Defying Gravity: Can Japanese sovereign debt continue to increase without a crisis?

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1. Introduction

Japan has the highest debt to GDP ratio among OECD countries. Many recent academic papers have concluded that the current Japanese government debts are not sustainable. But anyone who had taken bets on the sovereign crisis in Japan has been proven wrong so far.[1] There were some moments that a sovereign crisis seemed to occur. For example, the yield on the 10-year JGB climbed by 100 basis points within a few months (1998 and 2003). However, it soon came back down to a low level. Even occasional downgrades by credit rating companies in the last thirteen years did not bring down Japanese bond prices. Most recently, the ongoing sovereign debt crisis in Europe has not rattled the JGB yields. If anything, the turmoil in the US and Europe since 2007 has lowered the JGB yields even further, as Japan was considered to be a safe haven. Japanese government bond prices appear to defy the law of gravity.

Almost all recent papers on Japanese government debt reach the same conclusion: the current course of fiscal debt dynamics is not sustainable. For example, Doi (2009), Doi, Hoshi, and Okimoto (2011), Doi and Ihori (2009), Sakuragawa and Hosono (2011), Ito (2011), Ito, Watanabe, and Yabu (2011), and Ostry et al. (2010) all find that without a drastic change in fiscal policy, the Japanese government debt to GDP ratio cannot be stabilized. Imrohoroğlu and Sudo (2011) find that an unlikely high jump in productivity growth would be necessary to stabilize the debt to GDP ratio without changing fiscal policy. These results are a stark contrast to those of Broda and Weinstein (2005), which conclude that a reasonable increase in the tax rate can stabilize the net debt to GDP ratio, using the data available in 2003. This suggests the situation has deteriorated substantially in less than 10 years.

The fiscal problem of Japan has been highlighted by the IMF as well. 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 and to exceed 200% by 2023.

In many papers, Japan's fiscal policy is regarded as sustainable if the debt to GDP ratio is expected to come back down to where it is now in some distant future. No attention is paid however, to how high the debt to GDP ratio goes before it starts to fall. This paper differs from many previous analyses, in considering an explicit ceiling that the government debt should not exceed at any point of time. Such a ceiling is given by the amount of financial assets held by the domestic private sector. We show that even under an extreme assumption that all the private sector savings from now on are invested in government debt,

[1] We do not claim a credit for the analogy of Japanese debts to defying gravity. From serious press to financial newsletters, "defy gravity" as well as "Mt Fuji of debts" have been very popular.

the debt eventually will exceed the amount of private sector financial assets.[2] When the market believes that the point when the debt exceeds the domestic private sector financial assets is close, the yield will have to rise.

The current Japanese debt-to-GDP ratio is higher than southern European countries that are already in crisis. Greece got into a crisis and eventually defaulted on its debts when the debt-to-GDP ratio was still below 150%. The voluntary and involuntary bond exchanges will reduce the level to about 120%. Large Euro-zone countries that showed substantial vulnerability to contagion during the crisis, namely Spain and Italy, had debt-to-GDP ratios much lower than Japan. Japan was not at all affected by contagion from Greece; on the contrary, Japanese JGB yield got even lower as investors moved capital from the southern Euro-zone countries to "safe havens"—Japan, Switzerland and Germany. How could Japan be a safe haven with more than 200% debt-to-GDP ratio?

Japan finally took a small step toward fiscal consolidation in the wake of European sovereign debt crisis. A grand coalition among ruling and opposition parties were formed in the spring of 2012, deciding an increase in consumption tax rate from current 5% to 8% in 2014, and to 10% in 2015. The rare grand coalition (for the policy issues) was made possible, many argued, because sovereign debt crisis in Europe gave warning to politicians.

The rest of the paper is organized as follows. Section 2 points out that more than 90% of the Japanese government debt is held by the Japanese residents and suggests that this can be an important reason for the persisting low and stable JGB rates. This favorable condition for the Japanese government debt, however, cannot continue as Section 3 shows via simulation the expected paths for government debt and private sector financial assets under the assumption that the fiscal policy stance of the Japanese government does not change in the future. We find that the amount of government debt is expected to exceed the private sector financial assets in the next 10 years. The simulations depend on several important assumptions. Section 4 discusses how the results are sensitive to those assumptions. Section 5 identifies an alternative future tax path that would keep the future government debt below the private sector financial assets. Thus, if the market believes that Japan can still embark on such fiscal consolidation in the not so distant future, the low JGB yields are understandable. If and when the expectation changes, however, a fiscal crisis can be triggered even before the government debt hits the ceiling of the private sector financial assets. Section 5 discusses what would trigger such a change in expectation. Section 6 concludes by summarizing the paper's findings.

2. Why is the JGB yield so low?

[2] IMF (2009), Tokuoka (2010), and Oguro and Kobayashi (2011) all discuss the ceiling of private sector savings and provide simple calculations. This paper provides refinements over these earlier attempts by considering the dynamics carefully under several alternative scenarios.

Economic research has accumulated overwhelming evidence against the fiscal sustainability of Japan. Many international financial institutions, credit rating agencies, and private-sector analysts agree over this assessment. Yet, the JGB interest rate has been low and stable. The 10-year JGB rate has been below 2% since 1999, and between 0.8% 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 a 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, and Italy.

Figure 1 shows the gross debt to GDP ratios for Japan and several European countries that have experienced crises. The figure shows that Japan's debt to GDP ratio has been consistently higher than any of these European countries during the last decade. Figure 2 shows the net debt, which subtracts the financial assets that the government owns from the gross debt, numbers for the same set of countries. The figure tells a similar story. Japan's net debt to GDP ratio has been higher than the crisis countries of Europe with the exception of Greece after 2010.

The financial market, however, does not seem to show any concerns on the high indebtedness of the Japanese government. As the Japanese debt to GDP ratio increased, JGB yield actually fell as Figure 3 shows. Why has the JGB yield not risen? Several factors are identified to have contributed to the low and stable JGB yield (see Ito (2011), for example). This paper focuses on the oft-stated explanation that the JGB yields are low because there are high private savings in Japan that continue to be invested into government bonds. Thus, one does not have to worry about increasing bond yields as long as the massive amount of private savings is there.

Indeed most of Japanese government debt is held by Japanese residents. Table 1 shows the distribution of JGB ownership by type of investor from 2005 to 2010. Looking at the column for 2010, the largest share of 39% is owned by Japanese commercial banks, including the Japan Post Bank. The insurance companies hold about 20% of the total and 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%. An additional 5% is held by the households directly, and about 3% is held by other domestic investors. Thus, in total more than 95% of JGBs are owned by domestic residents.

The large amount of private savings does not necessarily imply that it has to be used to purchase low yielding domestic government bonds. The savings could chase higher returns and move abroad on a massive scale. Indeed this happened to some extent as Japan accumulated foreign assets over time. However, a large proportion of the savings stayed domestic, despite the persistent difference of returns in recent years. The proportion of

yen-denominated domestic assets for Japan is extremely high as compared to investors in other advanced countries.

What is important here is the home bias of the institutional investors. As Table 1 shows, the direct holdings of government bonds by households and non-financial corporations are not that large. Private savings are mostly deposited into the banks, and the banks buy Japanese government bonds.

Banks 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, either by regulation or by internal models, that determine the minimum amount of capital banks must hold. Pension funds and insurance companies seem to also be content with holding a large amount of long-term JGBs because their liabilities are also in the yen.

The stagnation of the Japanese economy also makes JGBs attractive to banks. The returns from alternative investments such as corporate loans have been quite low. The sustained near-zero interest rate policy of the Bank of Japan was another reason for low rates of return in general. Finally, continued deflation means that the real yields of JGBs for Japanese consumers have been higher than the nominal yields.

The regression analysis by Tokuoka (2010) finds that the low yields of JGBs may be indeed related to its ownership predominantly by Japanese residents. Table 2 shows a representative regression result. The results show that high household and corporate net savings are associated with low JGB yield. The regression results also show that high foreign ownership of the JGB is associated with high bond yield. One percentage point increase of foreign ownership of JGBs pushes up the yield by 11 basis points. When these two factors are controlled for, a standard negative relation between the debt to GDP ratio and the government bond yield re-emerges for Japan. The point estimate suggests that the bond yield rises by 2 basis points for each one percentage point increase in the debt to GDP ratio.

3. Sustainability calculation

If the growth of private savings decelerates and government debt continues to increase, the amount of government debt will eventually exceed the amount of private savings. At that point, even if all the private sector financial assets are invested in the JGBs, leaving nothing for private sector credit, at least some JGBs must be held by foreign investors. As soon as the market sees that the current course definitely leads to such a situation, the government will have trouble selling new JGBs at low interest rates. In this paper, we call such a situation a “crisis.” In a crisis, new JGBs cannot be sold at low interest rates and the interest rate would rise.

There is good reason to believe that household saving 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 start consuming out of their financial assets. Further, the working-age population is expected to decline by 8% over the next ten years.

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

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

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).

In comparing the government debt to the amount of private sector financial assets, it is sensible to exclude government debt that is held by the government itself from the definition of debt that we use. Thus, we use the concept of adjusted net debt as advocated by Doi (2008). The adjusted net debt is defined as the gross debt of the government sector in the national income accounting minus the government sector financial assets that are considered to be readily disposable. Thus, different from the standard definition of the net debt, some financial assets such as the fiscal adjustment funds of local governments are not subtracted. These financial assets are held as a buffer for unexpected losses and not expected to be used to redeem the government debt.

Thus, for the initial value of the debt to GDP ratio for our calculation, we use the amount of adjusted net debt calculated by Doi, Hoshi, and Okimoto (2011), which is 153%. The future government expenditure series also comes 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.

We consider three alternative assumptions for the interest rate.

R1: Interest rate is equal to the larger of the growth rate (η_t) and the level in 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, but constrains the interest rate not to be lower than the current rate even when the GDP growth rate declines further. R2 and R3 assume that the interest rate rises as the government accumulates more debt. Many empirical studies have demonstrated such a 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) and is the median estimate from studies of various advanced economies. In both cases, the interest rate is assumed to respond linearly to increases in the debt to GDP ratio. This is a conservative assumption in the light of some evidence that suggests the interest rate increases at a higher rate once the debt to GDP ratio exceeds certain a threshold, as Ardagna, Caselli, and Lane (2004) find.

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:

> 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.[3]

Starting from this initial value of the private financial assets, we assume the future private financial assets that are potentially available to finance government debts will evolve according to the following equation.

$$a_{t+1} = \frac{1 + r_0 + \theta(r_t - r_0)}{1 + \eta_t} a_t + s_t \tag{2}$$

where a_t is the private financial assets to GDP ratio at the beginning of time t and s_t is the (flow) saving from non-interest income divided by GDP in year t. As the interest rate, r, increases, the interest income increases. Thus, if we assumed that the interest income is fully reinvested, the financial assets available to finance government debts would grow faster as the interest rate rises even when the interest rate increase is a result of concern on the sustainability of the government debt. In other words, when investors require higher yields on government bonds to compensate for higher default risk, it *increases* the amount of financial assets that can be potentially used to buy more government bonds. To avoid this counter-intuitive implications, we assume that a proportion θ of the interest income that

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

exceeds the initial level of the interest income $(r_t\text{-}r_0)a_t$ is reinvested to increase the financial assets. Under this assumption, the private sector financial assets grow by $\frac{1+r_0+\theta(r_t-r_0)}{1+\eta_t}a_t$ in year t through reinvestment. The new saving (s_t) is then added to get to the new level of financial assets at $t+1$.

For the value of θ, we consider three cases. At one extreme we consider the case where the private sector reinvests all the interest income ($\theta = 1$). The other extreme we consider is that no portion of the interest income that exceeds the initial level is reinvested ($\theta = 0$). As an intermediate case, we consider $\theta = 0.5$.

The aggregate saving rate is a function of the demography. Appendix 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, falling almost to -3% by the end of the 2040s.

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 must satisfy the following constraint.

$$B_t - B_{t-1} \le S_{t-1} + (A_{t-1} - B_{t-1}) \tag{3}$$

where B, S, and A denote the levels of the government debt, total private saving, and the private sector financial assets respectively, not normalized by GDP. Or rewriting this in terms of the ratios to GDP,

$$b_t \le \frac{s_{t-1} + a_{t-1}}{1+\eta_{t-1}} \tag{4}$$

We consider several different future growth rates. We start by a simple, but unrealistically optimistic assumption that Japan's 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 assuming 2% GDP growth rate 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 interest rate scenario RX. The figure also shows the right hand side of the constraint (4) as MaxDebtX (X=1, 2, 3). For this figure, θ is assumed to be 0.5. Under the scenario 1, which assumes that the current low interest rate environment continues, the government debt exceeds MaxDebt for the first time in 2024.

Under the other scenarios, which assume the interest rate rises as the debt to GDP ratio increases, the government debt exceeds MaxDebt in earlier years: 2022 for Scenario 2 and 2021 for Scenario 3.

The assumption of 2% real GDP growth indefinitely is probably too optimistic. The assumption ignores the tremendous shift in Japanese demography, namely the shrinking working-age (age 20-65) population. A more reasonable assumption may be that GDP per working-age population rather than GDP itself will grow at a constant rate.

Note that:

$$rGDP = POP * \frac{wPOP}{POP} * \frac{rGDP}{wPOP}, \tag{5}$$

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

$$\Delta rGDP = \Delta POP + \Delta \frac{wPOP}{POP} + \Delta \frac{rGDP}{wPOP}, \tag{6}$$

where Δ is the growth rate operator, $\Delta x = \{x(t)-x(t-1)\}/x(t-1)$. Thus, the real GDP growth rate, ΔrGDP, is the sum of the population growth rate, ΔPOP, the growth rate of the ratio of working-age population to population, Δ(wPOP/POP), and the growth rate of GDP per working-age person, Δ(rGDP/wPOP). The last term, the growth rate of GDP per working-age person, can be roughly regarded as the rate of labor productivity growth. Thus, we refer to this term as the labor productivity growth for short.[4] Table 3 demonstrates the demographic growth decomposition for the years 1955 to 2010.

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 the growth rate of GDP into several contributing factors; population growth (1%), increase in the proportion of working-age population (1.0%), and 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.[5] The overall growth rate fell over time as all of these sources of growth declined. The growth rate of GDP per working-age person, however, seems to have stabilized after the 1990s.

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[4] The number of actual workers who engage in production 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 increases, or more elderly participate in the labor market. This paper ignores these possibilities.

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

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).[6] This produces the first two terms of the right-hand side of the equation (6).

Given these expected demographic changes, how much growth of GDP per working-age person is necessary to maintain the GDP growth of 2%? Table 4 gives the answer. The 2% real economic growth implies that the growth rate of GDP per working-age person must be at around 3% in the next twenty years (2011-2030) and at 3.5% for the following twenty years (2031-2050). The productivity growth rate of 3% and above has not been observed for Japan since the 1980s. It seems implausible that the Japanese economy can repeat the miraculous growth of the 1970s and 1980s in the next 40 years.

Thus, a more reasonable approach is to assume the growth rate of GDP per working-age person to be similar to that of the 1990s and the 2000s. We consider two alternative growth rates of GDP per working-age population. The low growth scenario assumes 1.05% (average of 1994-2010) and the high growth scenario assumes 2.09% (average of 2001-2007).[7] Table 5 shows the growth decomposition under the assumption of 1.05% growth rate of GDP per-working-age person.

The result for the debt sustainability calculation under the low growth scenario is reported in Figure 6. The value for θ is again set to be 0.5. Figure 6 is very similar to Figure 5. The upper bound for the debt accumulation is reached in 2025 for Scenario 1, 2022 for Scenario 2, and 2021 for Scenario 3.

Table 6 shows the growth decomposition under the high growth scenario. The growth rate will be close to 1% for the next twenty years until 2030, then falls to 0.6% in the 2030s and the 2040s. The result of the dynamics for government debt and private sector saving shown in Figure 7, again is pretty much the same as those in the previous figures. The Japanese government is expected to run out of room to sell more bonds domestically by 2024 at the latest.

When a larger proportion of the interest income is reinvested, the domestic private sector financial assets grow faster, creating more room to absorb new government bonds domestically. Thus, a larger θ tends to push out the year when the government debt exceeds the private sector assets further into the future. Table 7 summarizes how the year when the government debt exceeds MaxDebt changes as we change the reinvestment rate (θ), the

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[6] For the IPSS population forecasts, see http://www.ipss.go.jp/pp-newest/e/ppfj02/top.html.

[7] The years 2001-2007 roughly correspond to the years when Junichiro Koizumi was the Prime Minister. 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 in office.

growth rate assumption, and the interest rate scenario. The table shows that as the reinvestment rate increases, it takes longer for the government debt to exceed to the private sector financial assets. For the parameter values we consider, the table shows that the amount of government debt will exceed the private sector assets sometime between 2020 and 2024.

In the calculations that use future GDP growth rates that are different from the government projection of 2% per year, the future government expenditure to GDP ratios 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 government expenditure does not fall as much, our procedure results in underestimation of the 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) * (1.02) / (1+x). The results are shown in Table 8. Under this alternative assumption of the fixed level of government expenditures, the government debt can exceed the MaxDebt sooner, but not by more than a couple of years.

Overall the results 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 the Japanese population. This does not mean that the population dynamics do not matter for the sustainability of the fiscal situation. On the contrary, expected increases in social security related spending in the future as a result of aging, which is also embedded in all of the simulations above, is at the heart of the sustainability problem.

4. Caveats

The above simulations are based on several assumptions. First, we assume that the outstanding balance of corporate savings will remain constant for the forecast horizon. Given that corporate saving has been positive (balance has been increasing) in recent years, this assumption may appear too conservative. If Japanese corporations continue to save and increase their deposits, then absorption of the JGB by domestic financial institutions may continue forever. However, high corporate saving may have been motivated by potential large investment in the near future. Direct investment and M&A activities abroad that draw down corporate savings may occur in the future. Indeed some corporations seem to have stepped up their efforts on overseas investment taking advantage of the appreciated yen. When any sign of JGB vulnerability appears, corporate savings are more likely to find alternative investment outlets other than household savings. Thus, assuming corporate savings to remain constant seems to be reasonable.

Second, our simulations assume that the private financial assets already outside Japan would not be called back to be invested in the JGBs. In other words, the Japanese investors that already invested substantially in foreign assets are assumed to be free from the home bias. In this sense, these Japanese investors would behave similarly to foreign investors. They would repatriate foreign assets to hold the JGBs only when the JGB interest rate rises significantly to match the yields of foreign assets. Thus, for our calculation of the ceiling of domestic financial assets, ignoring foreign assets owned by Japanese residents seems justifiable.

One interesting possibility is that Japanese investors have been accumulating foreign assets out of Ricardian consideration. Since the budget deficit is high, which implies future tax increases, the Japanese taxpayers save in the form of foreign assets so that they can repatriate those assets in the future to pay for increased taxes. If this is the case, the Japanese investors would not repatriate foreign assets before the tax is actually increased. Thus, our assumption that foreign savings would not come back to buy more government debts seems reasonable in this case as well.

Third, for the new flow of household and corporate saving, we assume that all of these savings can be invested into the JGBs with no outflow to hold foreign assets. If this assumption does not hold, the government debt would catch up with the domestic private financial assets even sooner.

What is important is the amount of private sector savings that exhibit substantial home bias. This reasoning casts a doubt on an oft-heard argument that a fiscal crisis cannot happen as long as the current account is in surplus. The current account deficit is neither a necessary nor sufficient condition for a fiscal crisis. Government debt may become unsustainable even when the current account is still in surplus if domestic savers refuse to purchase JGBs at a low rate and shift their portfolio to hold other domestic or foreign assets. On the contrary, a fiscal crisis may not happen even when the current account turns to a deficit if the current account deficit is a result of large capital inflow to Japan.

Fourth, our analysis does not deal with the exchange rate explicitly. Exchange rate fluctuations that anticipate fiscal problems in the future can influence the fiscal crisis in several ways. On the one hand, a threat of fiscal crisis may lead to yen depreciation before a fully developed crisis. This may help export-oriented manufacturing firms in Japan and lead to an increase in government revenues. This may also postpone the fiscal crisis to a later date than our analysis suggests. On the other hand, the currency depreciation may be quicker and more violent, which was the case in many currency crises in emerging economies. Domestic investors may shift their assets abroad, intensifying the fiscal crisis.

Finally, our analysis implicitly assumes that all the government debts are one year bonds. This assumption tends to exaggerate the increases of interest payment when the interest rate rises: with the presence of some long-term bonds, the interest payment increases

more slowly because the interest rates on multi-year bonds do not adjust every year. The assumption also eliminates the possibility that inflation reduces the real value of debt and hence may improve the fiscal sustainability.

Although we do not have data for the maturity structure of all the debts for the general government sector, the maturity structure for the JGBs, which are the liability for the central government, is easily available. Figure 8 shows the maturity structure of the Japanese government bonds from 2003 to 2012. It clearly shows that the maturity structure has been shifting toward larger proportion of long-term bonds. This is probably a result of conscious efforts by the Japanese government to take advantage of the recent low interest rate environment and increase the duration of JGBs. The average remaining maturity, shown in Figure 9, increased from about 5 years in 2003 to 7 years in 2012.

Using the data on the maturity structure of JGBs, we can do a simple calculation of how inflation reduces the real burden of the government. Following Cochrane (2010), let us start by noting that the real value of the government when there are long-term government bonds with different maturities is given by $\int_{j=0}^{\infty} e^{-rj} E_t \left[\frac{1}{P_{t+j}} \right] B_t^{(j)} dj$. 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. When the price level is expected to rise in the future, the real value of the government bonds falls by: $\int_{j=0}^{\infty} e^{-rj} \left(1 - \frac{P_{t+j}^0}{P_{t+j}} \right) B_t^{(j)} dj$. Here P_{t+j}^0 is the expected price level just before the change.

Let us calculate the impact of higher expected inflation on the real value of JGBs using the maturity structure as of March 2012. We assume the constant real interest rate of 1.5%. We assign the maturity of 0.5, 1.5, 2.5, and so on to the bonds with remaining maturity of less than one year, 1 to 2 years, 2 to 3 years, and so on respectively. For the bonds with remaining maturity 10 to 20 years and more than 20 years, we assign the maturity of 17 years and 26 years respectively. Given the maturity structure of March 2012, these assigned maturity numbers imply the average maturity of 7 years, which matches the actual observation. With these assumptions, we can calculate the impact of higher expected inflation on the real value of government debt. For example, if the expected inflation rate increases by 2% permanently, the real value of the government debt falls by 11.1%. If the expected inflation rate increases by 4% permanently, the real value of the government debt falls by 20.0%.

These are certainly large numbers and confirm the potential importance of inflation when there are long-term government bonds. Possibility of inflation, however, is not likely to change our analysis of comparison between the government debt and the private sector financial assets, because the existing government debt is a part of the private sector financial assets. Inflation may reduce the value of the government debt, but it also reduces the value of the private sector financial assets at the same time. Thus, inflation is not likely to change the time when the government debt would exceed the capacity of the domestic private sector.

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.

5. Triggers of the Crisis

The simulations above suggest that Japanese government debt will soon exceed private sector financial assets. As soon as the market expects this, we would expect the interest rate on government debt to start increasing, but the JGB yields do not seem to behave as if a crisis is expected in the next 10 years or less. One explanation is that the market participants believe the government will implement a drastic fiscal reform to restore fiscal sustainability well before government debt exceeds the private sector financial assets. A source of such expectation may be the fact that the total tax burden to GDP ratio for Japan is still low at around 30% (including payment into the social security system).[8] Japan may be able to eliminate fiscal deficits if it increases the tax burden to a level that is comparable to many European countries. For example, the deficit of the central government (general account) in the initial budget was 44 trillion yen in fiscal year 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), an 18% increase in the consumption tax rate would increase the government revenue by 45 trillion yen.[9] Thus, if the consumption tax rate is

[8] The tax burden ratio for fiscal 2011 was estimated to be 29.2% in the initial budget (http://www.mof.go.jp/budget/fiscal_condition/basic_data/201104/sy2302n.pdf).

[9] To be more precise, one percent out of five percent increase of consumption tax will be given to local governments, so that only 80% of the consumption tax increase is reserved for the central government tax

raised from the current 5% to 23%, the entire deficit can be eliminated. Most European countries have a VAT rate more than 15% and some as high as 25% (e.g. Sweden), so the 23% consumption tax may not be outrageous. Thus, at least in theory, Japan still has room for increasing the consumption tax rate.[10]

Indeed, as we noted in the introduction, the Japanese Diet passed the consumption tax reform bill in 2012, which can be the first step for fiscal consolidation. If we assume one percentage point increase of the consumption tax rate increases the tax revenue by 0.5% of GDP, the tax rate increase of 3% planned for April 2014 will raise the tax and social security contribution to GDP ratio (hereafter, tax burden ratio) in fiscal 2014 from the current 30% to 31.5%. For fiscal 2015, the planned mid-year increase of the consumption tax rate of 2% will similarly increase the tax revenue by another 0.5% to 32% of GDP. The tax burden ratio for fiscal 2016 will be 32.5%.

How far do these consumption tax hikes go in addressing the sustainability problem of the Japanese government debt? We can use the simple simulation model described in Section 3 to see the likely impact of the tax hikes. For example, Figure 10 shows the simulation results under the high growth scenario and assuming $\theta = 0.5$. Comparing with Figure 7, one can see the tax hikes delay the year when the debt exceeds MaxDebt for the first time by 2 to 4 years.

Thus, the planned consumption tax hikes are clearly insufficient to stabilize the debt; all they do is to buy a few years. By continuing on increasing the consumption tax rate, Japan can buy more time. For example, Figure 11 shows what happens if the consumption tax rate is continued to be raised by 1% every year starting on April 1, 2017 till it reaches 25% (in 2031). Under the scenarios where the interest rate is assumed to rise as the debt accumulates, this gradual increase in the consumption tax rates does not buy very much time. Under the interest rate scenario R1, where the interest rate is assumed to continue to be low even when the debt to GDP ratio starts to rise, the government debt stays below the private sector financial assets until 2048.

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revenue. However, if the central government reduces the transfers to the local government by the same amount of consumption tax revenue increase for local governments, the central government ends up receiving 100% of the consumption tax increase. There is no academic study to establish the relation between the consumption tax rate and the consumption tax revenue, but many people have used this rule of thumb. It comes from the experience of the consumption tax hike in 1997. When the consumption tax rate was increased from 3% to 5% in April 1997, the consumption tax revenue increased by 5 trillion yen (4 trillion yen to the central government and 1 trillion yen to local governments). This suggests that the tax revenue increases by 2.5 trillion yen, which was about 0.5% of GDP, for every 1 percentage point increase in the tax rate.

[10] After 4 supplementary budgets, the general account deficit for fiscal 2011 ended up as high as 54 trillion yen. To eliminate this deficit entirely, the consumption tax rate would need to be raised to 27%, which would be higher than the VAT rates in Europe.

To fully stabilize the debt to GDP ratio eventually, Japan needs more than gradual consumption tax increase. Using the simple simulation model in Section 3, we can find a path for future tax burden ratios that eventually brings down the debt to GDP ratio to the initial value in 2010 (153%).[11] Obviously such a path is not unique. Figure 12 shows one possible path for each interest rate assumption (R1, R2, and R3) that makes the debt process sustainable. Each path starts with the consumption tax increase that is already planned. The growth rate of GDP divided by working-age person is assumed to be 2.09% (high growth scenario).

Under R1, the tax burden ratio increases from 32% in 2015 to 33% in 2016, and increases by 1% a year until it reaches 43% in 2026. The ratio stays at 43% until 2092 and then falls to 42%. This tax burden ratio path brings the debt to GDP ratio down to 153.7% by 2100 as Figure 13 shows.

Under R2 or R3, the 1% tax rate increase each year would take the tax rates to an 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 a ratio above 50%. The highest rate observed ratio between 2003 and 2010 is 50.8% for Denmark in 2005.[12] Thus, we search for a tax burden ratio path that does not go over 50%. For R2, this implies that the tax burden ratio needs to increase by 1.5% a year from 2016 to 2027. The tax burden ratio reaches 50% in 2027 and stays there for 27 years. Then, the ratio gradually falls to 42% by 2100. Figure 13 shows that the tax policy brings the debt to GDP ratio down to 153.5% by 2100.

The sustainable tax burden ratio under R3 jumps by 4% in 2016 and 2017. Then, the tax burden ratio increases by 3% till it reaches 50% in 2012 and stays there for 37 years until 2059. Eventually the tax rate falls gradually to 42% by 2100. The tax policy brings the debt to GDP ratio down to 153.2% by 2100 as Figure 13 shows.

Figure 14 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 (MaxDebt) for each interest rate scenario. For all interest rate scenarios, the ratio never exceeds 100%, suggesting that the amount of government debt continues to be below the private financial assets.

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[11] In our simple framework, tax revenue increase and government expenditure reduction are completely symmetric: one percentage point increase in tax revenue to GDP ratio has the same impact as one percentage point reduction in government expenditure to GDP ratio. Thus, although we present the analysis in terms of tax increase, one can interpret the "tax increase" here as a combination of tax increase and expenditure cut.

[12] http://www.oecd-ilibrary.org/taxation/total-tax-revenue_20758510-table2. If we interpret the increase in tax burden ratio in our experiment as a combination of tax increase and expenditure reduction, 50% may not be the constraint.

If the market participants expect future tax increases such as the ones in Figure 12, it is quite understandable why we have not yet observed high yields on JGBs. We know, however, that the market expectation can change quickly. If and when market participants are convinced that tax increases are unlikely to come, it can trigger a crisis.

One can consider several potential triggers for such a change in the expectation. First, a change in the expectation may be triggered by some events in the financial market. An example is a downgrade by credit rating agencies. Investors may revise their assessment of bonds and re-balance portfolios based on (unexpected) changes in credit rating. The past experience of downgrades in Japan, however, suggests that a downgrade is not likely to be an important trigger, as we discuss further below.

Second, a change in the expectation may be triggered by a political event. For example, if the financial market sees that the government is not likely to do more than the already planned consumption tax hike, the market may conclude the government cannot achieve fiscal consolidation in time. Another example is a change in the policy of government financial institutions to buy JGBs. In 1998, some confusion over how many government bonds the Fiscal Investment and Loan Program (FILP) would buy led to a sudden rise of the JGB yield by more 100 basis points in less than three months.

Third, contagion from a foreign country that is experiencing a debt crisis may trigger a change in the expectation for Japan. For example, the debt crisis in Greece has spread to other highly indebted countries in the euro area, including Ireland, Portugal, Spain and Italy. One cannot rule out the possibility that such a contagion may influence countries outside the euro area, such as Japan.

Fourth, a change in the expected future interest rates may trigger a crisis. Such a change in the interest expectation may be a consequence of a change in monetary policy action. The Abe government that was formed in December 2012 following the victory of Liberal Democratic Party (LDP) in the lower-house election has been pressuring the Bank of Japan to introduce more aggressive monetary easing in order to get out of deflation. Haruhiko Kuroda, who became new governor of the Bank of Japan on March 20, 2013, has made it clear that he is willing to do whatever it takes to end the deflation. Higher inflation expectation has not resulted in higher interest rates, yet, but the nominal interest rate will eventually start to rise once the economy gets back to the normal growth path.

An event in the summer of 2003 illustrates how a small rise in the JGB yield can be amplified quickly. The yield of 10-year JGB went up from 0.5% in June to 1.6% in September in 2003. A sudden price decline raised the VaR (value at risk) of the JGB, and many financial institutions sold JGBs to reduce the risk. This behavior, which was individually prudent, resulted in depressing the JGB price further.

A JGB downgrade by a credit rating agency is another potential trigger of a crisis. Japan's past experience suggests, however, that the credit rating agencies are not likely to be

a trigger. The JGB has already undergone a series of downgrades by Moody's, S&P and Fitch in the late 1990s to the beginning of 2000s, and again recently. Looking back at these experiences, we can judge the likelihood that credit rating agencies would pull the trigger for the Japanese sovereign debt crisis. The history of the above-mentioned changes in credit rating is summarized in Figure 15 and Table 7.

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 go up, the yen to depreciate, and the stock prices to decline. To see whether these reactions have been observed at the time of downgrading in the past, market reactions in various event windows (from 1 to 150 days) are examined. Figure 16 shows such results. Panels 1 to 3 show the reaction of the JGB bond rate to S&P downgrades and negative watch announcements (Panel 1); to Moody's downgrade and negative watch announcements (Panel 2); and to Moody's both downgrades and upgrades (treated as negative downgrades) (Panel 3). The vertical axis is the interest rate change (percentage point changes), and the horizontal axis is the window of changes from day t-k to t, or from t to t+k, where k=1, 5, 25, 75, 150. Since other news and events influence the bond yield, immediate changes (k=+1 and +5) are more appropriate in evaluating the impact of credit rating changes. The changes before the credit rating change are shown in order to check whether there were significant trends before the credit rating downgrade, either for rationally anticipating credit rating changes or for other reasons, which may carry over to the post-event days. In all the panels, the changes in the bond yields around the event date are hardly positive. If anything, downgrades tend to lower the yields. Similarly, Panels 4 to 6 show the reactions of the yen/dollar rate to various categories (S&P, Moody's, and Moody's including upgrades) of credit rating changes. The (+) means yen depreciation and the unit is in percentage changes. These panels suggest that the yen/dollar rate has been unpredictable before or after the credit rate changes, but downgrades do tend to be followed by slight yen appreciation if any. With respect to a stock price index, Panels 7 (S&P downgrades), 8 (Moody's downgrades) and 9 (Moody's including upgrades) suggest that the stock price index tended to fall both before and after the downgrades, as the changes are mostly below 0 in the vertical axis, which measures the percentage change in the stock price index. Downgrades tended to occur in the phase of negative market trend, but in sum, we do not find evidence that any of the expected reactions occurred when the JGB was downgraded.

The most dramatic downgrade event so far was the 2-notch downgrading by Moody's on May 31, 2002. The Ministry of Finance was quite upset and wrote an open letter to Moody's questioning the judgment. The market remained calm, however, sending the bond yield actually lower. Thus, it seems safe to conclude that credit rating agencies are not likely actors that pull a trigger for a crisis, at least for Japan.[13] This assessment has been

[13] Because Japan has not experienced any crisis despite repeated downgrading by credit rating agencies, some compare the credit rating agencies to "a boy who cried wolf" in Aesop's fable. A relevant lesson from the

confirmed by what followed after the downgrading by Moody's on August 24, 2011 and the most recent one by Fitch on May 22, 2012. The downgrades were more or less expected and the JGB yield did not change at all following the announcements.

Another possible trigger may be a hike in the Credit Default Swap (CDS) spread. Figure 17 shows that the CDS spread for the JGB has been trending upward 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, and spiked up again immediately after the March 11 earthquake/tsunami. The CDS spread reflects the default probability assessment by the market. Figure 17 suggests that the market assessment of the default probability for the JGB increased over the last three years. Although the level of spread for Japan is still low compared to some European countries that have experienced fiscal crises in 2010-11, the upward trend is obvious. Just for comparison, CDS spreads for Spain and Italy were at around 100 bp in November/December 2009, before rising higher than 100 in 2010, and then above 300 in the summer of 2011.

6. Concluding remarks

The Japanese government debt is clearly unsustainable without a drastic change in fiscal policy. The interest rates of Japanese government bonds, however, have been low. Market participants do not seem to worry about the problem of high and rising debts. The continuing low JGB yields may reflect the market's view that the ample amount of private sector financial assets in Japan will always be there to absorb additional JGBs, but the current calm situation may not continue. The rapid aging of the Japanese population means that the growth of private sector savings is slowing down and eventually will turn negative. The Japanese government cannot rely on the private sector to continue buying JGBs beyond a certain point.

In order to avoid its debt hitting the ceiling of private saving, the government may raise taxes to close the deficit gap in time. Since the Value Added Tax (consumption tax) rate is still 5%, there is some room for the Japanese government to achieve fiscal consolidation through tax hikes.

This paper formalizes the above ideas into a simulation model. If the government successfully increases taxes in time, the debt becomes sustainable. If the government fails to implement fiscal reform, however, a crisis of high bond yield will unfold. At that point, it may be too late to avert serious consequences of a drastic cut in government services (like European countries in the current ongoing crisis), a drastic cut in living standards caused by

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fable, however, is that a wolf eventually showed up and the people in the village were not prepared. Whether the evidence that credit downgrading so far has not triggered a crisis does not imply the crisis itself would not happen, with or without warnings.

depreciation, and a high rate of inflation that results from the central bank financing of government debt.

The simulation model in this paper is based on many simplifying assumptions. Relaxing some of these is an important task for future research. For example, our model ignores the fact that many Japanese government bonds have maturity longer than one year and hence cannot fully analyze potential impacts of inflation. Our model also treats any tax increase and any expenditure cut symmetrically. Thus, it cannot address some important issues such as the desirable combination of increases in various tax rates, reduction in various government expenditures, and reforms of national pension system to address the sustainability problem for the government debt. Ideally, one would want to develop a structural model that specifies the dynamic interactions of the key variables that we are studying. These are all important topics for future research.

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Appendix. 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:

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

$$N_E + N_S + N_R = N_T$$

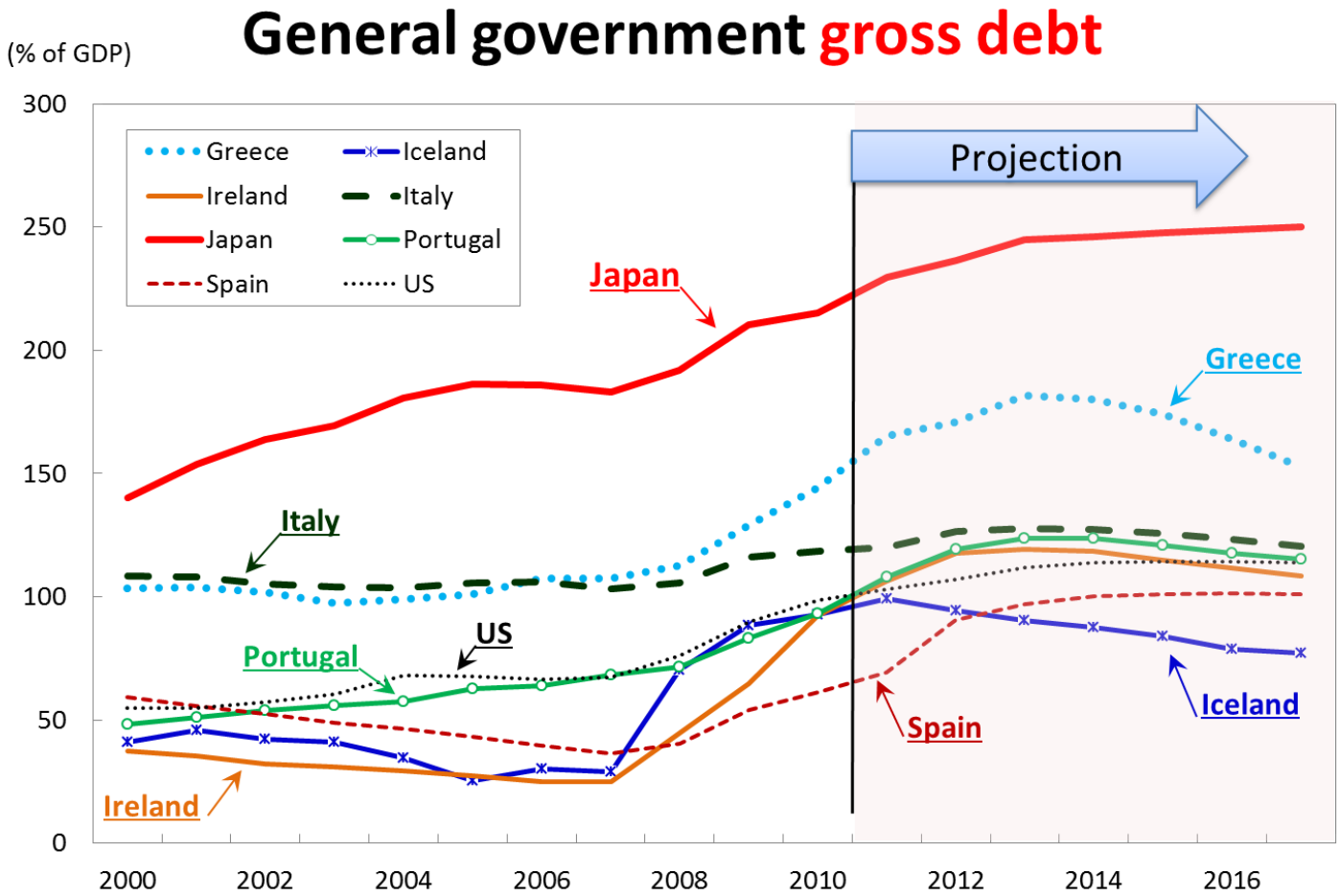
By solving these, we can calculate N_S and N_R.

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 a 2000-2010 interval and use that as θ_{it} for $t \in [2010, 2050]$.

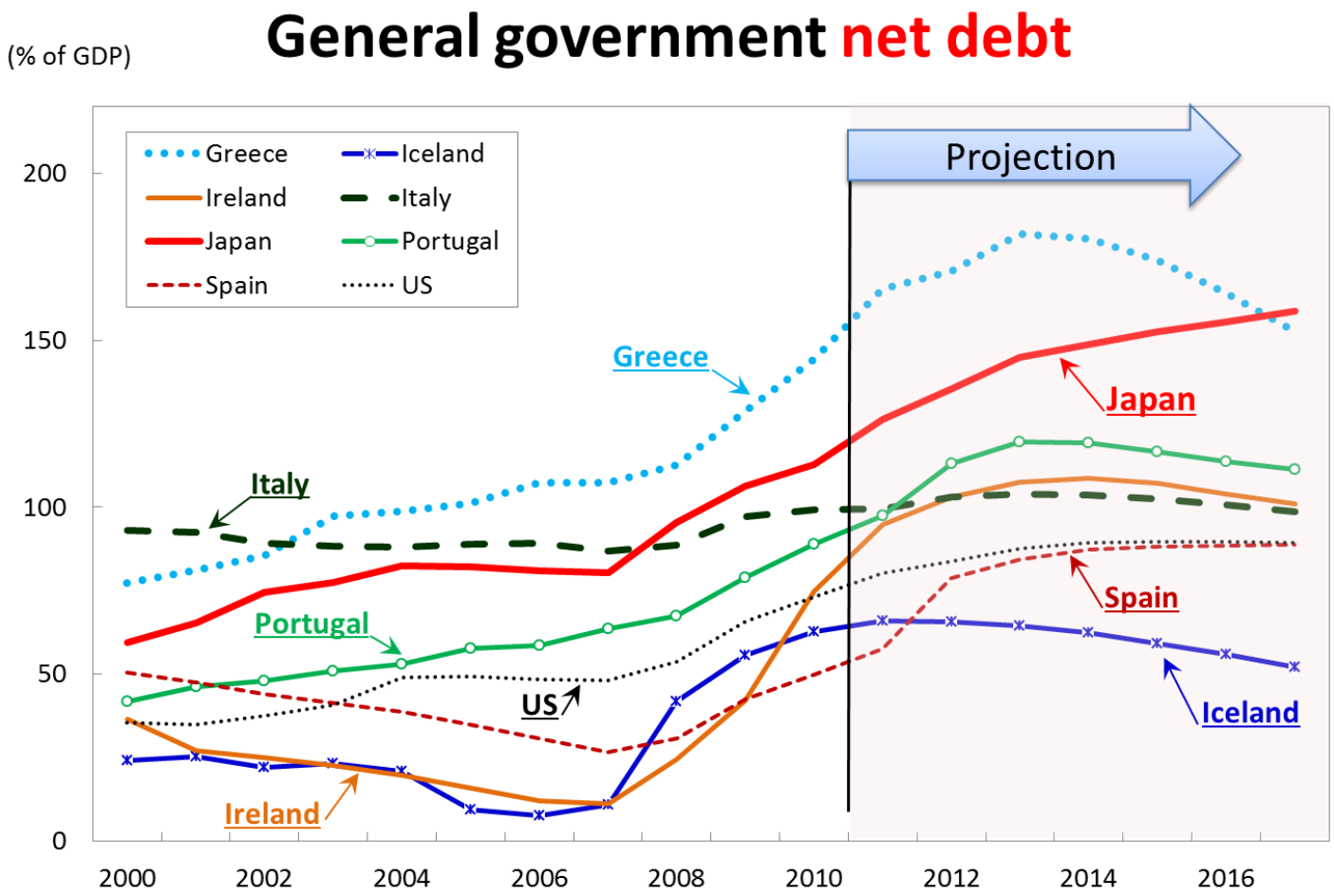
The population weight for each generation is calculated from the mid-point projection by the National Institute of Population and Social Security Research (IPSS). Figure A2 shows the population distribution for 2010, 2020, 2030, 2040, and 2050. We can see that the Japanese population is expected to age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

Figure 1. Gross Government Debt to GDP Ratios for Selected Countries



Source: International Monetary Fund, World Economic Outlook Database, Oct 2012.

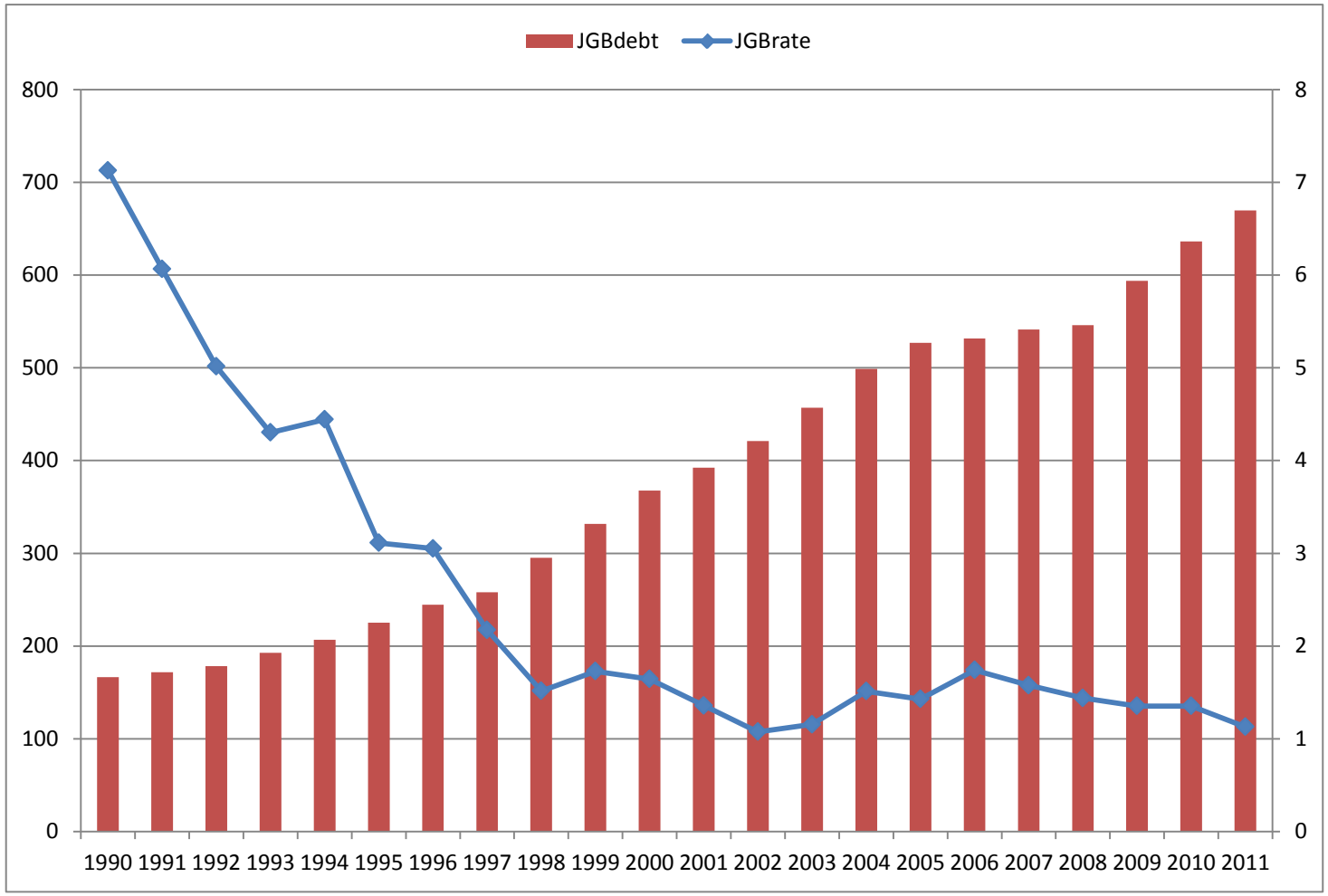
Figure 2. Net Government Debt to GDP ratios for Selected Countries



Source: International Monetary Fund, World Economic Outlook Database, Oct 2012.

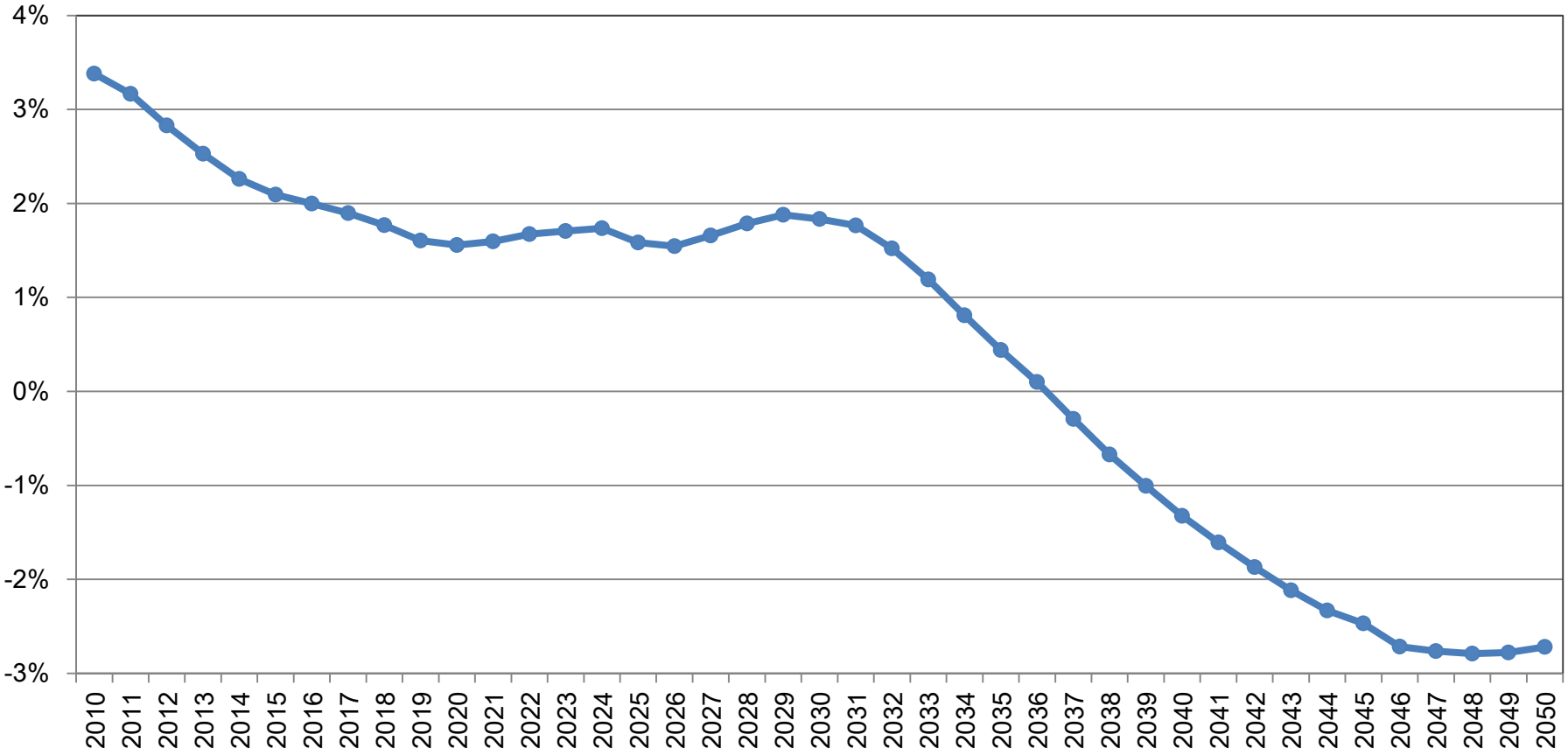
Excel FILE Name: WEO_Oct2012

Figure 3. JGB outstanding and JGB interest rate



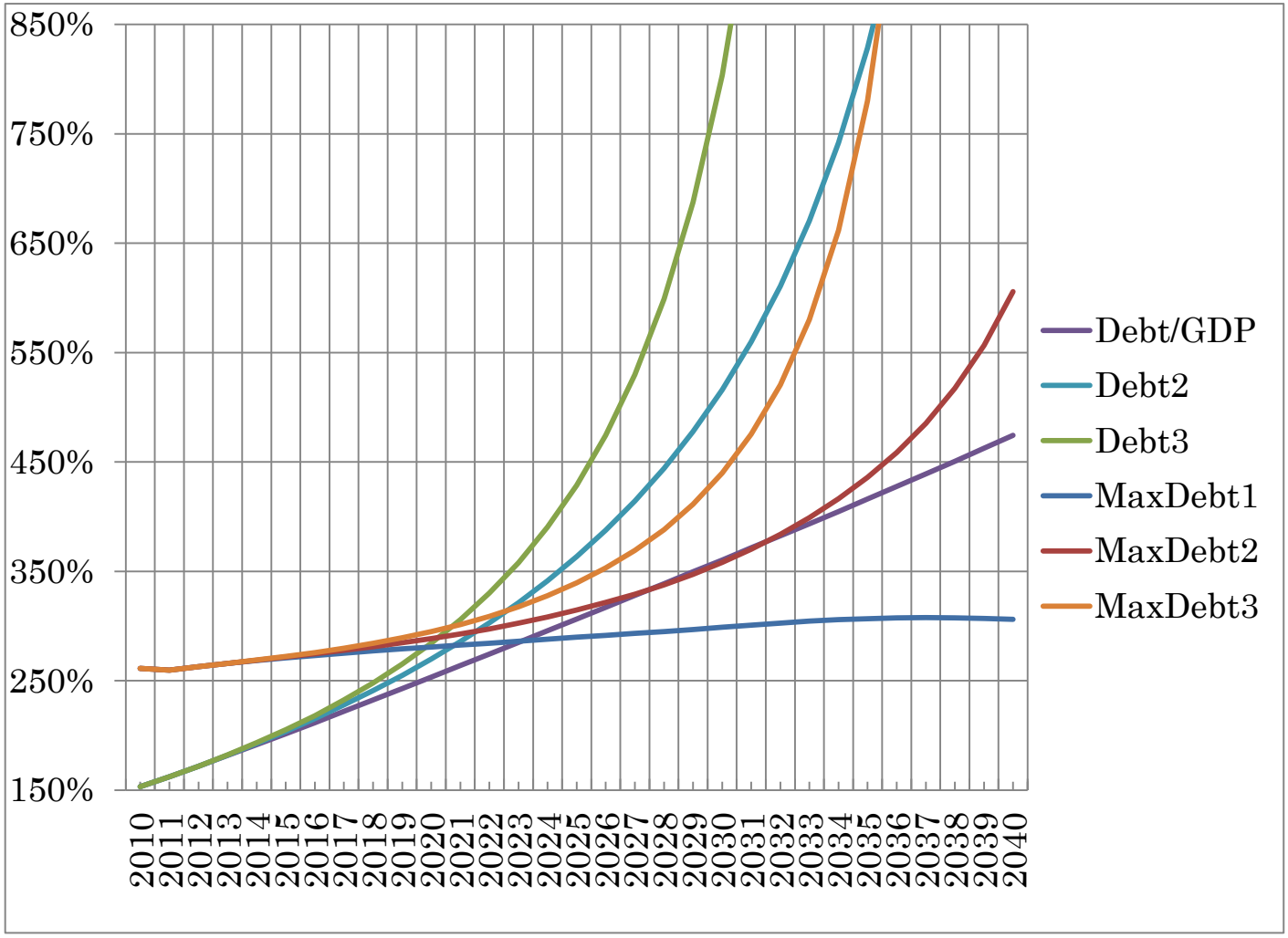
Source: Ministry of Finance.

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



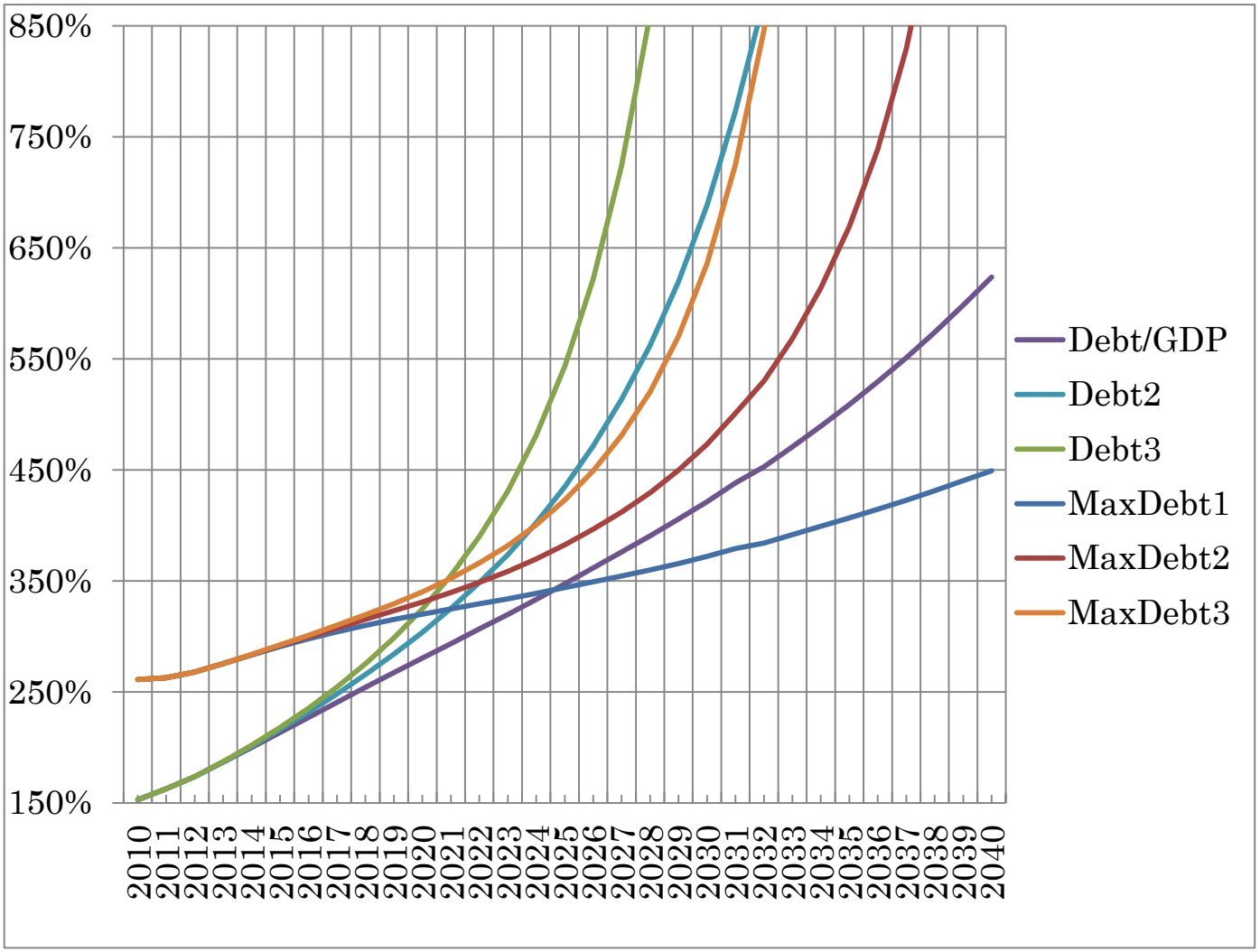
Note: Authors' calculation.

Figure 5. Government Debt and Private Sector Financial Assets: 2010-2040 (2% GDP Growth, θ=0.5)



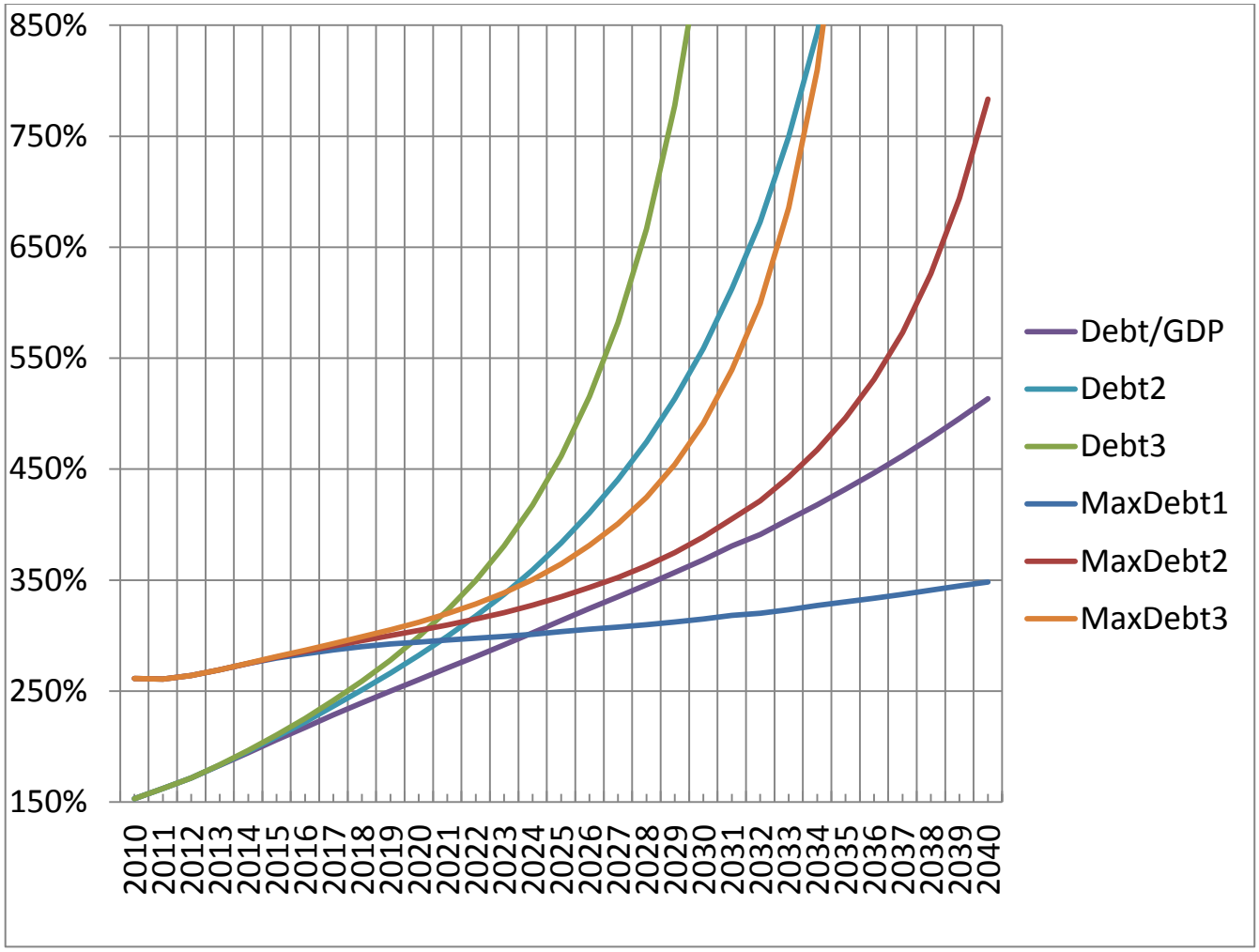
Note: Authors' calculation.

Figure 6. Government Debt and Private Sector Financial Assets: 2010-2040 (1.05% GDP per worker growth, θ=0.5)



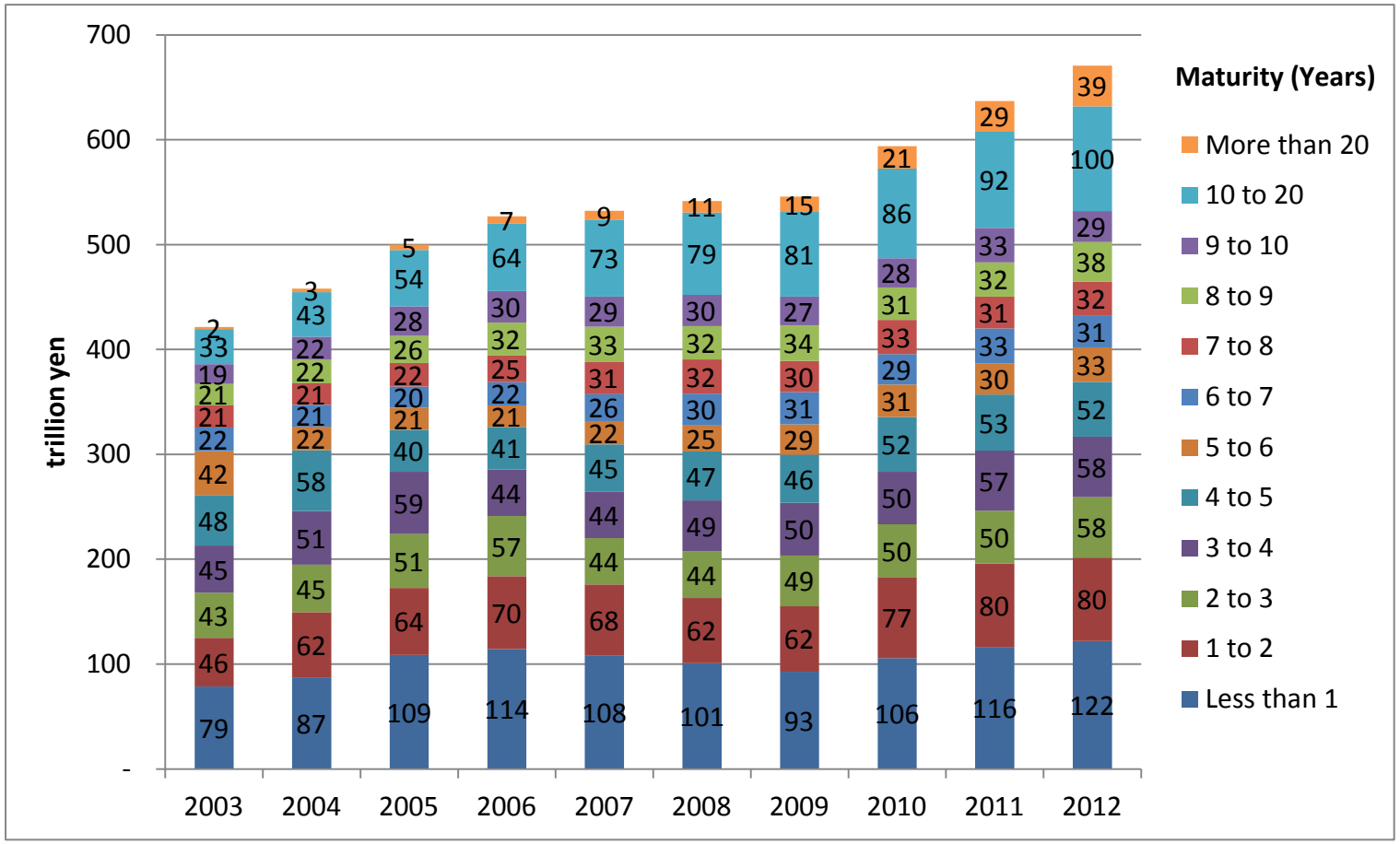
Note: Authors' calculation.

Figure 7. Government Debt and Private Sector Financial Assets: 2010-2040 (2.09% GDP per worker growth, θ=0.5)



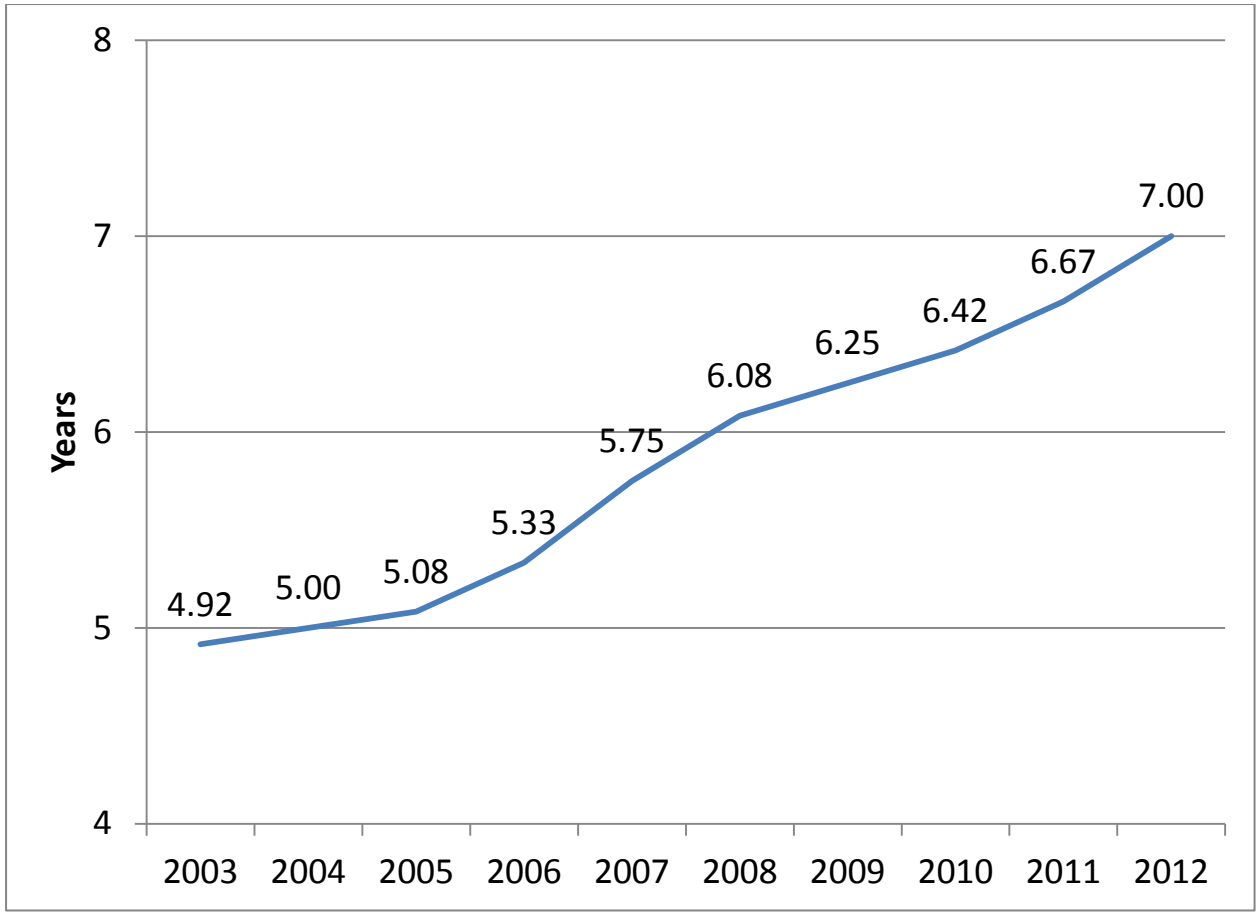
Note: Authors' calculation.

Figure 8. Remaining Maturities of Japanese Government Bonds (as of the end of March each year)



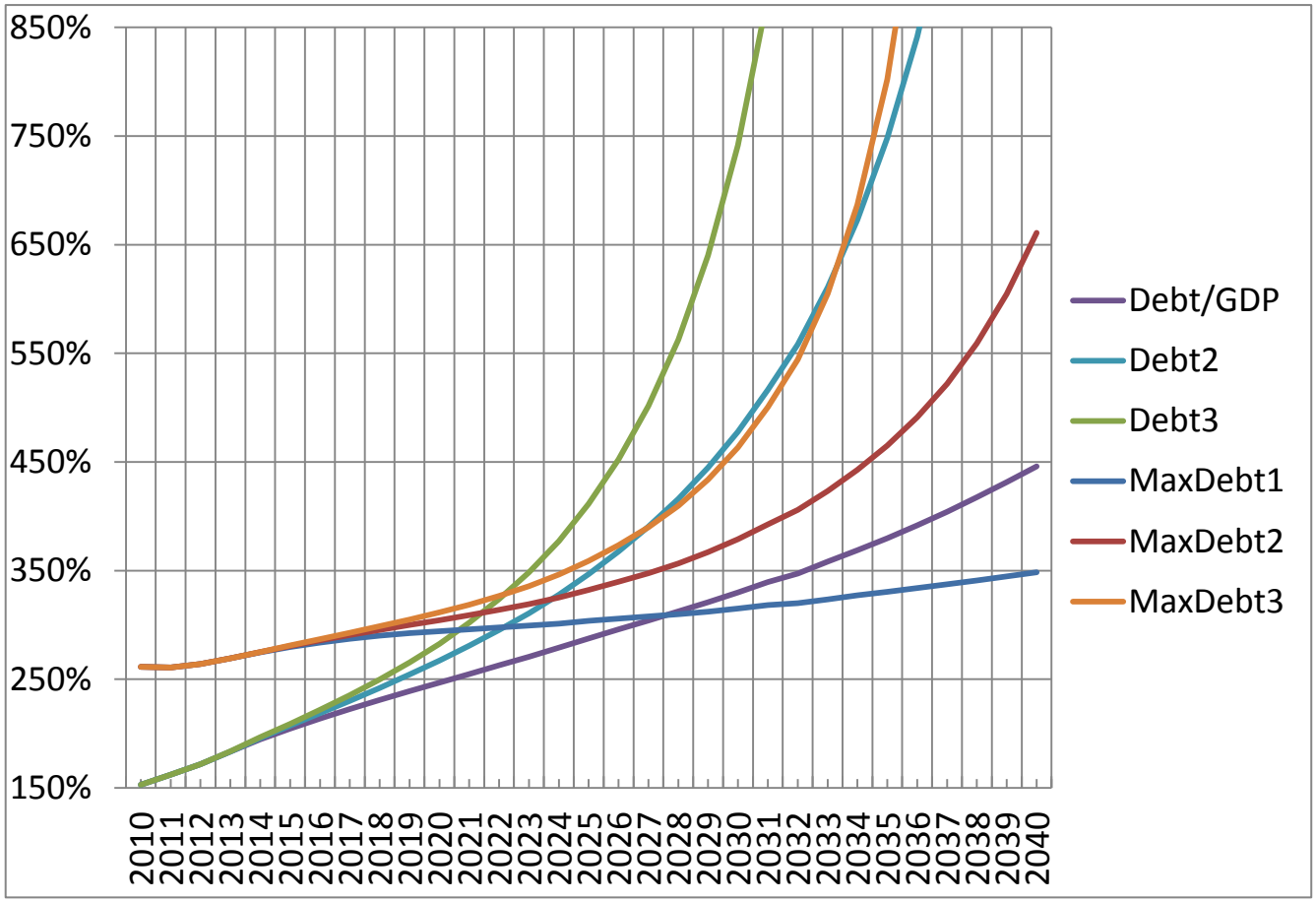
Source: Ministry of Finance, *Debt Management Report 2012*
(http://www.mof.go.jp/english/jgbs/publication/debt_management_report/2012/index.html)

Figure 9. Average Remaining Maturity of JGBs



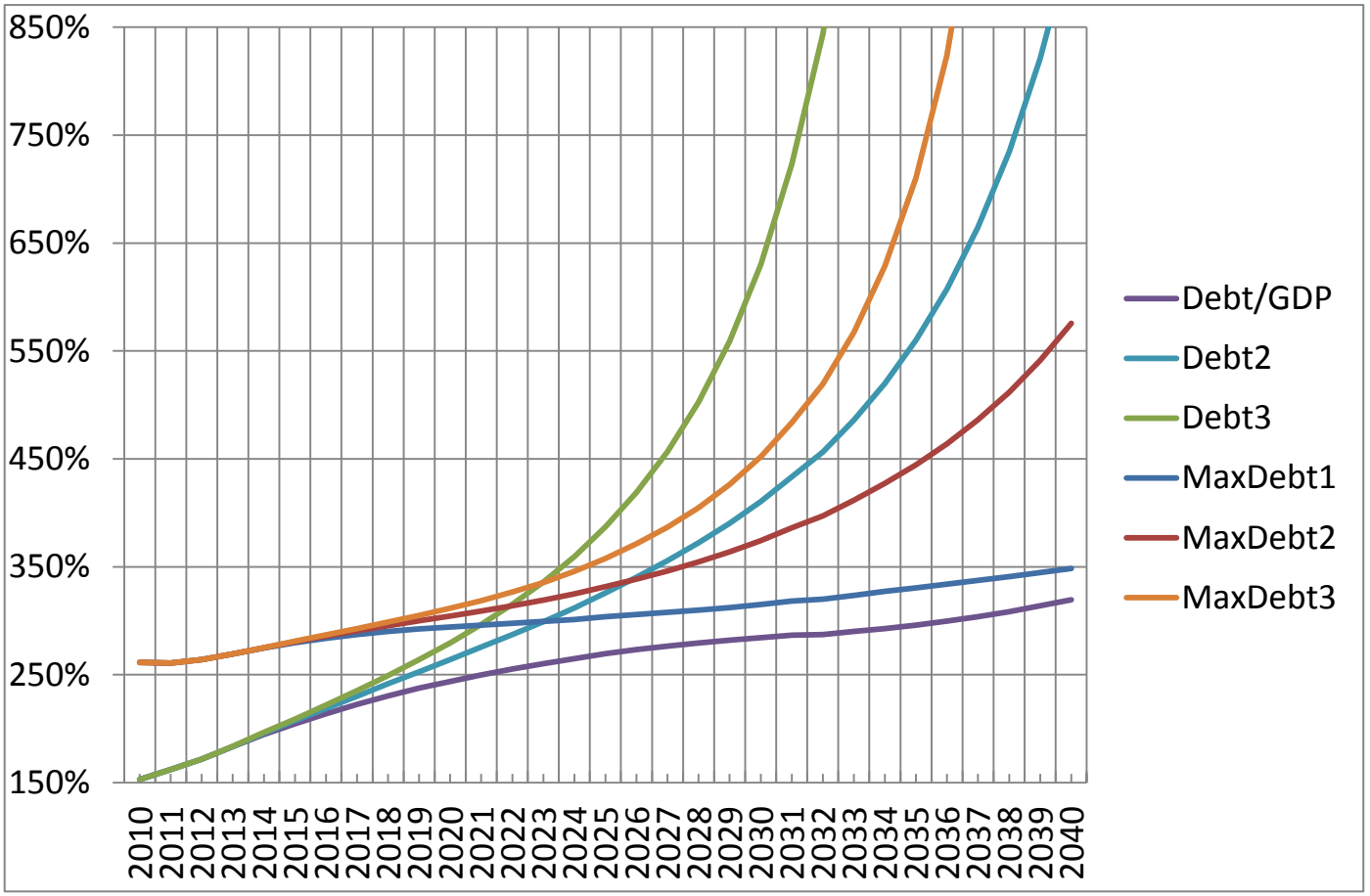
Source: Ministry of Finance, *Debt Management Report 2012*
(http://www.mof.go.jp/english/jgbs/publication/debt_management_report/2012/index.html)

Figure 10. Government Debt and Private Sector Financial Assets When the Currently Planned Consumption Tax Hikes are Implemented (but no more): 2010-2040 (2.09% GDP per worker growth, θ=0.5)



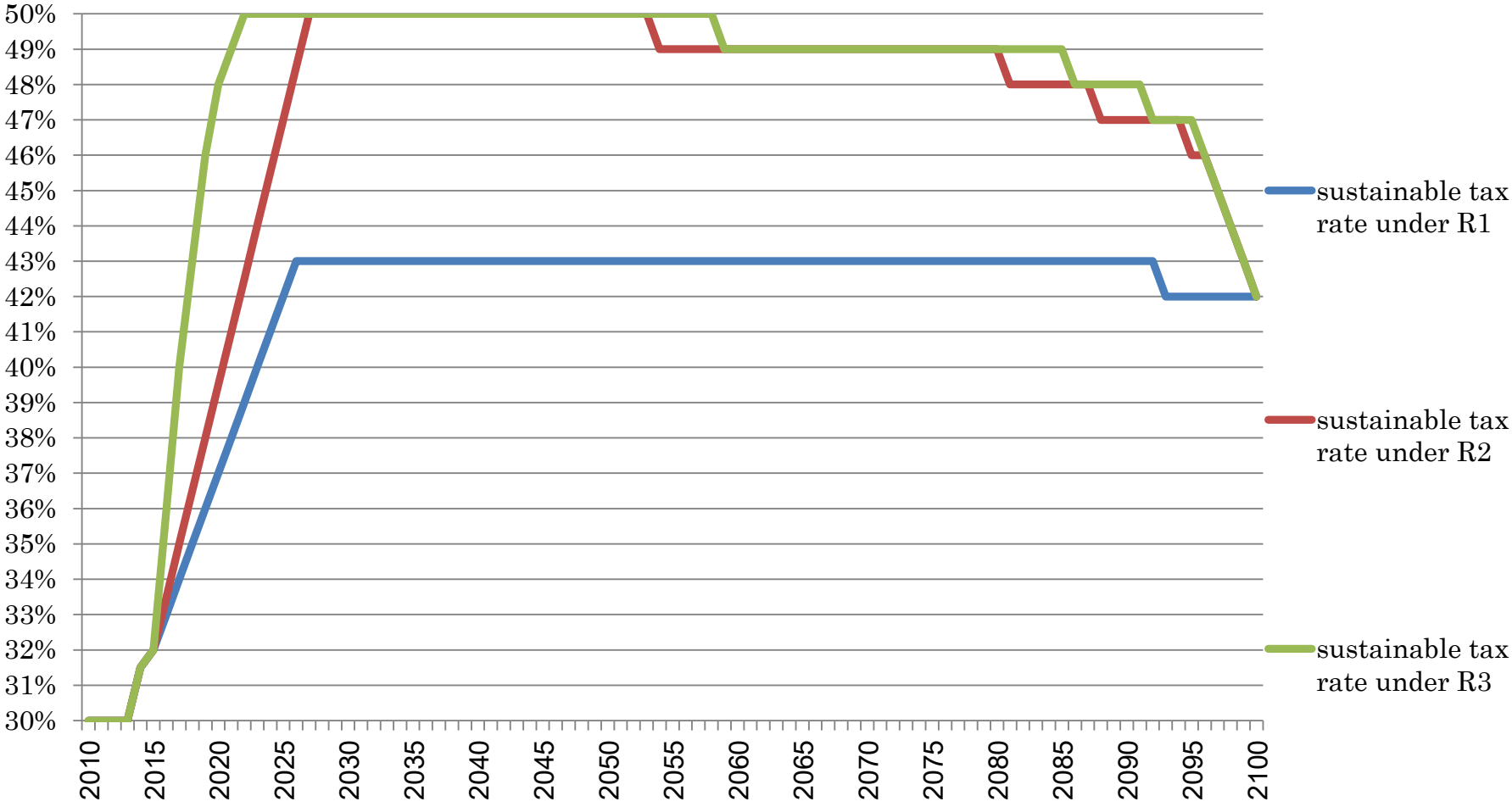
Note: Authors' calculation.

Figure 11. Government Debt and Private Sector Financial Assets When the Consumption Tax Rate is Raised Gradually to 25% by Fiscal 2031 : 2010-2040 (2.09% GDP per worker growth, θ=0.5)



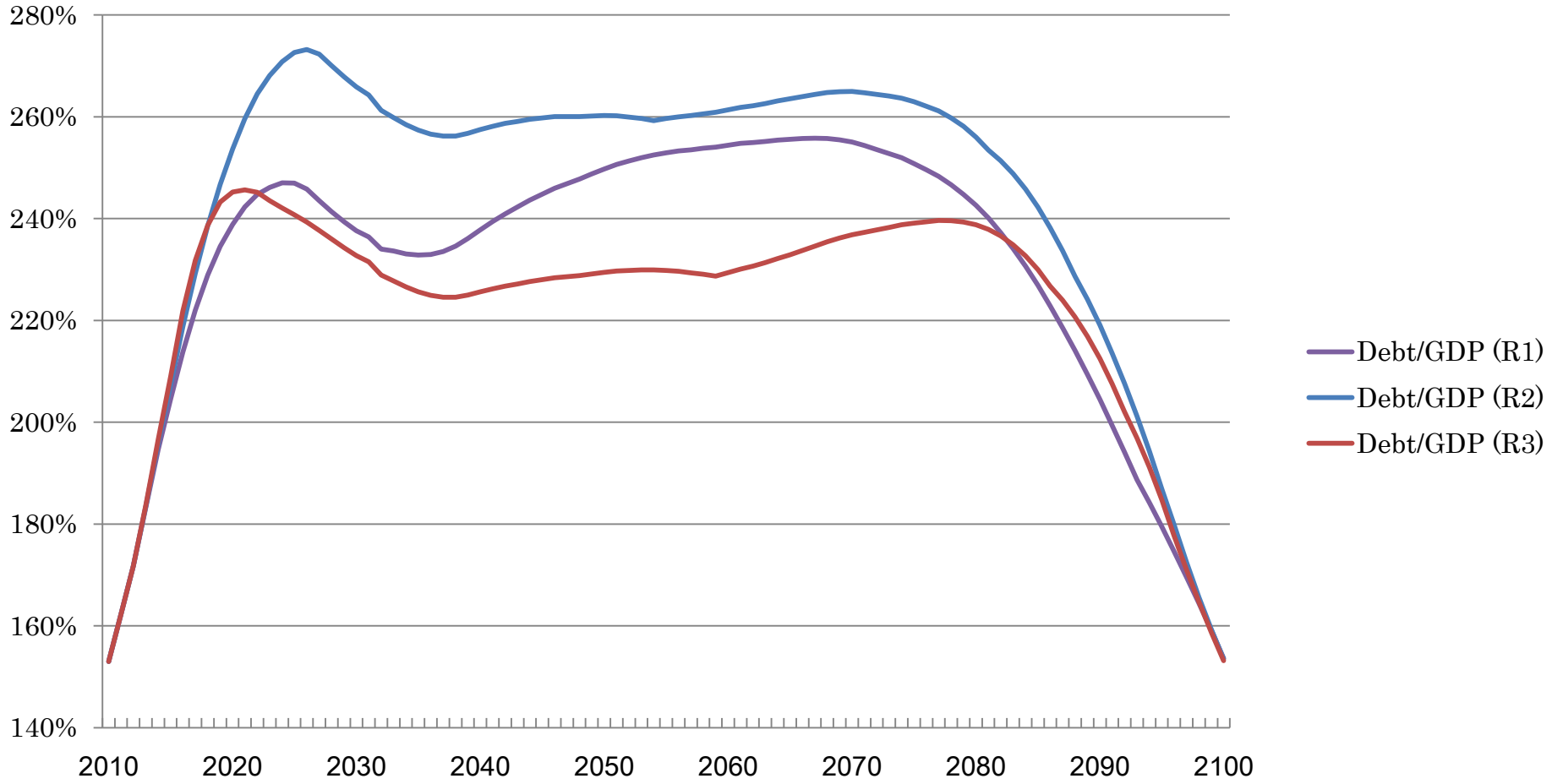
Note: Authors' calculation.

Figure 12. Sustainable Tax Policy under Each Interest Rate Assumption



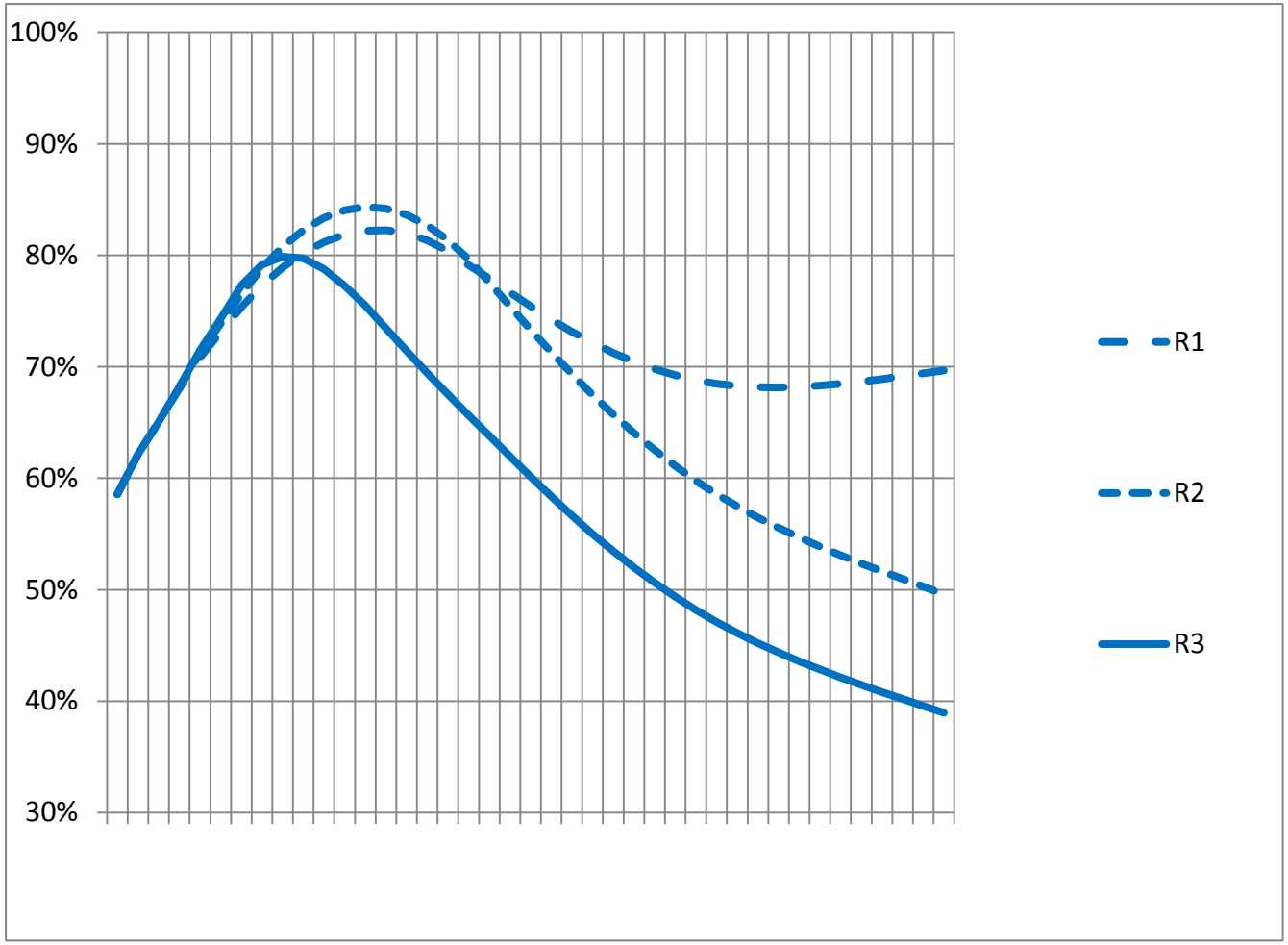
Note: Authors' calculation.

Figure 13. Debt/GDP Ratio with Sustainable Tax Policy



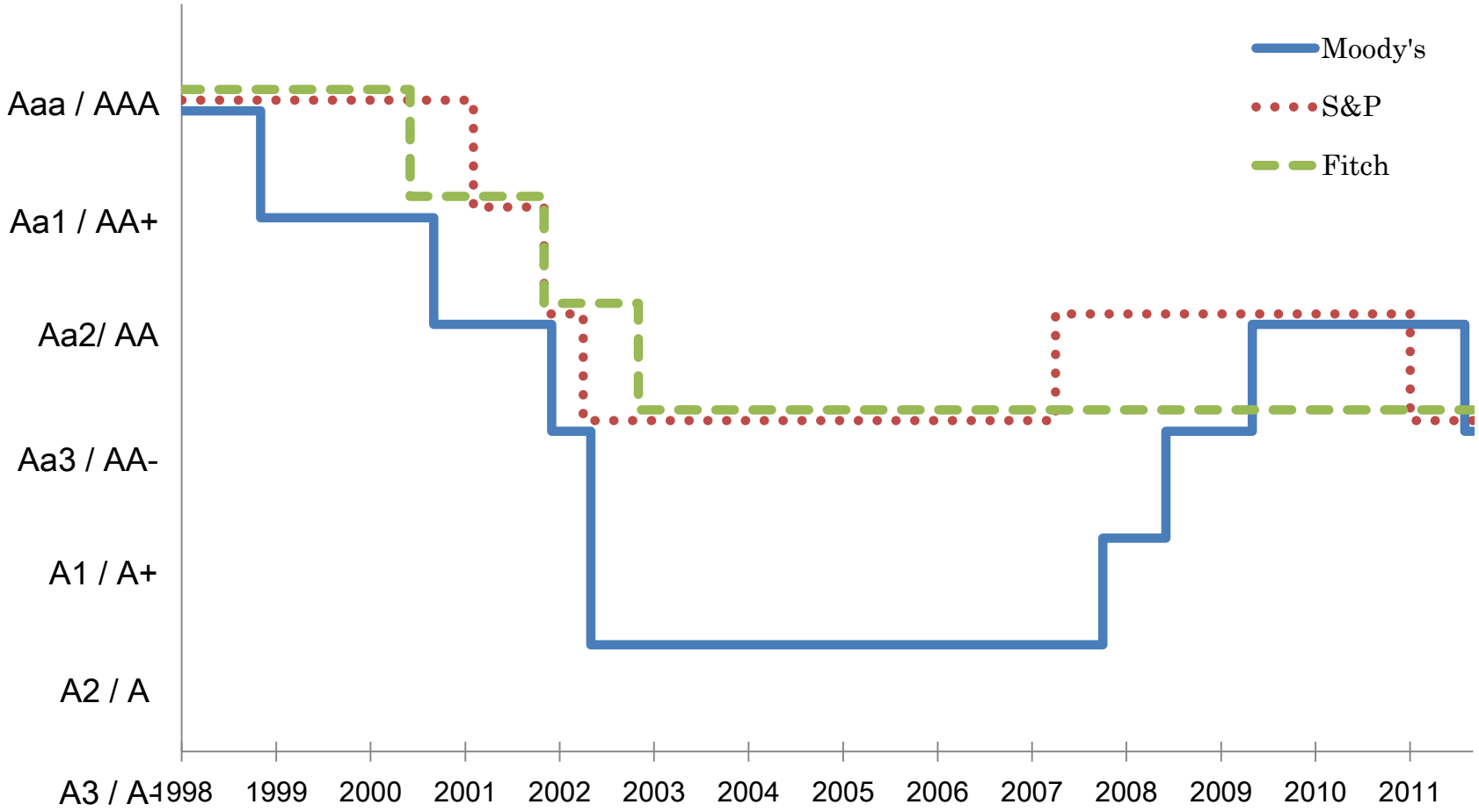
Note: Authors' calculation.

Figure 14. Debt to MaxDebt Ratio with Sustainable Tax Policy



Note: Authors' calculation.

Figure 15. Credit Rating



Source: Bloomberg.

Figure 16. Event Analysis, downgrade on JGB rate

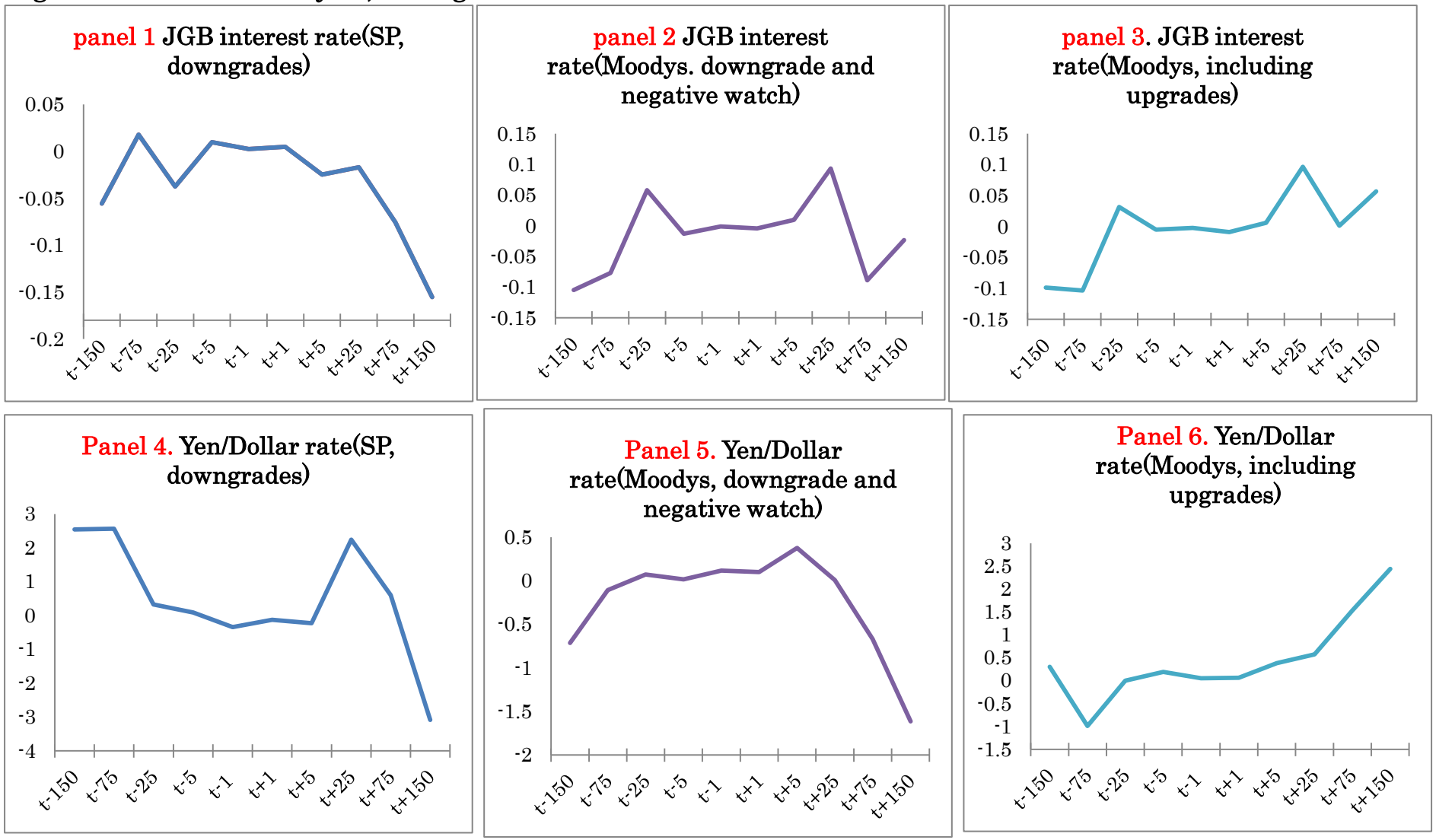
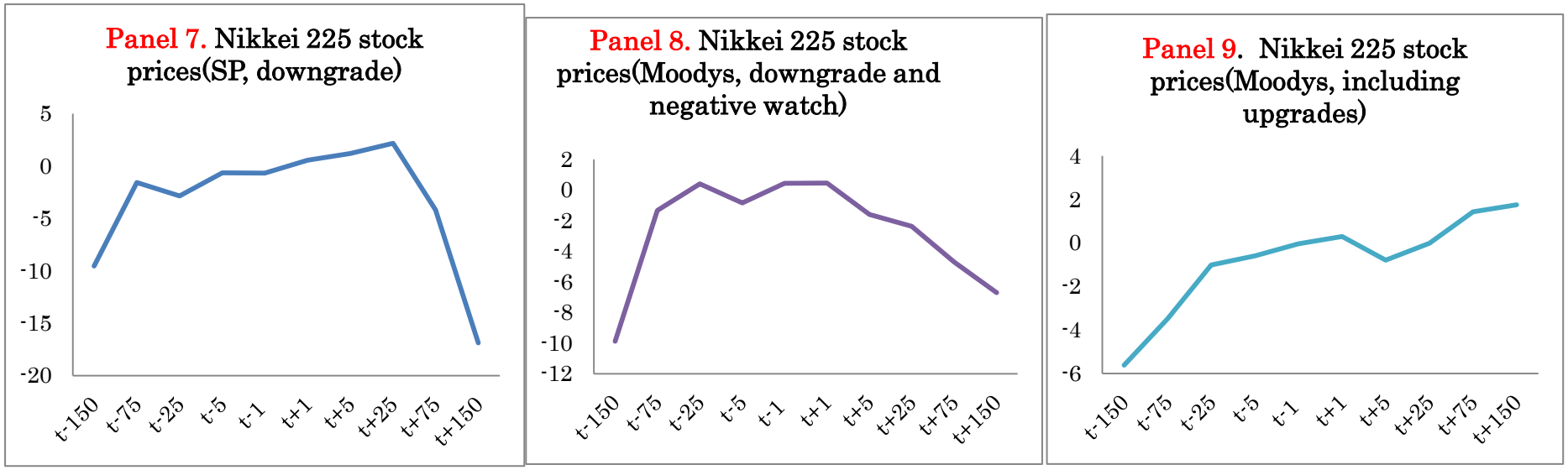
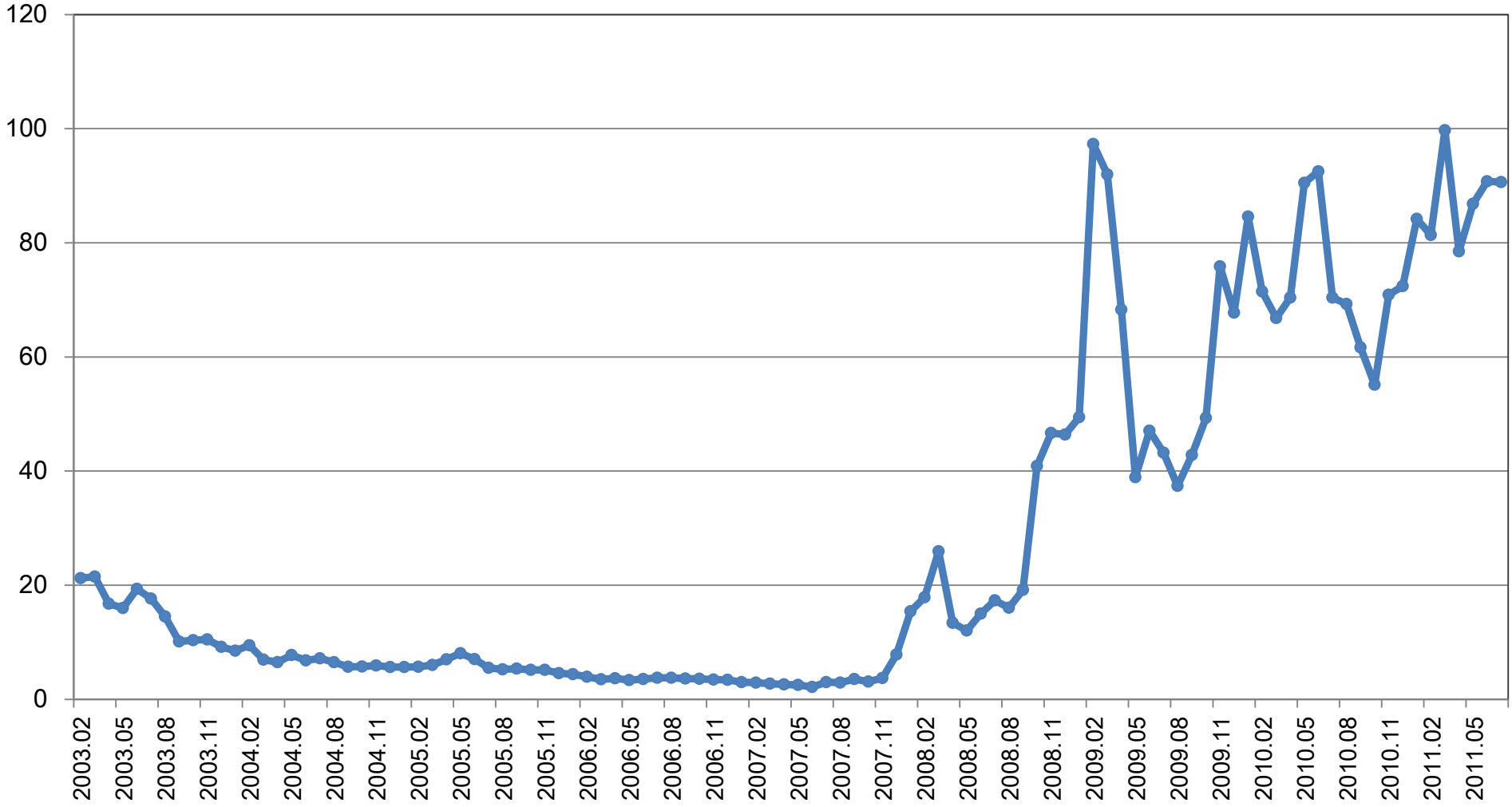


Figure 16 (continued). Event Analysis, downgrade on JGB rate (continued)



Note: Author's calculation.

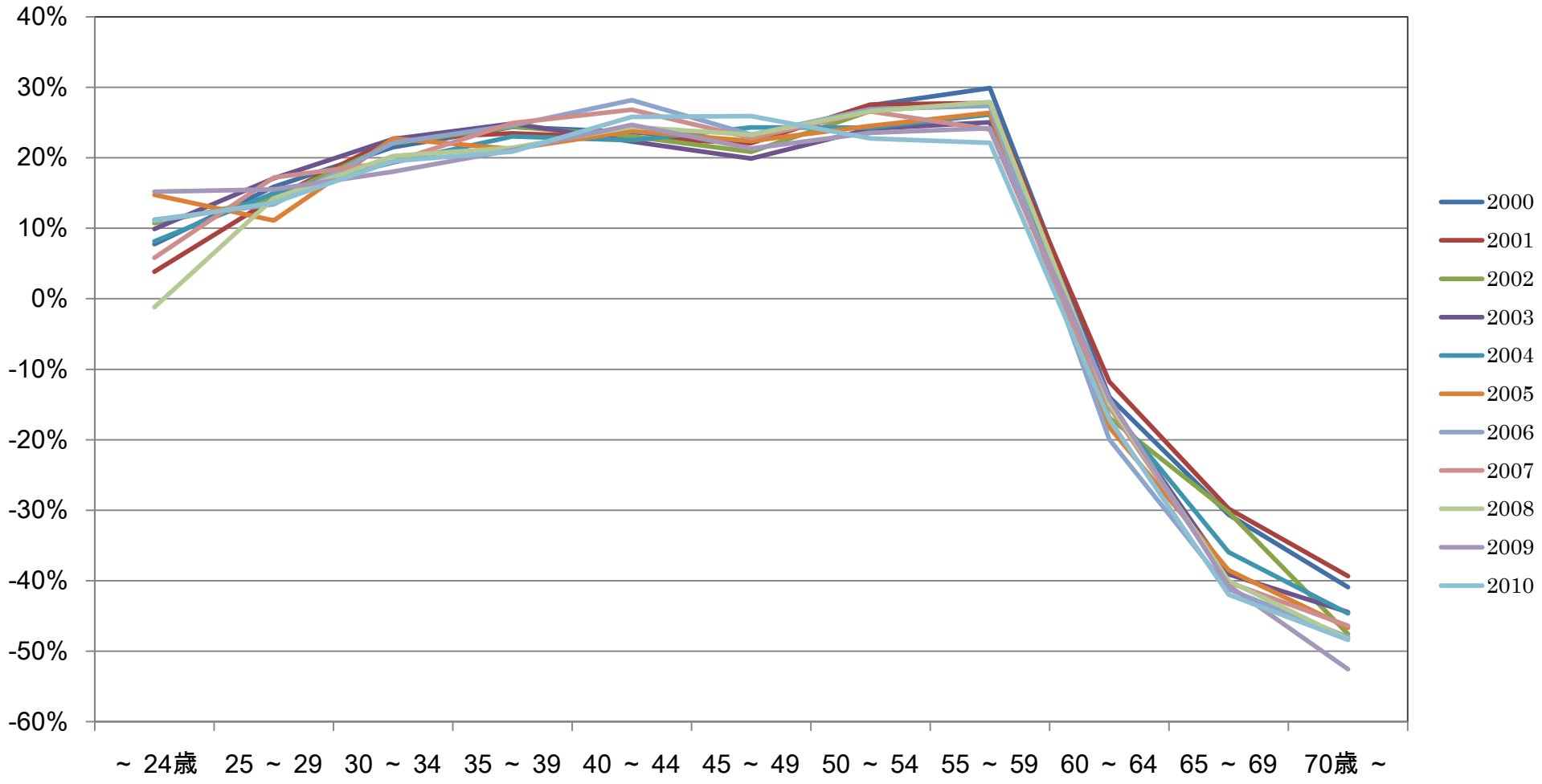
Figure 17. JGB CDS Spreads: 2003-2011 (Weekly)



Source: Authors' calculation

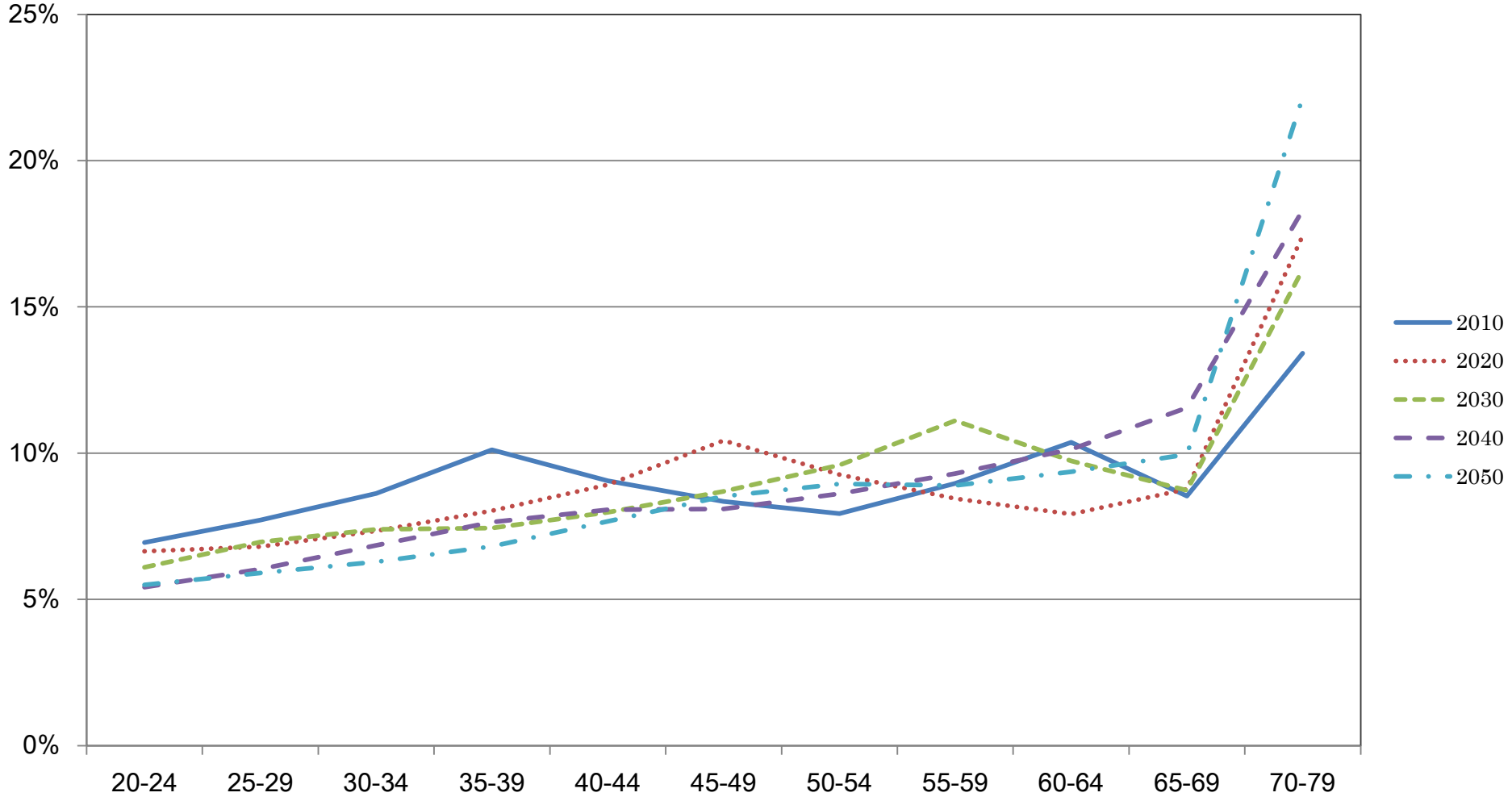
Note: Authors' calculation.

Figure A1. Saving Rate by Household Age Bracket



Source: *Family Income and Expenditure Survey.*

Figure A2. Population Distribution



Source: National Institute of Population and Social Security Research (IPSS), mid-point projection.

Table 1. Owners of JGBs

	2005 March		2006 March		2007 March		2008 March		2009 March		2010 March		2010 Dec	
	tril. Yen	(%)	tril. Yen	(%)	tril. Yen	(%)	tril. Yen	(%)	tril. Yen	(%)	tril. Yen	(%)	tril. Yen	(%)
General Government	2.0	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%	57.0	8.5%	61.0	9.1%	—	—	—	—	—	—	—	—
Bank of Japan	92.1	14.3%	86.7	13.0%	71.0	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%	147.0	20.2%
private pension funds	21.3	3.3%	24.0	3.6%	26.2	3.9%	26.8	3.9%	25.6	3.8%	28.0	4.1%	28.2	3.9%
others	31.0	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%	28.0	4.2%	33.4	5.0%	36.3	5.2%	36.0	5.3%	34.4	5.0%	33.0	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%	695.0	100.0%	680.9	100.0%	682.1	100.0%	727.1	100.0%

Source: Ministry of Finance.

Table 2. Explaining 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)**	

Tokuoka (2010) Table II.6

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.

Table 3. History of Demographic Dividend

	⊿rGDP =	⊿POP +	⊿(wPOP /POP) +	⊿(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

Table 4. Implications of 2% growth

	⊿rGDP =	⊿POP +	⊿(wPOP /POP) +	⊿(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 . ⊿POP and ⊿(wPOP/POP) are calculated from forecasts of IPSS, then ⊿(rGDP/wPOP) is assumed to be 2.09%, which was the average of 2001-2007. ⊿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).

Source: Authors' calculation.

Table 5. Growth per worker productivity at 1.05%

	⊿rGDP =	⊿POP +	⊿(wPOP /POP) +	⊿(rGDP /wPOP)
2011-20	-0.04%	-0.31%	-0.77%	1.05%
2021-30	0.28%	-0.62%	-0.15%	1.05%
2031-40	-0.46%	-0.83%	-0.68%	1.05%
2041-50	-0.44%	-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 . ⊿POP and ⊿(wPOP/POP) are calculated from forecasts of IPSS, then ⊿(rGDP/wPOP) is assumed to be 1.05%, which was the average of 1994-2010. ⊿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).

Table 6. Per-worker labor productivity increase of 2.09%

	⊿rGDP =	⊿POP +	⊿(wPOP /POP) +	⊿(rGDP /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 . ⊿POP and ⊿(wPOP/POP) are calculated from forecasts of IPSS, then ⊿(rGDP/wPOP) is assumed to be 2.09%, which was the average of 2001-2007. ⊿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)

Table 7. Year When the Amount of Government Debt Exceeds the MaxDebt

	Interest rate Scenario 1	Interest rate Scenario 2	Interest rate Scenario 3
2% GDP growth, $\theta = 0$	2024	2021	2020
2% GDP growth, $\theta = 0.5$	2024	2022	2021
2% GDP growth, $\theta = 1$	2024	2023	2023
Low growth, $\theta = 0$	2025	2021	2020
Low growth, $\theta = 0.5$	2025	2023	2021
Low growth, $\theta = 1$	2025	2025	2024
High growth, $\theta = 0$	2025	2021	2020
High growth, $\theta = 0.5$	2024	2022	2021
High growth, $\theta = 1$	2024	2023	2023

Table 8. Year When the Amount of Government Debt Exceeds the MaxDebt (assuming the level of government expenditures to be fixed when the growth rate is lower)

	Interest rate Scenario 1	Interest rate Scenario 2	Interest rate Scenario 3
Low growth, $\theta = 0$	2024	2021	2020
Low growth, $\theta = 0.5$	2024	2022	2021
Low growth, $\theta = 1$	2024	2023	2023
High growth, $\theta = 0$	2024	2021	2020
High growth, $\theta = 0.5$	2024	2022	2021
High growth, $\theta = 1$	2024	2023	2023

Table 9. Year When the Amount of Government Debt Exceeds the MaxDebt (assuming the planned consumption tax hikes will be carried out)

	Interest rate Scenario 1	Interest rate Scenario 2	Interest rate Scenario 3
Low growth, $\theta = 0$	2024	2021	2020
Low growth, $\theta = 0.5$	2024	2022	2021
Low growth, $\theta = 1$	2024	2023	2023
High growth, $\theta = 0$	2024	2021	2020
High growth, $\theta = 0.5$	2024	2022	2021
High growth, $\theta = 1$	2024	2023	2023