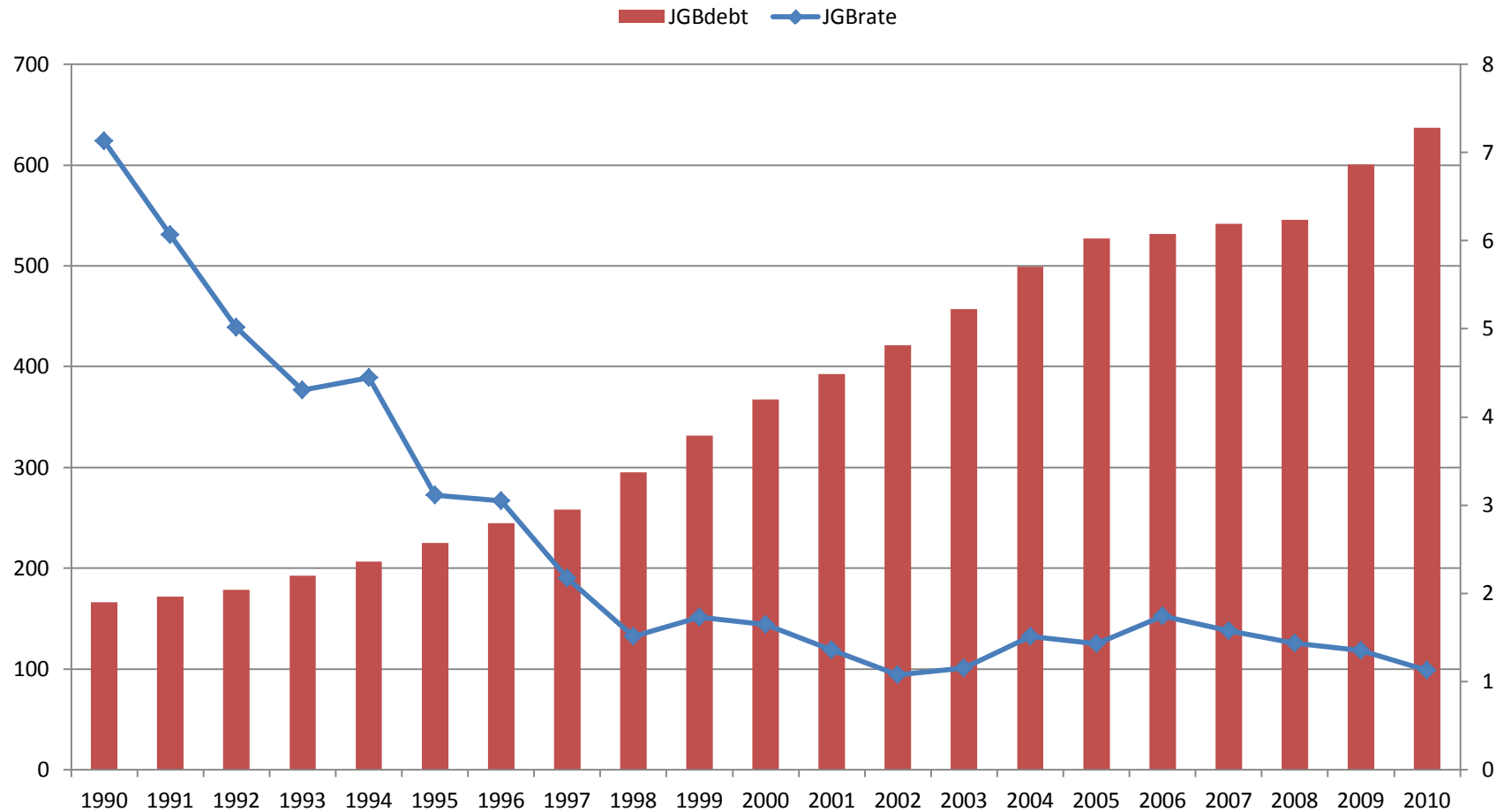


Table 3: Determinants of the JGB yield

Variable	Gross debt including FILP	JGB held by Bank of Japan	Net financial wealth held by household and corporate sectors	Share of foreign holdings of JGBs	R square
Estimate	0.02	0.01	-0.02	0.11	0.38
t-stat	(3.52)***	(0.36)	(-3.37)***	(2.06)**	
<p>Tokuoka (2010) Table II.6</p> <p>Notes: FILP is the government investment program, which used to be in the special account that were funded by Postal Bank surplus funds, and later became a part of government bond issues</p>					

Figure 4. Aggregate Saving to GDP Ratio: 2010-2050

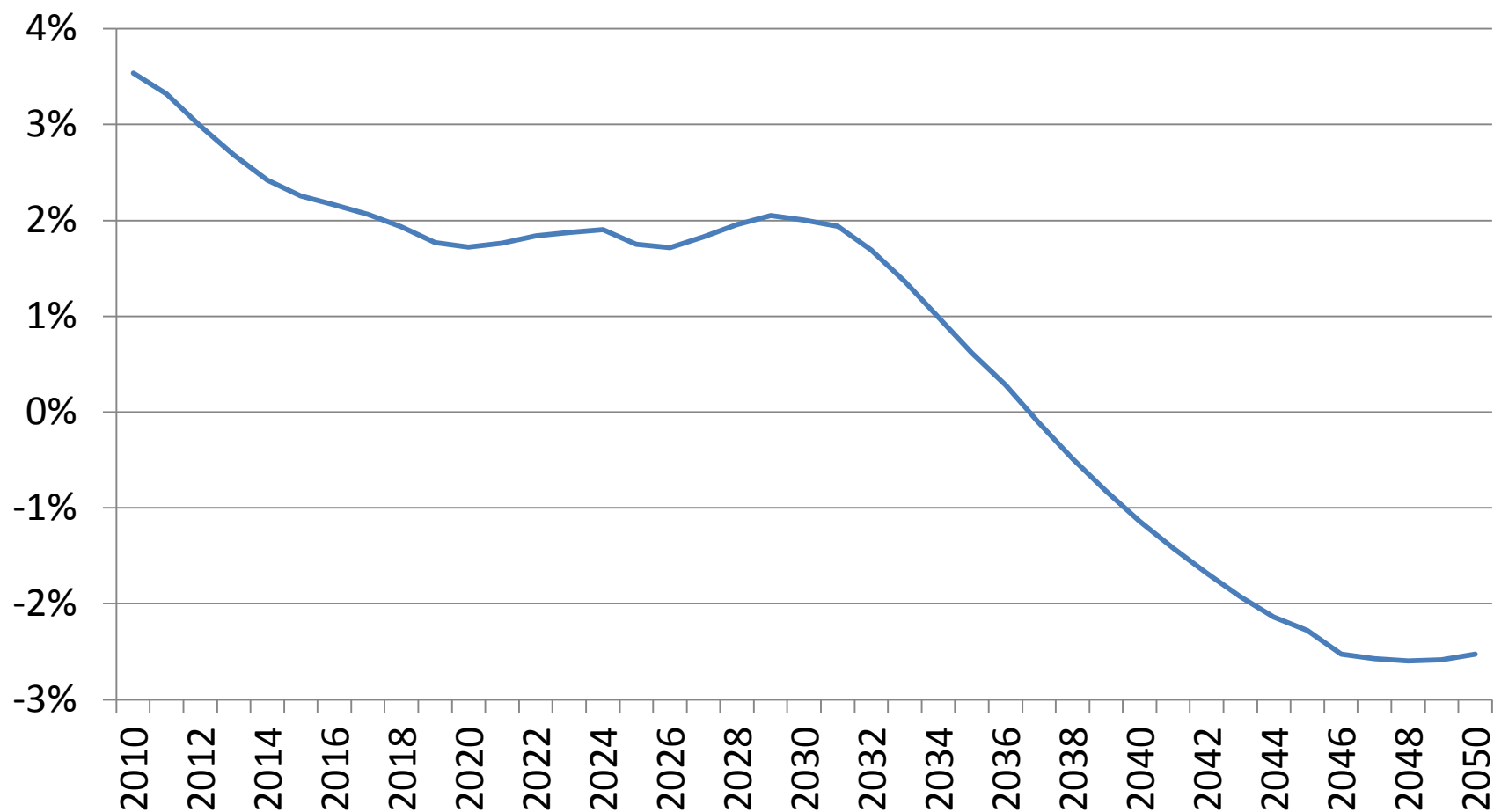


Table 4. History: Demographic Dividend

	$\Delta rGDP =$	$\Delta POP +$	$\Delta(wPOP / POP) +$	$\Delta(rGDP / wPOP)$
1955–1970	9.70%	1.00%	1.03%	7.77%
1971–1980	4.46%	1.22%	0.01%	3.46%
1981–1990	4.68%	0.55%	0.18%	3.92%
1991–2000	1.06%	0.27%	0.10%	0.69%
2001–2010	0.72%	0.09%	−0.49%	1.12%

Notes: Authors' calculation. Each row does not exactly add up as the equation suggests, due to approximation in ten-year average growth rates

Data Source: GDP from Cabinet Office, Japan for GDP ; and population from National Institute of Population and Social Security Research

File: For 1955-1980, GrowthDemographyOld.xlsx;
For 1980-2010, DemographyJapan.xlsx

Table 5. Implication of 2% growth

	$\Delta rGDP =$	$\Delta POP +$	$\Delta(wPOP / POP) +$	$\Delta(rGDP / wPOP)$
2011–20	2.00%	–0.31%	–0.77%	3.09%
2021–30	2.00%	–0.62%	–0.15%	2.77%
2031–40	2.00%	–0.83%	–0.68%	3.51%
2041–50	2.00%	–0.99%	–0.50%	3.49%

Notes: Authors' calculation. Each row does not exactly add up as the equation suggests, due to approximation in ten-year average growth rates. $\Delta rGDP$ was assumed; ΔPOP and $\Delta(wPOP/POP)$ are calculated from forecasts of IPSS, then $\Delta(rGDP/wPOP)$ is derived from the identity.

Data Source: GDP from Cabinet Office, Japan for GDP ; and population from National Institute of Population and Social Security Research (IPSS) File: DemographyJapan.xlsx

Figure 5. Government Debt and Private Sector Financial Assets: 2010-2050 (2% GDP Growth)

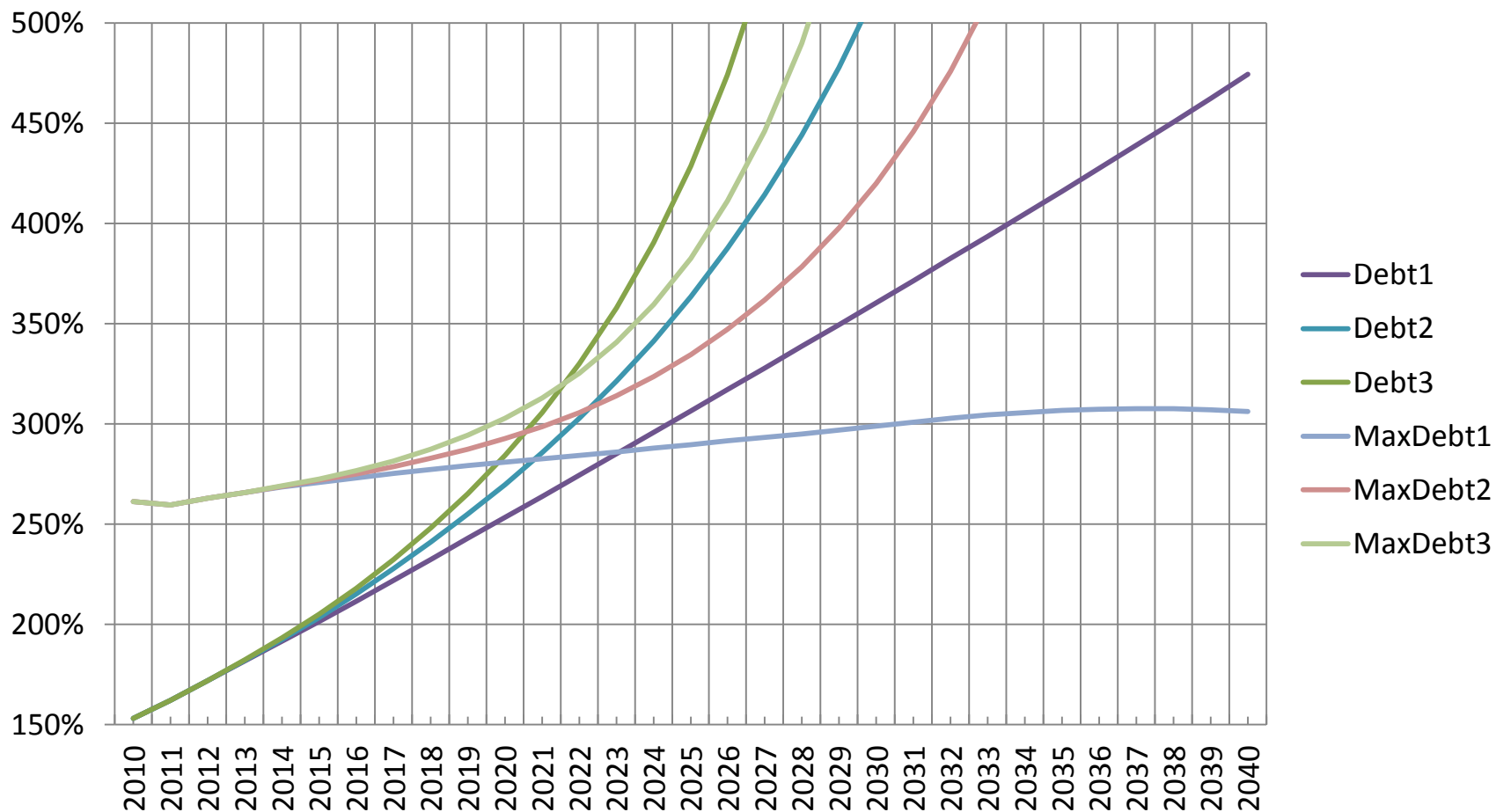


Table 6. Growth per worker productivity at 1.05% to future

	$\Delta rGDP =$	$\Delta POP +$	$\Delta(wPOP / POP) +$	$\Delta(rGDP / wPOP)$
2011–20	–0.04%	–0.31%	–0.77%	1.05%
2021–30	0.27%	–0.62%	–0.15%	1.05%
2031–40	–0.47%	–0.83%	–0.68%	1.05%
2041–50	–0.45%	–0.99%	–0.50%	1.05%

Notes: Authors' calculation. Each row does not exactly add up as the equation suggests, due to approximation in ten-year average growth rates. ΔPOP and $\Delta(wPOP/POP)$ are calculated from forecasts of IPSS, then $\Delta(rGDP/wPOP)$ is assumed to be 1.05%, which was the average of 1994-2010. $\Delta rGDP$ was derived from the identity;

Data Source: GDP from Cabinet Office, Japan for GDP ; and population from National Institute of Population and Social Security Research (IPSS)file: DemographyJapan.xlsx

Figure 6. Government Debt and Private Sector Financial Assets: 2010-2050 (1.05% GDP per worker growth)

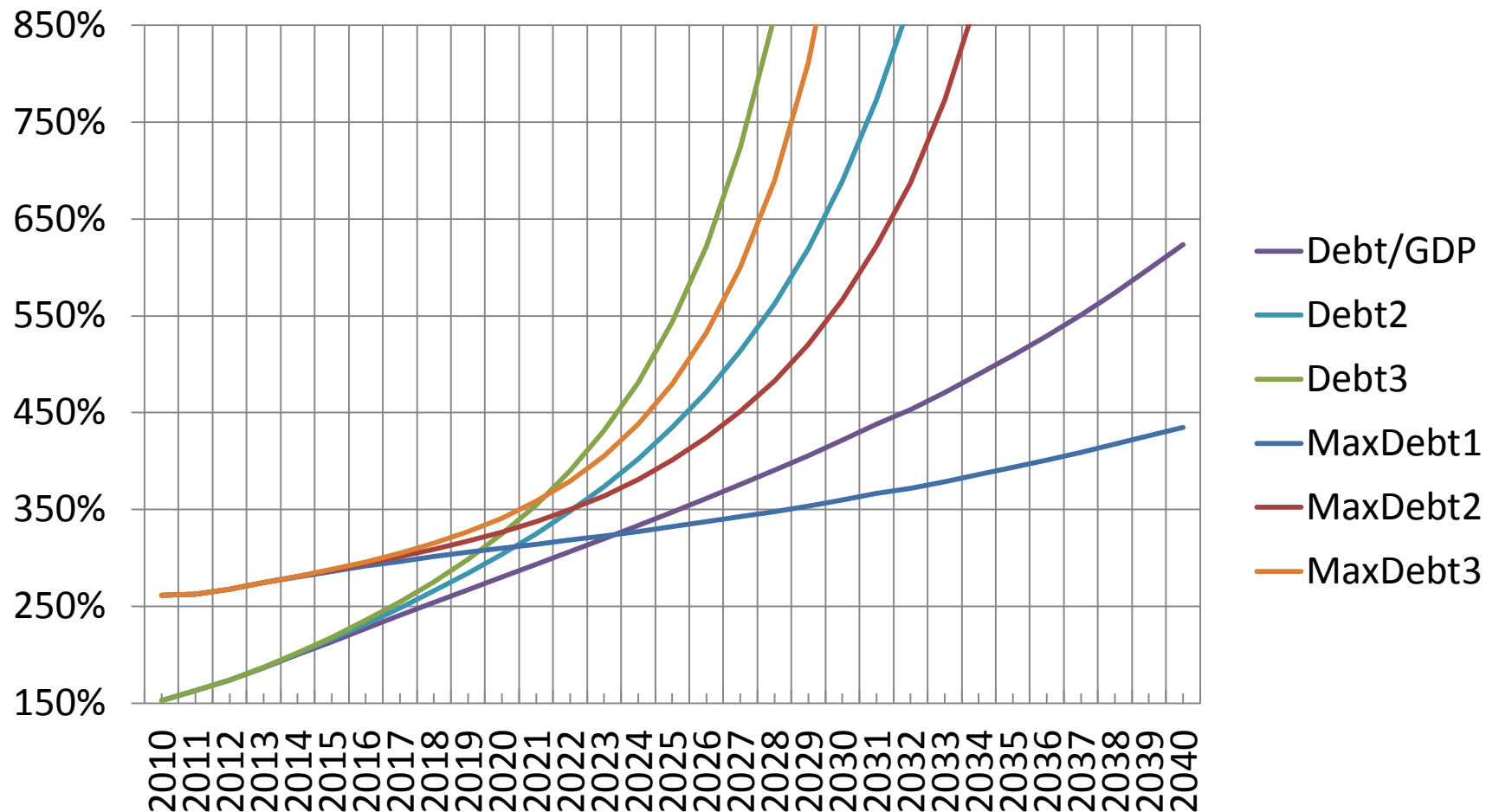


Table 7. Per-worker labor productivity increase of 2.09%

	$\Delta \text{rGDP} =$	$\Delta \text{POP} +$	$\Delta (\text{wPOP} / \text{POP}) +$	$\Delta (\text{rGDP} / \text{wPOP})$
2011–20	0.98%	–0.31%	–0.77%	2.09%
2021–30	1.30%	–0.62%	–0.15%	2.09%
2031–40	0.55%	–0.83%	–0.68%	2.09%
2041–50	0.57%	–0.99%	–0.50%	2.09%

Notes: Authors' calculation. Each row does not exactly add up as the equation suggests, due to approximation in ten-year average growth rates. ΔPOP and $\Delta (\text{wPOP} / \text{POP})$ are calculated from forecasts of IPSS, then $\Delta (\text{rGDP} / \text{wPOP})$ is assumed to be 2.09%, which was the average of 2001–2007. ΔrGDP was derived from the identity;

Data Source: GDP from Cabinet Office, Japan for GDP ; and population from National Institute of Population and Social Security Research (IPSS) file: DemographyJapan.xlsx

Figure 7. Government Debt and Private Sector Financial Assets: 2010-2050 (2.09% GDP per worker growth)

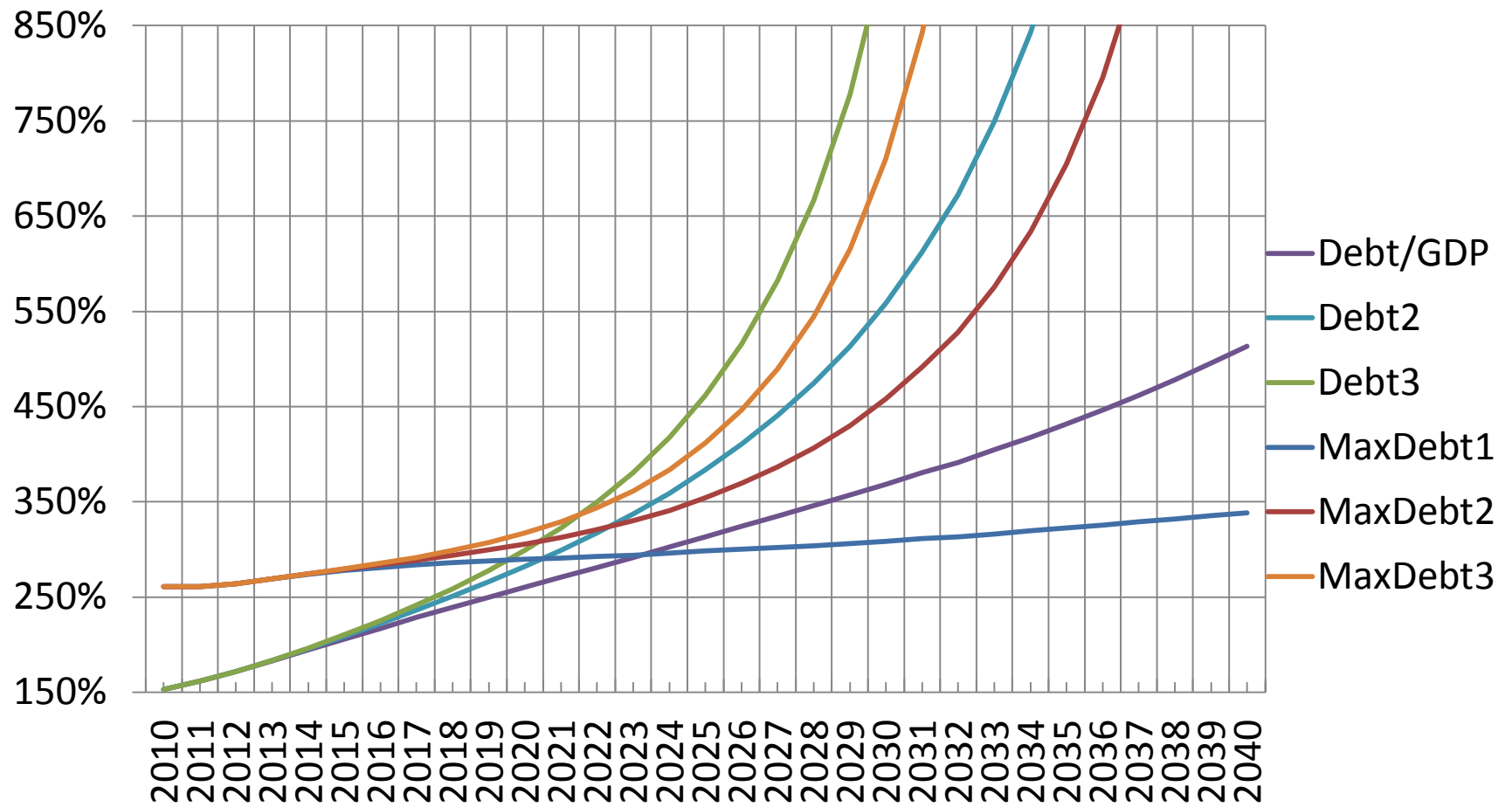


Figure 8. Growth rate (y-y) MA4Q Bond rate – CPI inflation rate

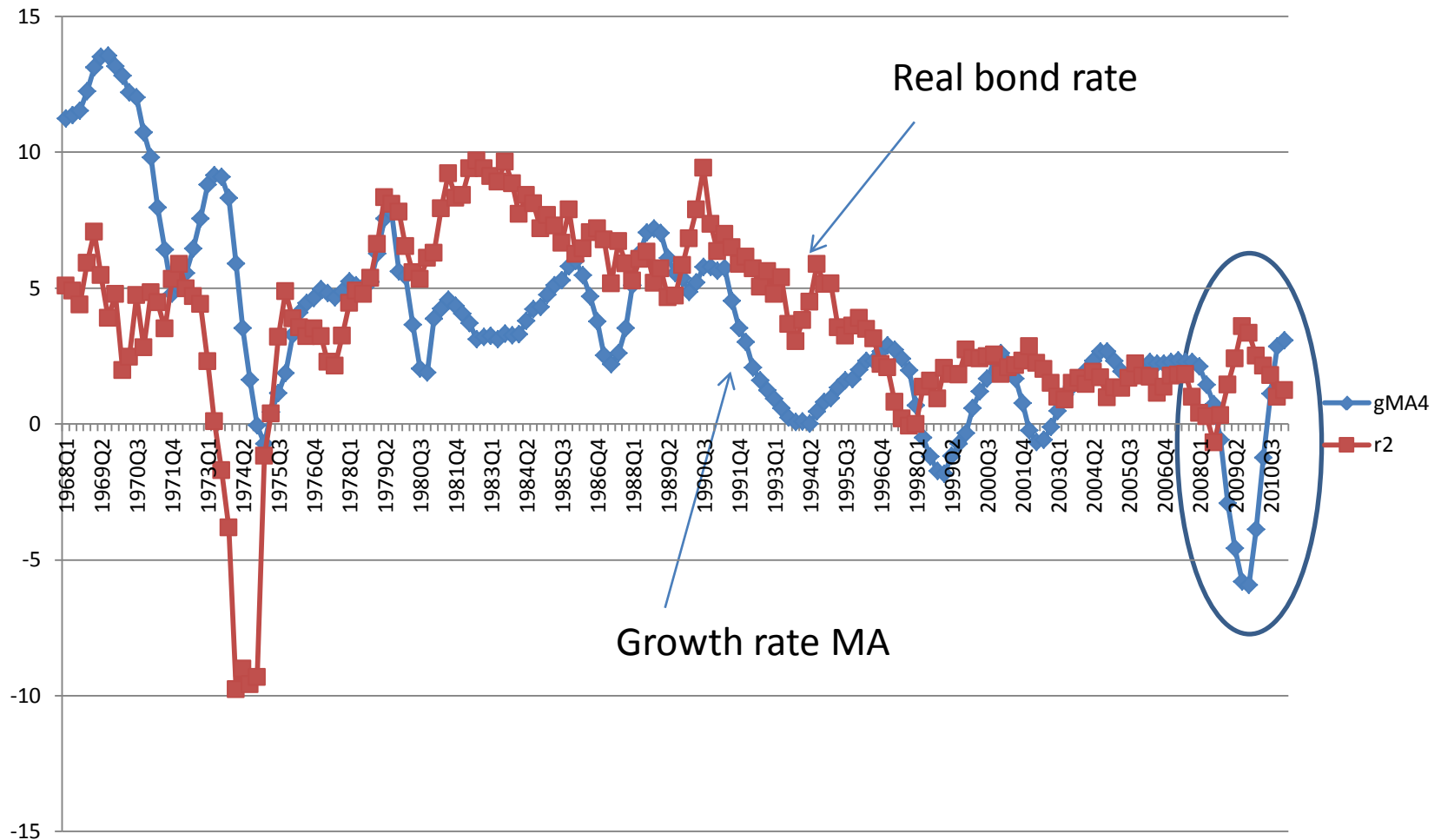


Figure 9. Impulse (all) 1975-2011

Response to Cholesky One S.D. Innovations ± 2 S.E.

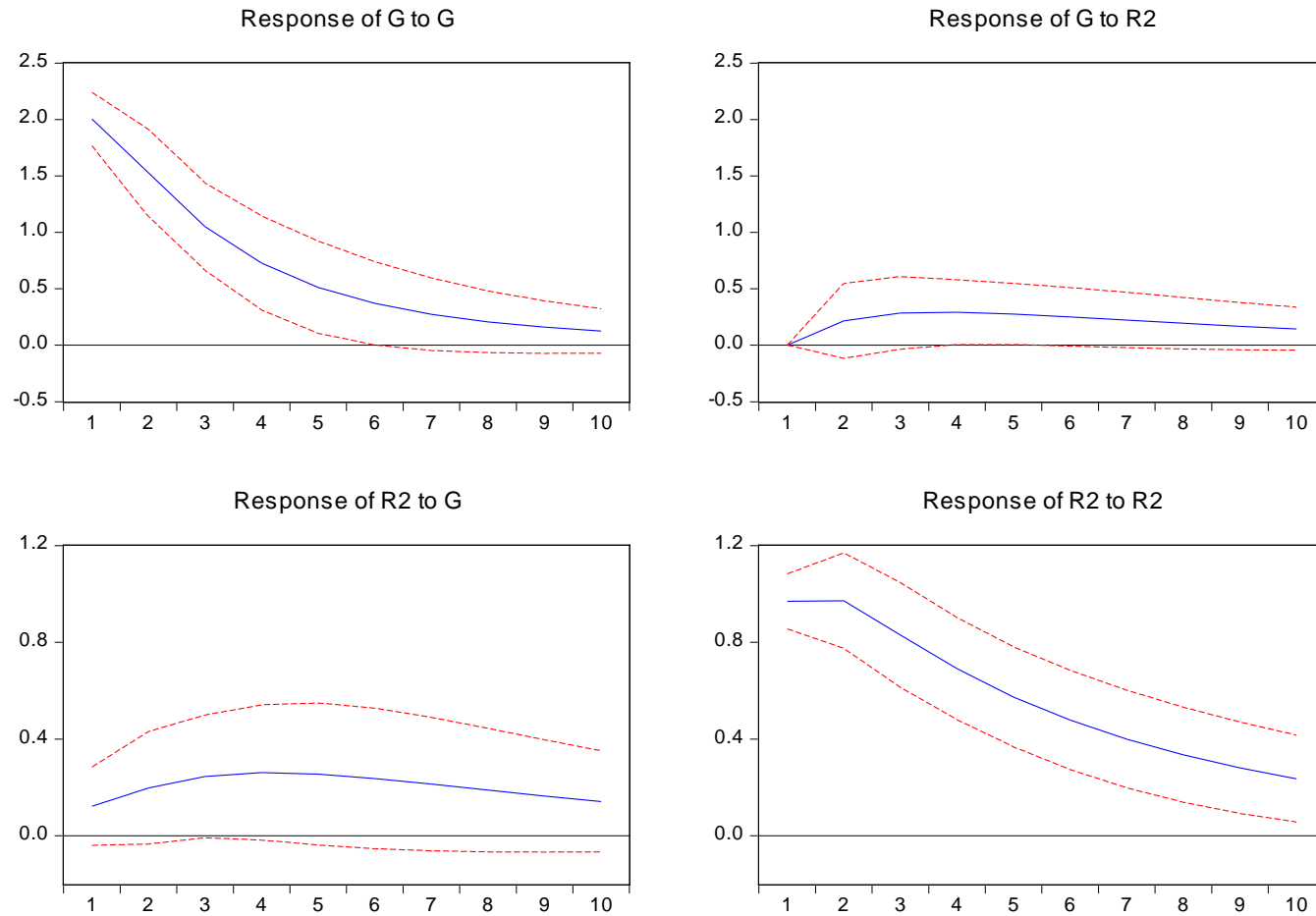


Figure 10. Impulse (I) 1975-1993

Response to Cholesky One S.D. Innovations ± 2 S.E.

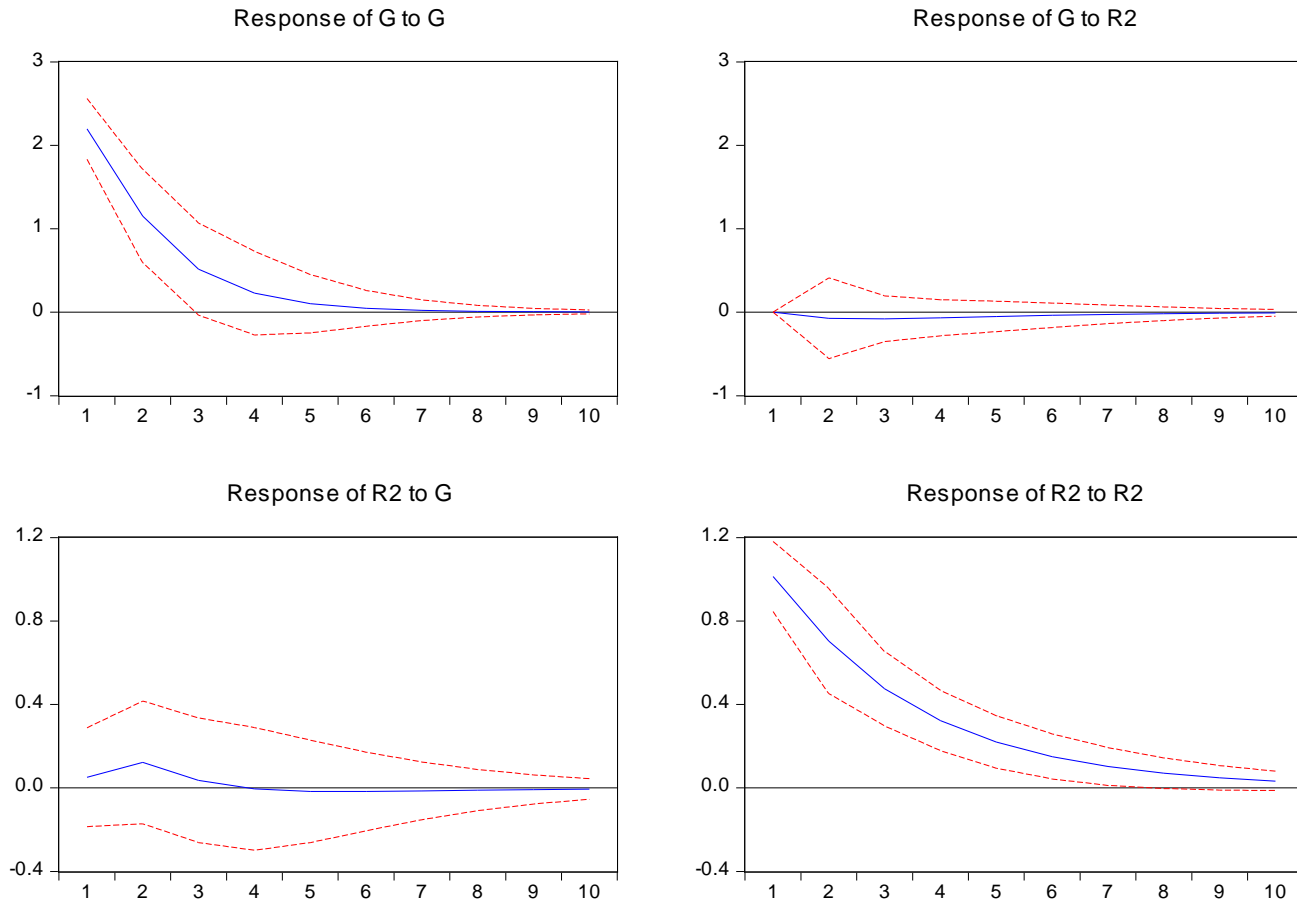


Figure 11. Impulse, VAR 1993-2011

Response to Cholesky One S.D. Innovations ± 2 S.E.

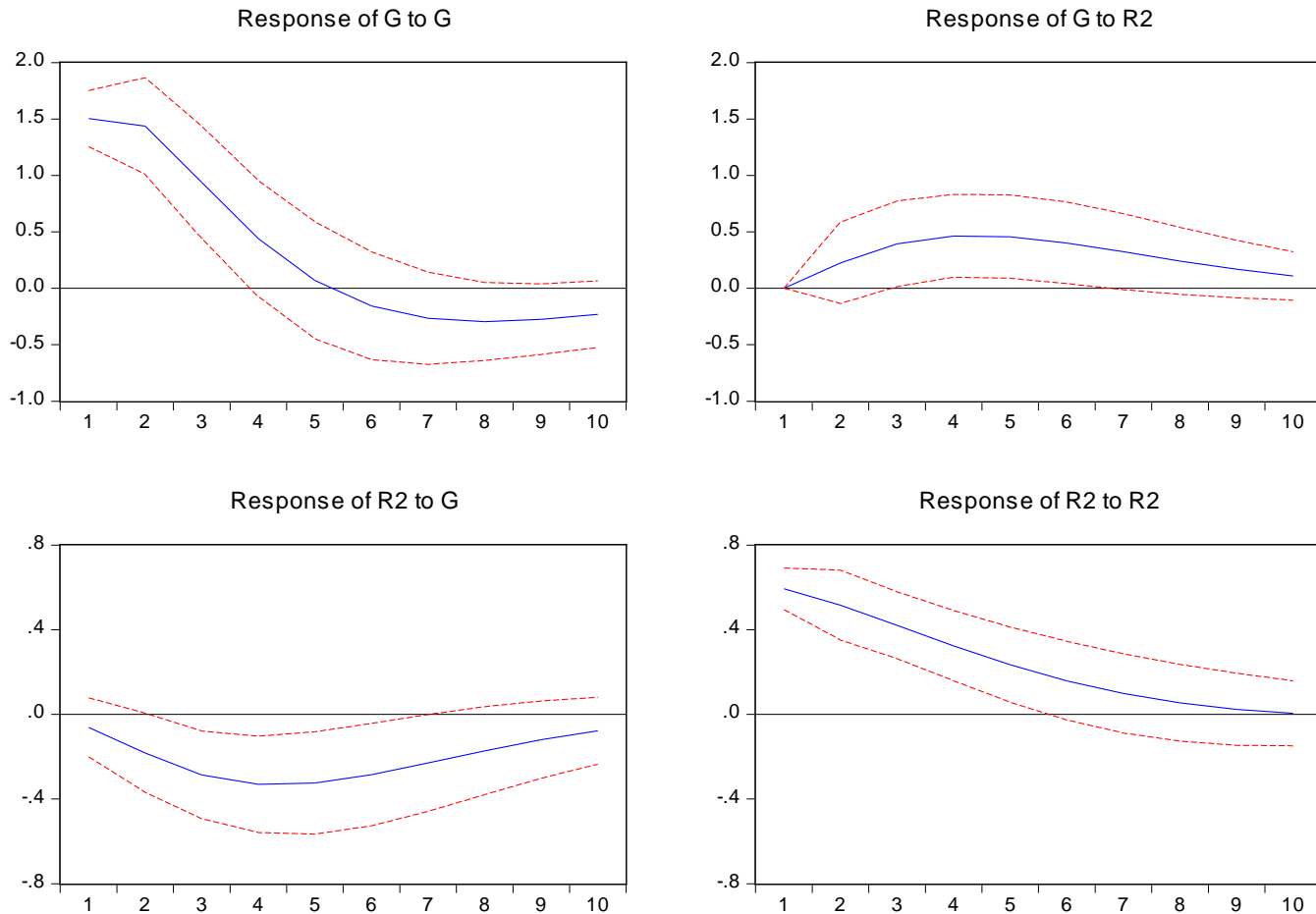


Figure 12. Increase in the Interest Rate that would Trigger a Crisis

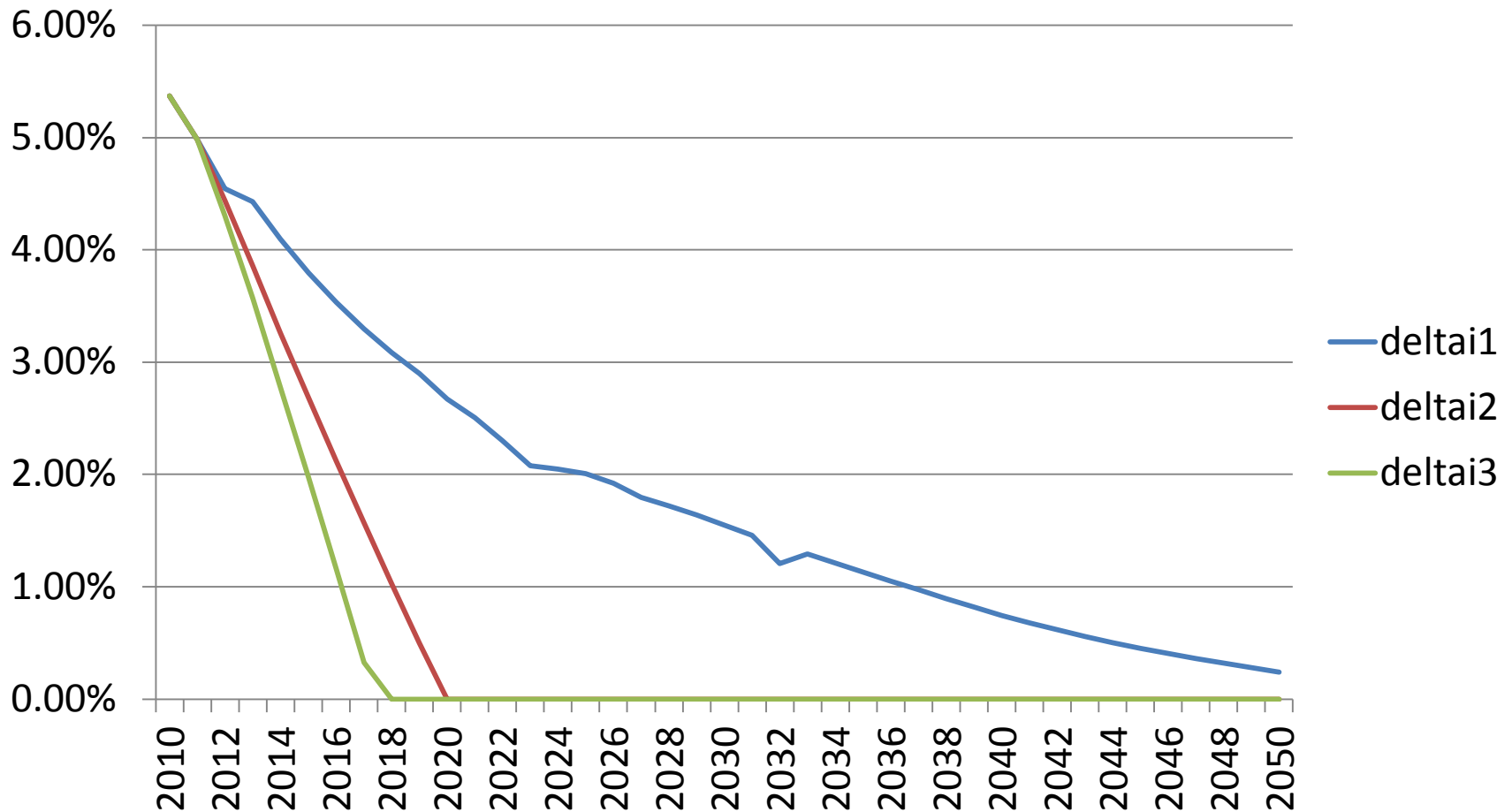


Figure 13. Sustainable Tax Policy under Each Interest Rate Assumption

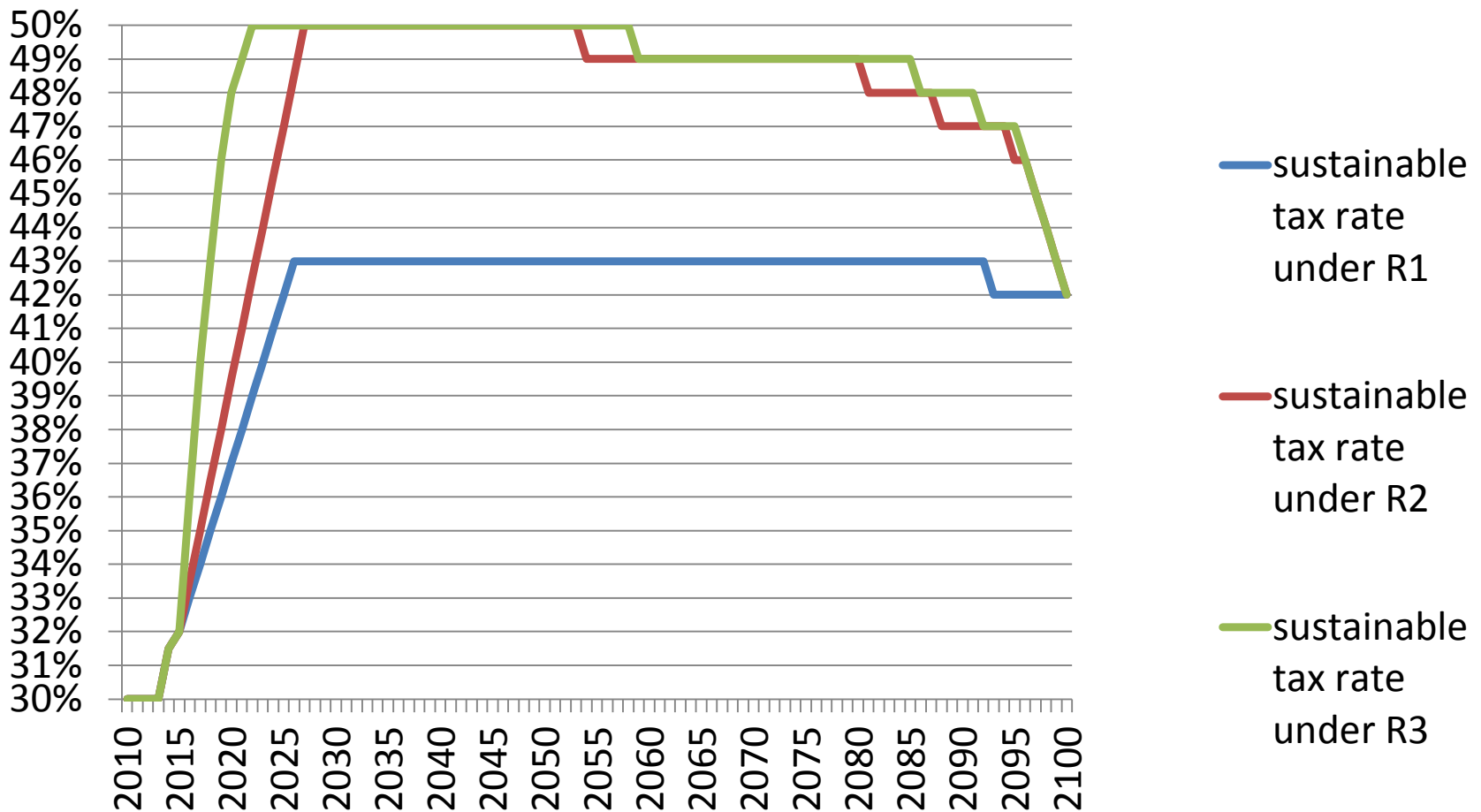


Figure 14. Debt/GDP Ratio with Sustainable Tax Policy

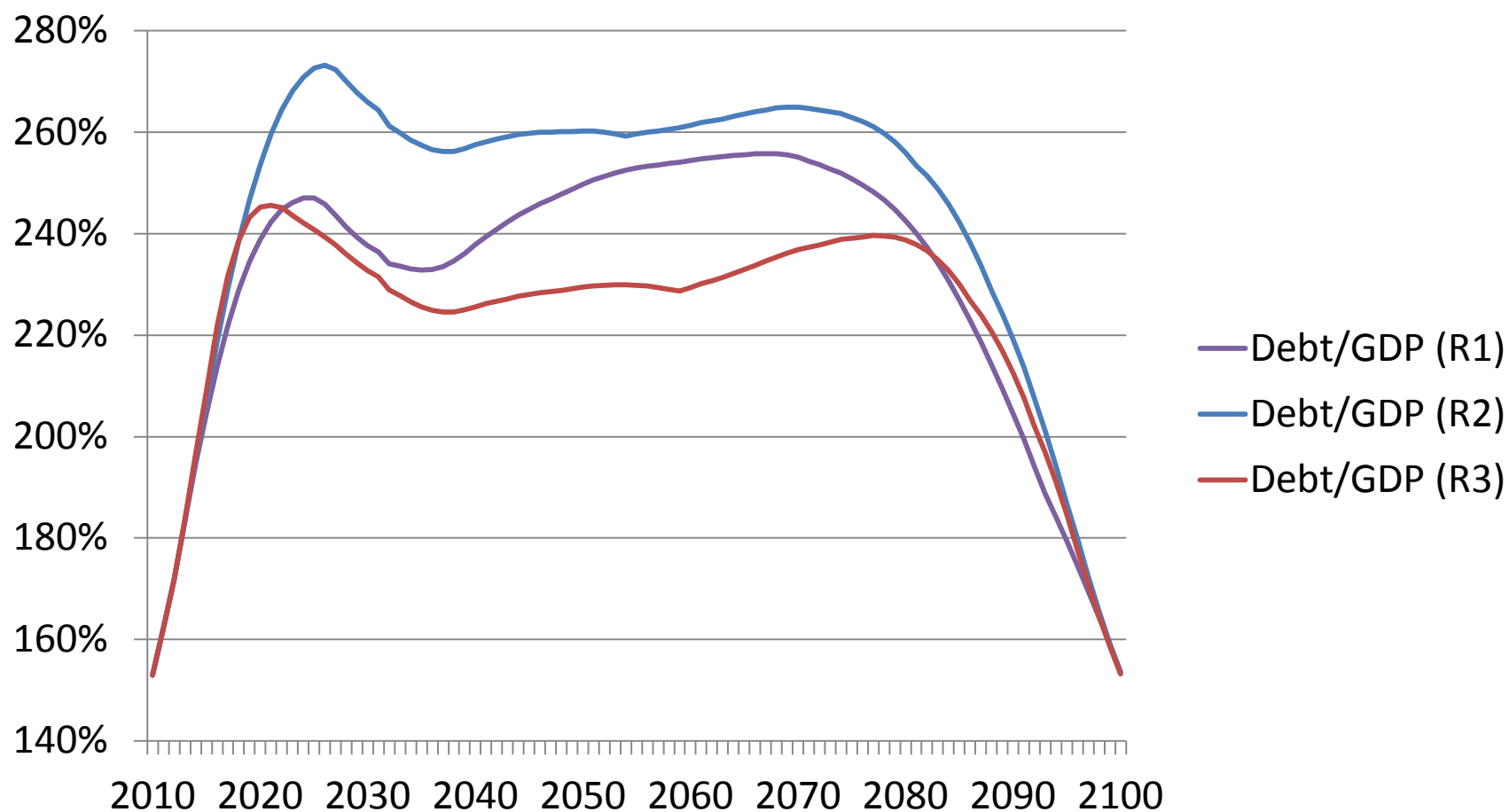


Figure 15. Debt to MaxDebt Ratio with Sustainable Tax Policy

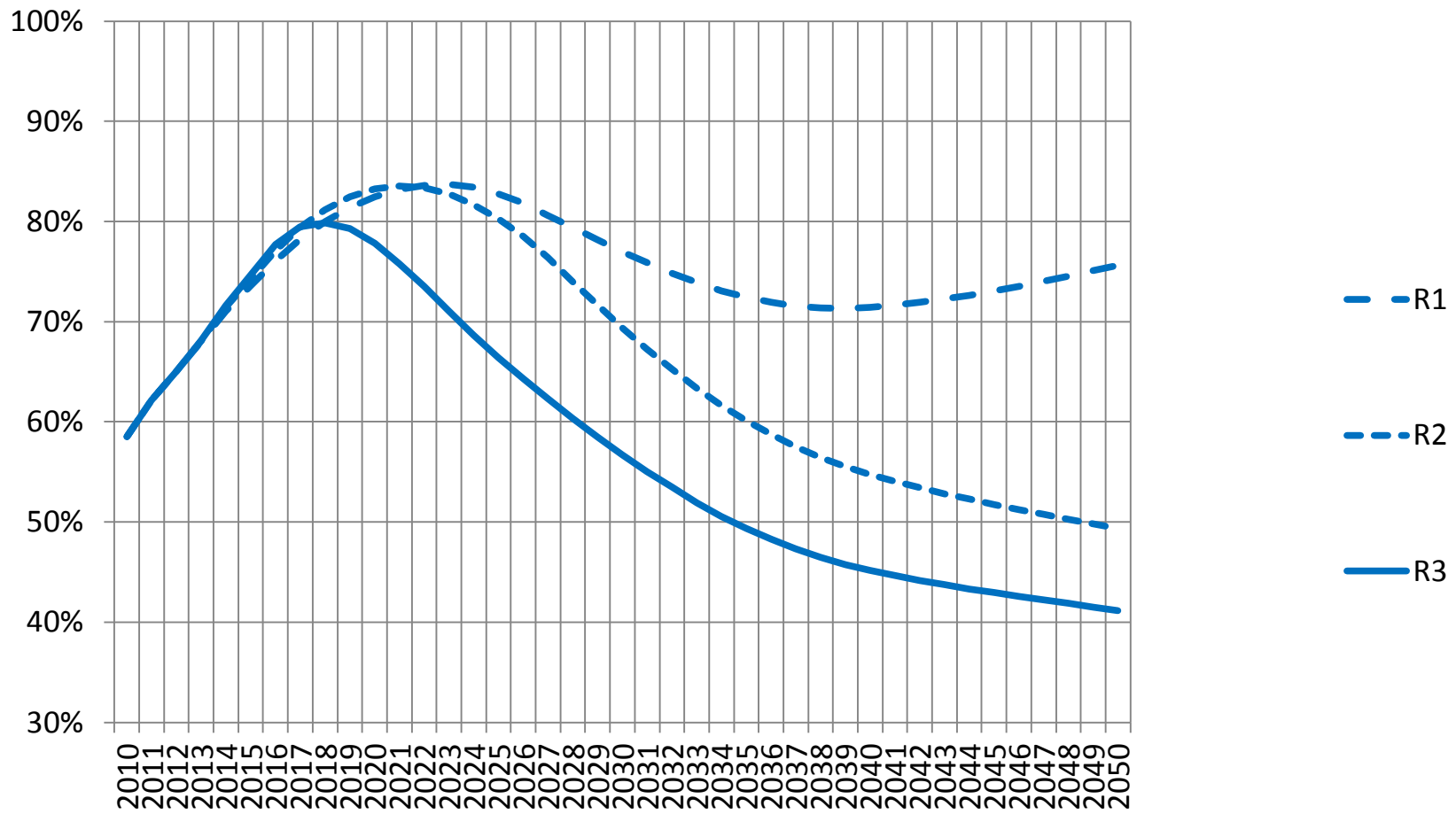


Table 7. Credit rating history

Figure 13. Credit Rating

Moody's			S&P	
Date		Change to		Change to
1993	5/3	Aaa		
1998	7/23	Watch (-)		
	11/17	Aa1		
2000	2/17	Watch (-)		
	9/8	Aa2		
2001	9/6	Watch (-)	2/22	AA+
	12/4	Aa3	11/27	AA
2002	2/13	Watch (-)	4/15	AA-
	5/31	A2(*)		
2007	7/4	Watchi (+)	4/22	AA
	10/11	A1		
2008	6/30	Aa3		
2009	5/18	Aa2		
2011	8/24	Aa3	1/27	AA-

(*) 2-notch downgrade

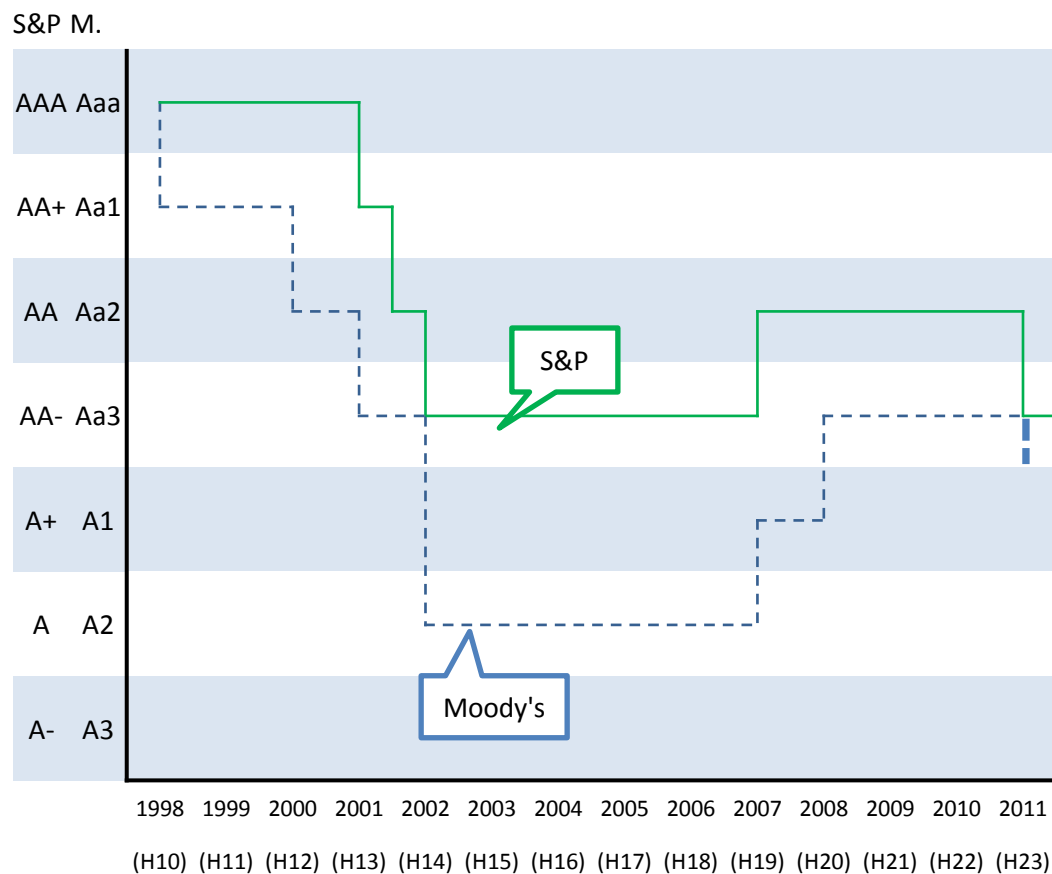
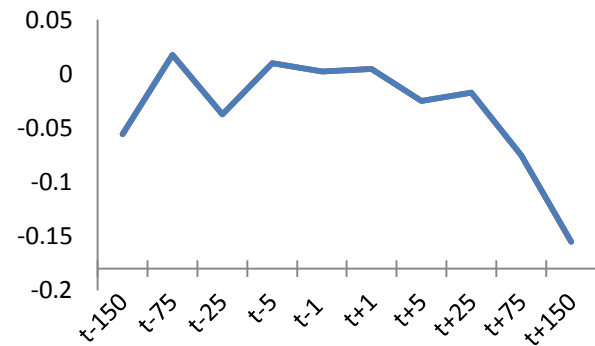
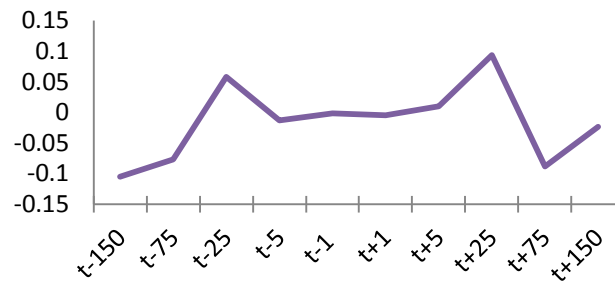


Figure 16. Event Analysis, downgrade on JGB rate

panel 1 JGB interest rate(SP, downgrades)



panel 2 JGB interest rate(Moodys. downgrade and negative watch)



panel 3. JGB interest rate(Moodys, including upgrades)

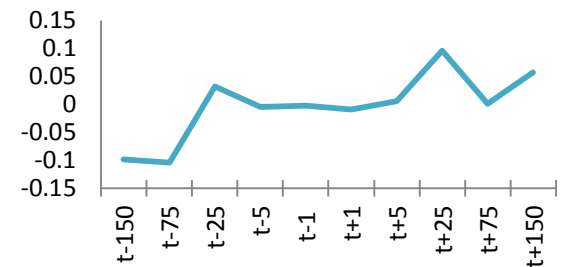
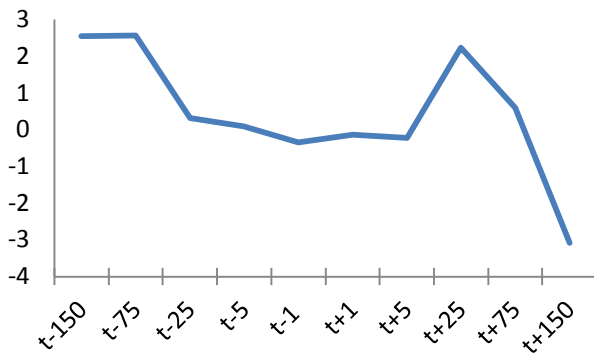
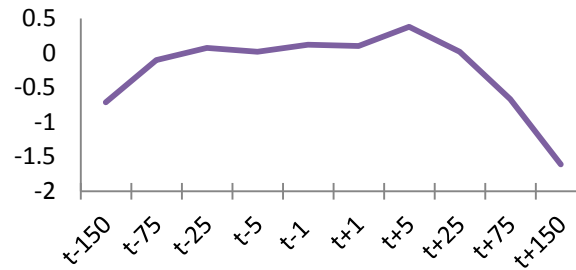


Figure 16

Panel 4. Yen/Dollar
rate(SP, downgrades)



Panel 5. Yen/Dollar
rate(Moodys,
downgrade and
negative watch)



Panel 6. Yen/Dollar
rate(Moodys,
including upgrades)

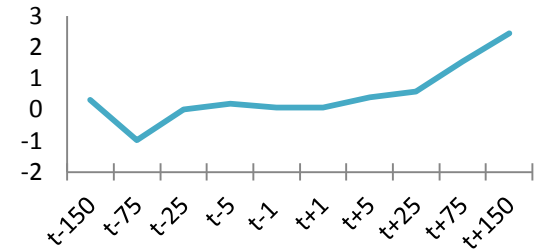
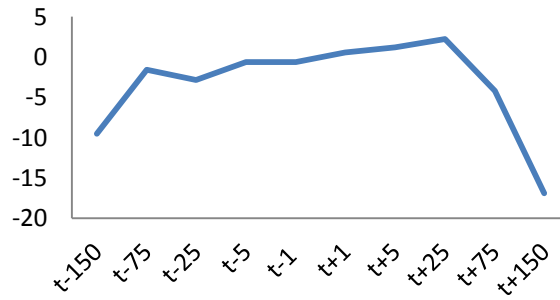
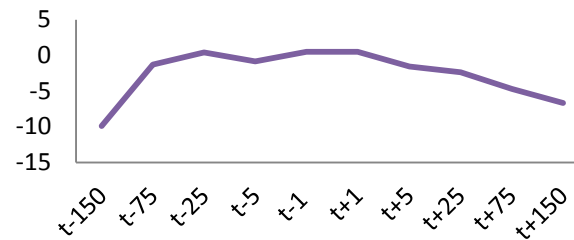


Figure 16

Panel 7. Nikkei 225 stock prices(SP, downgrade)



Panel 8. Nikkei 225 stock prices(Moodys, downgrade and negative watch)



Panel 9. Nikkei 225 stock prices(Moodys, including upgrades)

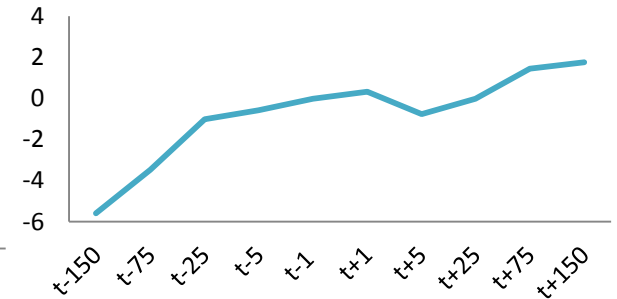


Fig 17. JGB CDS wkly 2003-2011

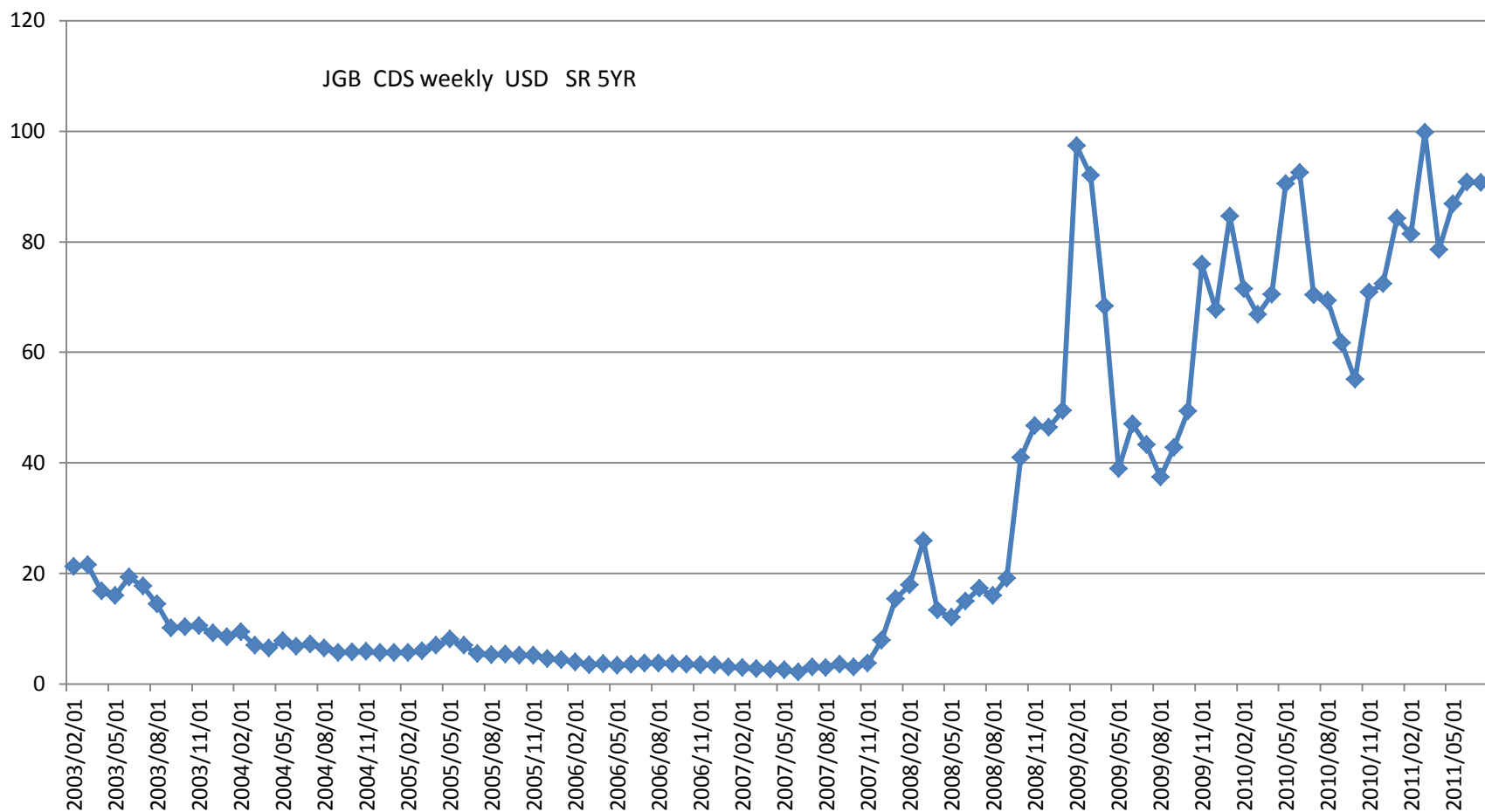


Figure 18. Debt to MaxDebt ratio with reconstruction expenditures

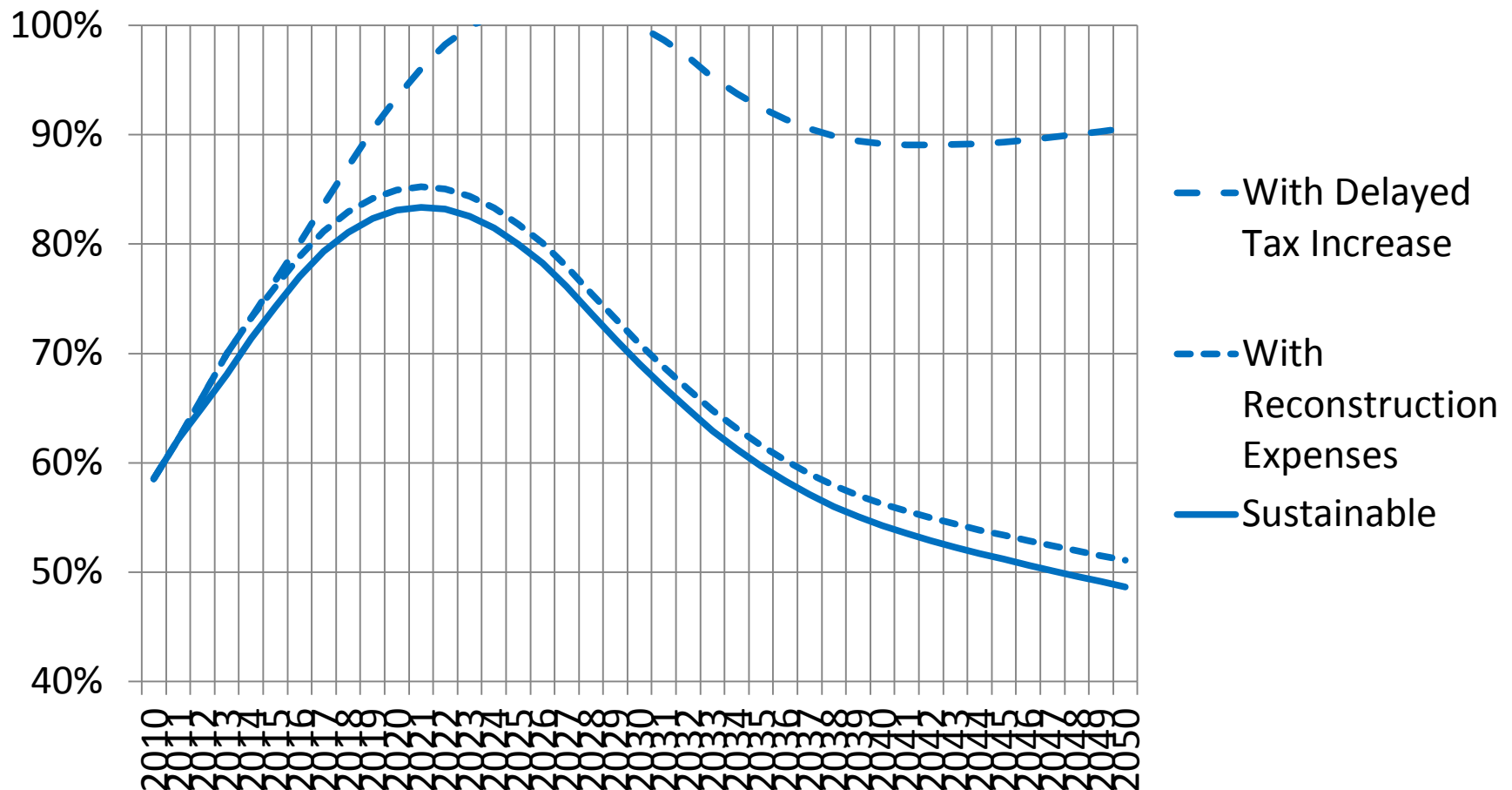


Figure 19. Debt to MaxDebt ratio with reconstruction and nuclear cleanup expenses

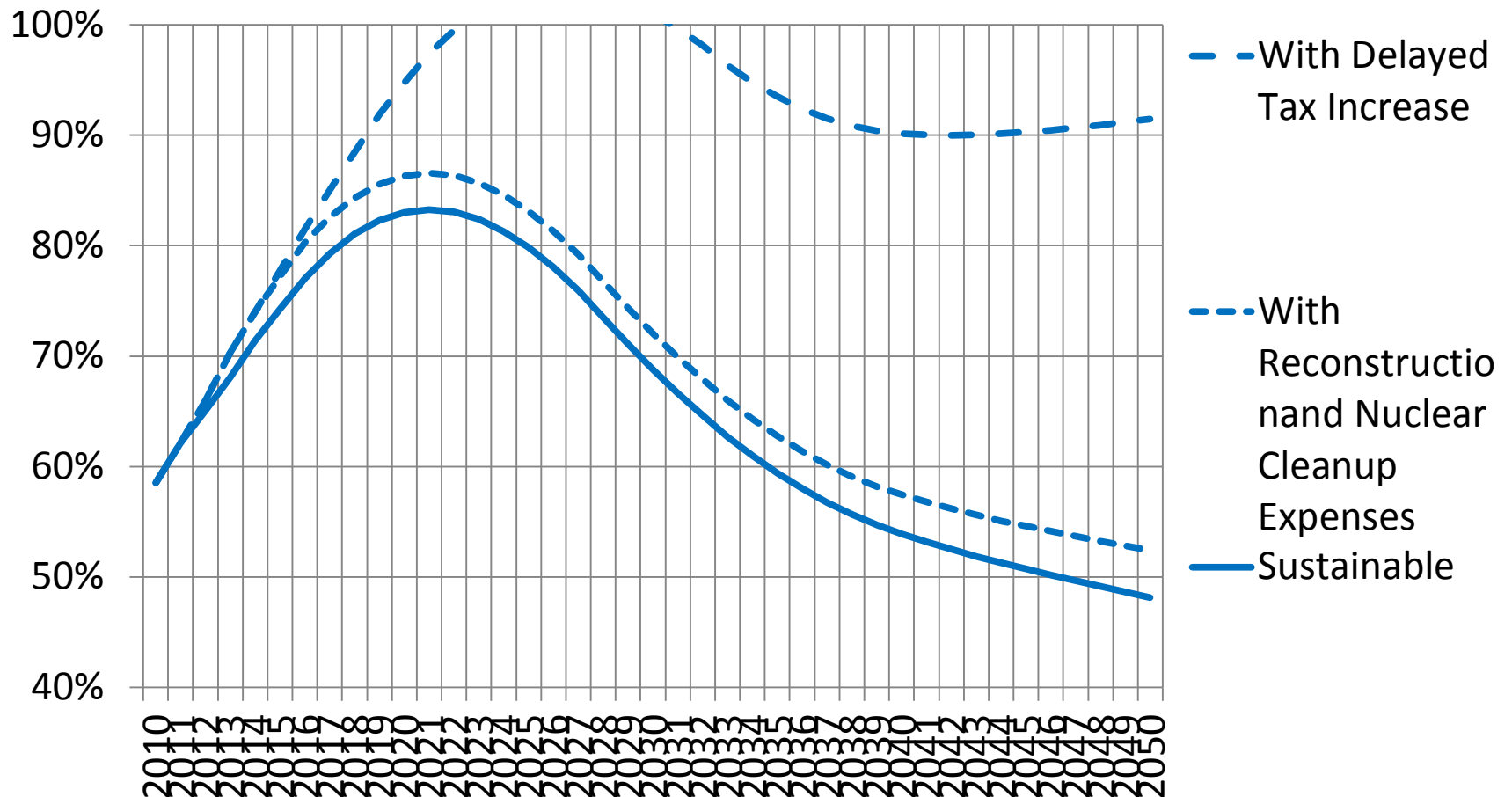


Figure A1. Saving Rate by Household Age Bracket

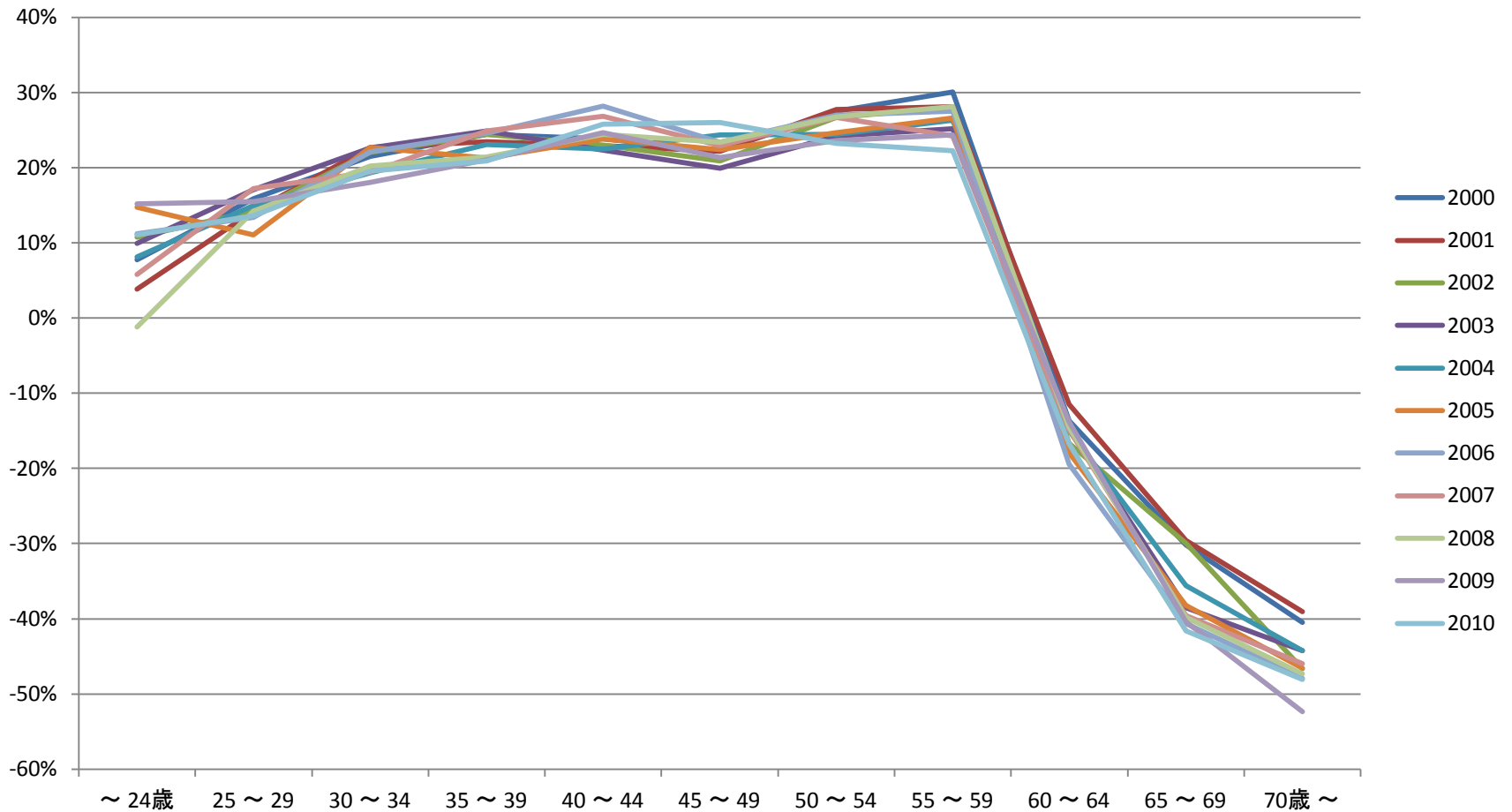


Figure A2. Population Distribution

