GDP-linked Bonds in Japan and Their Implications on Public Pension Policy

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[Abstract]
In the first half of this paper, we consider the possibility of GDP-linked bonds in Japan. After considering the detailed plan of GDP-linked bonds in Japan, we consider the effects of GDP-linked bonds to the debt limit. We find that introduction of GDP-linked bonds raises the debt limit significantly in Japan. However, since risk premium and novelty premium can be very large now, the gradual approach to GDP-linked bonds is recommended.

In the second half of the paper, we point out that NDC (notional defined contribution pension) is similar to non-tradable GDP-linked bonds, so NDC is effective to keep fiscal sustainability of public pension. At the same time, NDC may not provide fair return rate since it does not include risk premium demanded by tradable GDP-linked bonds holders. The “macroeconomic indexation” adjustment of the current Japanese public pension has similar characteristic to temporal NDC. The fundamental pension reform proposal replacing Japanese existing public pension by funded defined contribution pension and smoothing the double burden by issuing ordinary government bonds may damage fiscal sustainability.

Since GDP-linked bonds have important implications for Japanese fiscal and public pension policy, further study is desirable.
1. Introduction

After fiscal crises in Europe and emerging countries, GDP-linked bonds, originally proposed by Shiller (1998) and Kamstra and Shiller (2009), draw renewed interest of economists and policy makers recently. Bank of England had the workshop on GDP-linked bonds, and proposes a standard contract for GDP-linked bonds (“London Term Sheet”) with practitioners and market participants. G20 Finance Ministers and Central bank Governors Meeting in Baden-Baden in Germany announce “Compass for GDP-linked bonds” in March 2017. IMF (2017) issued the policy paper about state-contingent government debt (including GDP-linked bonds) in March 2017 and recommended a gradual approach to GDP-linked government bonds. However, while Japan faces the heaviest public debt burden in the world now, the possibility of introduction of GDP-linked bonds is not discussed actively.

In the first half of this paper, we consider the possibility of GDP-linked bonds in Japan. After considering the detailed plan of GDP-linked bonds in Japan, we consider the effects of GDP-linked bonds to the debt limit. We find that the introduction of GDP-linked bonds can raise Japanese debt limit significantly. However, since risk premium and novelty premium can be very large now, the gradual approach to GDP-linked bonds is recommended.

In the second half of the paper, we point out that NDC (notional defined contribution pension) is similar to non-tradable GDP-linked bonds, so NDC is effective to keep fiscal sustainability of public pension. At the same time, NDC may not provide fair return rate since it does not include risk premium demanded by tradable GDP-linked bonds holders. The “macroeconomic indexation” adjustment of the current Japanese public pension has similar characteristic to temporal NDC. The fundamental pension reform proposal replacing Japanese existing public pension by funded defined contribution pension and smoothing the double burden by issuing ordinary government bonds may damage fiscal sustainability.

Since GDP-linked bonds have important implications for Japanese fiscal and public pension policy, further study is desirable.

In Section 2, we consider the detailed design of GDP-linked bonds in Japan based on London Term Paper and the existing Japanese inflation-indexed bonds. In Section 3, we consider the effects of GDP-linked bonds on Japanese debt limit and also discuss the

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1 The latest version of London term sheet can be found in Ad Hoc Working on GDP-linked Bonds (2016).
2 IMF (2017)
possible problems. In Section 4, we consider the similarity and difference between GDP-linked bonds and notional defined contribution pension. In Section 5, we discuss their important policy implications to Japanese pension reform debate. There are brief concluding remarks.

2. The Design of GDP-linked Bonds in Japan

(1) The Design of GDP-linked Bonds in London Term Sheet

According to IMF (2017), state-contingent sovereign financial instruments (including GD-linked bonds) have three types: “linker” whose principal and return rate fluctuate with GDP, “floater” whose only return rate fluctuate with GDP, and “extendible” whose maturity can be extended when predetermined types of disasters occur. For restoring fiscal sustainability, linker is useful, since it is necessary to adjust not only return rate but principal in order to stabilize debt/GDP ratio against GDP shocks. The linker type of GDP-linked bonds adjusts the principal following the fluctuation of nominal GDP. The interest payment is determined by the amount of principal times the predetermined interest rate, so that the amount of interest payment also fluctuates based on GDP. It is possible that upper or lower limit of the change of the principal is set if investors avert too large fluctuation of the principal. IMF (2017) supposes that this type of GDP-linked bonds has five or longer maturity bonds issued in country’s currency. Appropriate issuing countries are advanced and developing countries having capital markets in their own currencies. Supposed investors are foreign investors, domestic pension funds and other long-term investors.

After the conference held at Bank of England, Ad Hoc Working Group on GDP-linked Bonds (2016) proposes the outline of standard GDP-linked bonds called “London Term Sheet.” In their proposal, linker type of GDP-linked bonds denominated in issuing countries’ currencies is considered. The amount of principal and coupon payment fluctuates with nominal GDP without limits. The detailed design of GDP-linked bonds follows that the design of existing inflation-indexed bonds. Coupons are paid biannually, while the full redemption of amount of principal occurs at maturity.

It is necessary to determine the detailed procedure of adjustment of the amount of principal following nominal GDP. GDP statistics are often revised, and the estimation method of GDP itself is revised sometimes. In U.K., the first estimate of quarterly GDP is announced one or two months later of the end of the quarter. The second estimate is
announced one month later, and the final estimate is announced a few months later. Further revision is possible. With the recognition that the final GDP estimate is suitable for the adjustment of GDP-linked bonds, London Term Sheet suggests that the adjustment is applied six months later from the end of the quarter.

Further, since past GDP statistics are revised sometimes, how to respond to the revision of past GDP statistics is discussed. One possible solution is that the adjustments are conducted based on all of revised statistics. Another possible solution is that only the revised data of only the latest GDP growth rate is applied. Based on the preference of market participants, London Term Sheet recommends the second solution.

The proposals of London Term Sheet are very useful for considering the possible framework of GDP-linked bonds in Japan.

(2) Design of GDP-linked Bonds in Japan

In Japan, Takeda and Yajima (2003) analyze the merit of GDP-linked bonds from the viewpoint of optimal public debt management proposed by Barro (1995). And Takeda (2011) proposes the usage of GDP-linked bonds to earn fiscal resource for recovery cost from Great East Japan Earthquake. Those papers assume “Trill” type of financial instrument of Kamstra and Shiller (2009), while the recent “London term sheet” and other studies consider GDP-linked bonds which are similar to inflation-indexed bonds.

The existing inflation-indexed bonds provide a useful start point to consider the design of GDP-linked bonds also in Japan. Japanese 10-year Inflation-Indexed Bonds (JGBi) are the government bonds of which principal amount fluctuates in proportion with the consumer price index (CPI excluding fresh food). With JGBi, the principal amount fluctuates in proportion with the CPI. At maturity they are redeemed at the adjusted principal amount (“inflation-adjusted principal amount”). Inflation-adjusted principal amount is calculated by multiplying face value by “indexation coefficient.” Indexation coefficient is calculated by dividing CPI index for the day by CPI index at the time of issuance (specifically, the 10th day of the issue month). Since 2013, if the indexation coefficient falls below 1 at maturity, the bonds will be redeemed at the face value. Interest is paid twice a year, and the amount of interest also changes according to the rate of inflation as it is calculated by multiplying the inflation-adjusted principal amount at the time of interest payment by the pre-fixed coupon rate. When the base year for

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3 The explanation of JGBi follows the explanation on the homepage of Ministry of Finance of Japan.
CPI is updated, Ministry of Finance of Japan announces the timing of application of new indexes.

Based on the design of JGBi and the discussion about London term sheet, we can consider the possible design of GDP-linked bonds as below. With Japanese GDP-linked bonds, the principal amount fluctuates in proportion with the nominal GDP. Maturity is 10 years. At maturity they are redeemed at the adjusted principal amount (“GDP-adjusted principal amount”). GDP-adjusted principal amount is calculated by multiplying face value by “indexation coefficient.” Indexation coefficient is calculated by dividing quarterly GDP index for the quarter by quarterly GDP at the time of issuance. Interest is paid twice a year, and the amount of interest is calculated by multiplying the GDP-adjusted principal amount at the time of interest payment by the pre-fixed coupon rate.

How to deal with the revision of GDP requires careful consideration. In Japan, the first preliminary estimate of quarterly GDP data (first QE) is released announced about 45 days after the end of the quarter. The second preliminary estimate (second QE) is released about 70 days after the end of the quarter (Economic and Social Research Institute of Japan (2017)). The preliminary annual estate is only released in December of the next year, so that either of first QE or second QE is suitable for the index used for GDP-linked bonds. The first QE may be revised significantly, since one of the key data “Financial Statements Statistics of Corporations by Industry” is released after the first QE (Gonda(2016)). Thus, the second QE should be used for the index used for Japanese GDP-linked bonds. Based on the proposal of London Term Sheet, it is recommend that the GDP-adjusted principal amount should be updated according the 2nd QE six months later the end of quarter. Further, how to deal with the revision of past GDP data due to the change of annual estimates and benchmark year should be considered. Also, based on the proposal of London Term Sheet, the revised GDP data should be used only for calculation of indexation coefficient after the revision, and the past indexation coefficients should not be changed.

Whether the face value should be guaranteed or not also requires difficult consideration. Since the most important purpose of GDP-linked bonds is avoiding the large increase of debt/GDP ratio due to serious negative shocks on economy, it is desirable not to guarantee the face value. However, investors’ demand for GDP-linked ratio can be not enough without the guarantee of the face value. The detailed design of GDP-linked bonds in Japan should be determined after close consultation with market participants.
3. Effects of GDP-linked Bonds in Japan

(1) Effects of GDP-linked Bonds on Debt Limit

The most important purpose of the introduction of GDP linked bonds is improving fiscal sustainability. In many previous examples of fiscal crises, some negative shocks on economy triggered to make investors worry about fiscal sustainability, the interest rates jumped up and caused fiscal crises.

Following Burr et al. (2014), debt/GDP ratio changes according to the following formula.

\[ d_{t+1} - d_t = \frac{i_{t+1} - g_{t+1}}{1 + g_{t+1}} d_t - p b_{t+1} + \epsilon_{t+1} \]

(1)

(Where \( d_t \): debt/GDP ratio at the end of the period \( t \), \( i_{t+1} \): interest rate during the period \( t+1 \), \( g_{t+1} \): economic growth rate in year \( t+1 \), \( p b_{t+1} \): primary surplus /GDP ratio in the period \( t+1 \))

Further, we assume that nominal GDP growth rate \( g_t \) includes both trend \( g^* \) and stochastic shocks \( u_t \) (i.i.d.) and that there are stochastic shocks \( \epsilon_t \) (i.i.d.) on debt/GDP ratio. Then, the equation (1) can be rewritten into (2).

\[ d_{t+1} - d_t = \frac{i_{t+1} - g^* - u_{t+1}}{1 + g^* + u_{t+1}} d_t - p b_{t+1} + \epsilon_{t+1} \]

(2)

Lower GDP growth (\( u_t < 0 \)) or larger negative debt ratio shocks (\( \epsilon_t < 0 \)) implies larger increase of debt/GDP ratio.

Even when there are negative shocks on GDP growth rate and debt ratio, if a government increases primary surplus against them, fiscal sustainability can be restored (Bohn (1998)). In order to consider the government’s response to those shocks, we can assume the existence of fiscal reaction function. Following Barr et al. (2014), we assume a simple linear fiscal response function (3) below. In this fiscal reaction function, primary surplus reacts to not only debt ratio as in Bohn (1998), but also the difference between interest rate and growth rate. We assume that the maximum primary surplus/GDP ratio (\( p b_{max} \)) also exists, since some economic and political constraints exist to increase primary surplus beyond certain level.
\[ p_{b_{t+1}} = \min(\alpha + \beta(i_{t+1} - g*)d_t, pb_{\text{max}}) \]  

(3)

After primary balance \((pb_t)\) reaches its maximum \((pb_{\text{max}})\), if the right hand side of (2) continues to be mostly positive, debt/GDP ratio \(d_t\) will increase and may trigger defaults. Investors worry about the possibility of default so that the interest rate of government bonds increases. When investors are risk neutral, the arbitrage condition implies the following relationship (4).

\[ (1 - p_{t+1})(1 + i_{t+1}) + p_{t+1} \theta(1 + r*) = 1 + r* \]  

(4)

where, \(r^*\): risk free interest rate, \(p_t\): probability of default during the period \(t\) and \(\theta\): recovery rate (the portion of the face value of principal and interest payment of bonds which can be paid back in the case of default.) If the interest rate \(i\) is higher, debt ratio grows faster, and finally defaults will be inevitable.

The maximum debt ratio which can avoid such situation is called “debt limit (Gosh et al. (2013)).” Default probability is the probability that debt ratio \((d_{t+1})\) is higher than the debt limit \((d^*)\). Based on (2), (3) and (4), the debt limit \((d^*)\) corresponds to the maximum debt ratio satisfying the following condition:

\[ p_{t+1} = Pr\left(\frac{r^* - g^* - u_{t+1}}{1 + g^* + u_{t+1}} d^* + \frac{p_{t+1}}{1 + p_{t+1}} (1 - \theta)(1 + r*)d^* - \min(\alpha + \beta(i_{t+1} - g*), pb_{\text{max}}) + \epsilon_{t+1} > 0\right) \]  

(5)

The debt limit \((d^*)\) can be calculated from (5) by the numerical calculation method.

The debt limit can be raised by the introduction of GDP-linked bonds. The market interest rate of GDP-linked bonds (denoted by \(i^{\text{GDP}}\)) reflects both the predetermined interest rate of GDP liked bonds (denoted by \(i^{\text{pred}}\)) and nominal economic growth rate \((g_t)\).

\[ i^{\text{GDP}} = i^{\text{pred}} + g_t \]  

(6)

If all of the government bonds are GDP-linked bonds, (2) is modified as the following equation (7):
\[ d_{t+1} - d_t = \frac{i_t^{\text{GDP}} - g_t^{t+1}}{1 + g^* + u_t^{t+1}} d_t - p b_{t+1} + \varepsilon_t^{t+1} = \frac{i^{\text{pred}}}{1 + g^* + u_t^{t+1}} d_t - p b_{t+1} + \varepsilon_t^{t+1} \]

(7)

With risk neutral investors, \( i_t^{\text{GDP}} = r^* - g^* \) as long as the probability of default is nil. Then, the equation (7) is modified as the following condition (8):

\[ d_{t+1} - d_t = \frac{r^* - g^*}{1 + g^* + u_t^{t+1}} d_t - p b_{t+1} + \varepsilon_t^{t+1} \]

(8)

Comparing (3) and (8), while debt/GDP ratio shocks \( (\varepsilon_t^{t+1}) \) have the same effects on the growth of debt/GDP ratio, shocks to nominal growth rate \( (u_t^{t+1}) \) is smaller in (8). This difference makes the debt limit with GDP-linked bonds higher than the debt limit with ordinary bonds. For example, Barr et al. (2014) find that the debt limit with risk neutral investors increases from 93% to 195% by the introduction of GDP-linked bonds. Thus, GDP-linked bonds are very useful to avoid fiscal crisis in the countries with high debt/GDP ratios.

Further, we can introduce risk averse investors rather than risk neutral investors. Assuming the constant relative utility risk aversion (CRRA) utility function with the coefficient of risk aversion \( \delta \), the arbitrage condition (4) is modified to (9) below. (Details of derivation can be found in the appendix of Barr et al. (2014).

\[ 1 + i_{t+1} = (1 + r^*) \left[ \frac{1 - p_{t+1}^{\theta}}{1 - p_t^{\theta}} \right]^{\frac{1}{1-\delta}} \]

(9)

With \( \gamma = 4 \) (the upper end of what is normally assumed in macroeconomic models (Burr et al. (2014))), Barr et al. (2014) find that the debt limit with ordinary government bonds is 63%, while the debt limit with GDP-linked bonds is 114%. Both of them are much lower than the debt limits with risk neutral investors.

GDP-linked bonds also are useful to stabilize the debt/GDP ratio against various economic shocks. Blanchard et al. (2016) consider not only shocks to nominal GDP growth rate and debt/GDP ratio but also shocks to interest rate, and show that GDP-linked bonds reduce fluctuation of debt/GDP ratio significantly. Benford et al. (2016)
argue that the merits of GDP-linked bonds are larger for the countries with debt ratio close to the debt limits, huge contingent liabilities, fluctuating difference between GDP growth rate and interest rate and constrained monetary policies. Further, it is useful to avoid the situation that fiscal austerity for restoring fiscal sustainability harms macroeconomic conditions during recessions, since GDP-linked bonds decreases interest payment and bring some fiscal space during recessions. When fiscal crisis really occurs, GDP-linked bonds can be used as a kind of “debt equity swap” in the rescheduling plan. Finally, GDP-linked bonds can provide an effective risk sharing tool if foreign investors purchase them.

(2) Effects of GDP-linked Bonds on Debt Limit in Japan

One important effect of GDP-linked bonds is to raise the debt limit of the countries with very high debt-GDP ratios. Japan is one of the countries with highest debt ratio. Its gross public debt-GDP ratio is 189.1% in 2016. However, the current Abe administration is reluctant to have effective fiscal consolidation measures to reduce primary deficit. For example, they postponed the planned consumption tax (VAT) rate increase twice. Also, they postponed the fiscal target of eliminating primary deficit from 2020, while zero primary balance is not enough to restore fiscal sustainability. Economists agree that if there is no fiscal policy change, Japanese fiscal policy is not sustainable. Using their non-linear fiscal reaction function, Gosh et al. (2013) find that there is no fiscal space for Japan. As Kunieda (2015) shows, if significant negative shocks such as great earthquakes occur, severe fiscal crises are unavoidable. It will be very helpful if the introduction of GDP-linked bonds raise the debt limit significantly.

In order to estimate the increase of debt limit by the introduction of GDP-linked bonds in Japan, we will apply Burr et al. (2014) to Japanese case.

First, we will consider the fiscal response function of Abe administration. Abenomics economic policies were introduced under the second cabinet of Prime Minister Abe in December 2012. Not only the data of the actual fiscal policy taken from FY2013 to FY2016 but also the projected fiscal policy of the latest Economic and Fiscal Projection for Medium to Long Term Analysis announced by Cabinet Office in January 2018. There are two scenarios in their analysis: “baseline case” and “enhanced growth” case. While enhanced growth case is considered as a too rosy scenario by many economists, Abe administration claims that the enhanced growth scenario is their policy goal. Thus, we will use the projection of enhanced growth case from FY2017 to FY2027 in order to

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4 In Japan, FY2013 means Fiscal Year 2013 from April of 2013 to March of 2014.
estimate the fiscal reaction function of Abe administration.

We estimate a simple fiscal reaction function (3) with the assumption that primary balance does not reach the upper limit $pb_{max}$ during the sample period. The growth trend $g^*$ is calculated by adding the projected potential growth rate and GDP deflator in Economic and Fiscal Projection for Medium to Long Term Analysis.

$$pb_{t+1} = -0.013 + 0.276(i_{t+1} - g^*)d_t$$

(0.007) (0.195) 

( ): standard error (10)

The estimated coefficient of the second term is not statistically significant. Also, it is too small to reduce Japanese debt/GDP ratio to lower level. Based on this fiscal reaction function, the fiscal policy of Abe administration is unsustainable.

Since Bank of Japan started Quantitative and Qualitative Monetary Easing (QQE) in January 2013 and QQE with Yield Curve Control in September 2016, interest rate was kept near zero or even negative during the period of the second Abe administration. Also, in the latest Economic and Fiscal Projection for Medium to Long Term Analysis, it is assumed that long term interest rate will continue to be lower than the growth rate by 2025. Even with the weak response to the increased debt-GDP ratio represented by the estimated fiscal reaction function (10), debt-GDP ratio may not increase if the interest rate is lower than the nominal growth rate as shown in (2). Current very low interest rate is a crucial factor of the Abe administration’s justification of its very slow fiscal consolidation efforts.

However, in the long run, since Japanese population is expected to decrease rapidly, it is plausible that the long term interest rates will be higher than the trend of growth rate $g^*$ after the end of QQE monetary policy. In this meaning, the fiscal policy of Abe administration is unsustainable in the long run.

Still, there has not been a clear sign of immediate fiscal crisis in Japan. While there are some explanations about this puzzle, in this paper, we assume that investors expect that Japanese fiscal policy will be changed to be a more responsible and prudent policy after Abenomics. Applying Bohn (1998)’s criteria of fiscal sustainability to historical data, Mauro et al. (2013) show that the stance of fiscal policies of advanced countries changed frequently after observing the increase of interest rate or decrease of long run growth. Using Bai and Perron (1998)’s test with 25% of samples at minimum observations, Mauro et al. (2013) show that Japanese fiscal policy had two breaks at 1975 and 1992. Between 1975 and 1992, Japanese fiscal policy was prudent and sustainable, while it was not for the other periods.
In this paper, we assume that after Abenomics, Japanese fiscal policy will change to be prudent as the fiscal policy during 1975 to 1992. First, using the historical data of Mauro et al. (2013), we estimate the fiscal reaction function (3) during 1975 to 1992. We get the estimated fiscal reaction function as below.

\[ p_{t+1} = -0.014 + 2.056(r_t - g^*)d_t \]

where \( r_t \) is real long term interest rate, and \( g^* \) is the real growth rate trend based on Hodrick and Prescott filter. The constant term and the estimated coefficient of the second term are statistically significant at 10% level and 5% level.

Using (10) as the fiscal reaction function, we estimate the debt limit of Japan. For the other parameters, risk free rate and growth trend are set to be equal to the corresponding values (3.8% and 3.5%) shown in the end year of the enhanced growth case of Economic and Fiscal Projection for Medium to Long Term Analysis. The standard error of the regression (10), 0.029, is used for the standard deviation of the debt shocks (\( \varepsilon \)) in (2). The standard deviation of growth shocks \( u_t \) is estimated as 0.022 by using the differences between the actual growth rate and the trend growth rate estimated by Hodrick-Prescott filter since 1950. The coefficient of relative risk aversion (\( \delta \)) is 4 as before.

One parameter which is difficult to set is recovery rate. Japan did not have default except a very minor case. Burr et al. (2014) uses 0.7, while Gosh et al. (2013) uses 0.9. We assume that recovery rate \( \theta = 0.9 \). Since Japan did not have default of sovereign bonds except a very minor case (Reinhart and Rogoff (2009)), this relatively high recovery rate is consistent. The maximum primary surplus is assumed to be 10% of GDP as in Burr et al. (2014).

| Table 1: Parameters for the Simulation of Japanese Debt Limits |
|-----------------|----------|-----------------|
| **Parameter**   | **Value**| **Sources**     |
| Risk free interest rate \( r^* \) | 0.038    | Projected value in the end year of enhanced growth case |
| Trend GDP growth case \( g^* \)    | 0.035    | Projected value in the end year of enhanced growth case |
| Standard deviation of GDP            | 0.022    | Estimated from postwar data (since 1950) |
growth rate ($u_t$) after detrending by HP filter

<table>
<thead>
<tr>
<th>Standard deviation of the debt shocks ($\varepsilon_t$)</th>
<th>0.029</th>
<th>Standard deviation of the fiscal reaction function (11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recovery rate</td>
<td>0.9</td>
<td>Gosh et al. (2013)</td>
</tr>
<tr>
<td>Coefficient of relative risk aversion $\delta$</td>
<td>4</td>
<td>Upper end of what is normally assumed in macroeconomic models (Burr et al. (2014))</td>
</tr>
<tr>
<td>Intercept of fiscal reaction function</td>
<td>-0.014</td>
<td>Estimated fiscal reaction function (11) of the prudent fiscal policy years</td>
</tr>
<tr>
<td>Responsiveness of the primary balance change to $(i^* - g)d_{t-1}$</td>
<td>2.056</td>
<td>Estimated fiscal reaction function (11) of the prudent fiscal policy years</td>
</tr>
<tr>
<td>Maximum primary balance as a proportion of GDP</td>
<td>0.1</td>
<td>Burr et al. (2014)</td>
</tr>
</tbody>
</table>

With the assumptions above, the debt limit with ordinary government bonds is estimated as 195.4%. The debt-GDP ratio in 2016 is a little lower than this debt limit. Also, the projected debt-GDP ratios of Economic and Fiscal Projection for Medium to Long Term Analysis are also lower than this debt limit until 2027.

However, since only a small fiscal space is available, some additional negative shocks make future debt-GDP ratio is higher than the debt limit, and fiscal crisis may occur. If GDP linked bonds can extend fiscal space, it will be valuable. Using the same parameters, we estimate the debt limit with GDP-linked bonds when all of the ordinary bonds are replaced by GDP-linked bonds. The estimated debt limit is 399.9%, which is much higher than the debt limit with ordinary government bonds. This result shows that the introduction of GDP-linked bonds can be effective to avoid possible fiscal crisis in Japan.

(3) Problems of GDP-linked bonds in Japan

However, the introduction of GDP-linked bonds has several problems too.

Since the principal and interest amount changes according to nominal GDP growth rate, risk avert investors demand risk premium. The existing estimates of this risk premium include 0.35% (Barr et al. (2014)), less than 1% (Kamstra and Shiller (2009)), 1.5% (Borensztein and Mauro (2004)). Lower risk premium is possible only when foreign institutional investors bear the risk of nominal GDP growth rate for international
risk sharing.

Further, since there is no major GDP-linked bonds in the world now, investors are not familiar with GDP-linked bonds. Those investors may demand additional premium, called as “novelty premium.” Novelty premium can be reduced by standardization of design of GDP-linked bonds as London Term Sheet suggests.

With higher premium, debt/GDP ratio grows faster. If the premium of GDP-linked bonds is $\pi^{\text{GDP}} (>0)$, (8) will be modified as:

$$d_{t+1} - d_t = \frac{r_t - g^* + \pi^{\text{GDP}}}{1 + g^* + u_{t+1}} d_t - pb_{t+1} + \varepsilon_{t+1}$$

(12)

Comparing with (8), the right hand side of (12) is larger because of the existence of the premium $\pi^{\text{GDP}}$. Thus, it is possible that the introduction of GDP-linked bonds may reduce the debt limit if the premium of GDP-linked bonds is large.

Another possible problem is that investors take the introduction of GDP-linked bonds as a signal of gloomy fiscal outlook, then interest rate of all of government bonds may increase. It is necessary to consider some measures to avoid such situation. For example, the issue of GDP-linked bonds by the multiple countries including the country with solid fiscal outlook may prevent the decrease of fiscal credibility of the issuing countries.

Further, while pension funds and other institutional investors are mentioned as possible investors, some are doubtful that they really have incentive to purchase GDP-linked bonds. When investors are mostly domestic, the benefit of international risk sharing of GDP-linked bonds may be lost.

Based on the argument above, the introduction of GDP-linked bonds now in Japan seems to have the following serious problems.

a. Due to the current aggressive negative interest rate policy of Bank of Japan, the long term interest rate of government bonds of Japan is historically low. Thus, Japanese government seems not have serious demand for new type of government bonds for now.

b. Most of the current holders of JGB are domestic investors rather than the foreign investors who are efficient risk sharing partners of Japanese GDP related risks. Thus, the risk premium is likely to be much higher than Barr et al. (2014)’s estimate (0.35%) and Kamstra and Shiller (2009)’s estimate (less than 1%). Then, the financing cost of
GDP-linked bonds will be higher, and the merits of GDP-linked bonds in Japan are limited.

c. Japanese current fiscal policy is not sustainable, but the interest rate is very low. One alternative explanation from ours is that investors simply do not realize the seriousness of Japanese fiscal situation. Under such situation, if Japanese government decides to issue GDP-linked bonds, investors may realize that Japanese fiscal situation is so serious and demand larger risk premium. One way to avoid this country’s reputation problem is that the countries with sound fiscal outlook start to issue GDP-linked bonds first as IMF (2017) suggests, while those countries have less incentive to issue GDP-linked bonds.

d. With rapid future decrease of population in Japan, nominal Japanese GDP growth rate can be negative often. It means that the return rate of GDP-linked bonds can be negative sometimes. It raises a question of whether sufficient numbers of investors who demand GDP-linked bonds with possible negative returns exist. The guarantee of the principal may avoid such problem, but increased the financing cost of GDP-linked bonds.

With these considerations above, it seems not appropriate to issue GDP-linked bonds immediately in Japan. However, since the future merits of GDP-linked bonds of the countries with possible large fiscal risk such as Japan cannot be ignored, it is appropriate to consider the possibility of GDP-linked bonds seriously. Japanese government should participate more actively to the international debate about GDP-linked bonds.

4. Notional Defined Contribution Pension (NDC) as Non-Tradable GDP-Linked Bonds

(1) Notional Defined Contribution Pension (NDC)

In the recent public pension reform debate, notional defined contribution (NDC) scheme is getting popular in the world. NDC is the main pension system of Swedish public pension, and a World Bank report (Holzmann and Palmer (2006)) and Barr and Diamond (2008, 2016) recommends NDC for not only advanced countries but also emerging countries including China and Chile. Under NDC, contribution is paid to individual accounts. After retirement, retirees can receive cash benefit from their

\footnote{It is also called as “Nonfinancial Defined Contribution,” but the same NDC in short.}
accounts. The amount of benefit is determined by the contributed amount times (1+notional return rate). The notional return rate is set by government. For individuals, NDC is similar to ordinary defined contribution pension, while the return rate of ordinary defined contribution is the return rate of financial investments.

Consider a simple overlapping model where each generation has only two periods, young period and old period (retirement period). The generation born at the period t will contribute cw_t (where c is contribution rate, and w_t is wage income during the period t.) Suppose that government set that the notional return rate is \( \rho \). Then, the benefit they can receive during the period t+1 (denoted by \( b_{t+1} \)) is:

\[
b_{t+1} = (1+\rho)cw_t
\]

Financing method of NDC is pay-as-you-go. Namely, all of the contribution of the current young workers is paid as the benefit to the current old retirees. In order to balance the total amount of contribution paid by the generation t+1 should equal to the total amount of the benefit to the old retirees.

\[
cw_{t+1}N_{t+1} = b_{t+1}N_t
\]

where \( N_t \) and \( N_{t+1} \) are the population of the generations born at t and at t+1.

By substituting (11) into (10), we will have:

\[
1+\rho_t = (w_{t+1}/w_t)(N_{t+1}/N_t) = (1+\rho)(1+n) = 1+g_t
\]

where \( \gamma \) is productivity growth rate, \( n \) is population growth rate and \( g \) is economic growth rate. (12) implies that the notional return rate of fiscally sustainable NDC is the GDP growth rate. When GDP growth rate falls, the required benefit from NDC also decreases, so the fiscal balance of NDC will be maintained.

Since NDC is financed by PAYGO method, there exists intergenerational transfer among different generations. In dynamically efficient economies, the economic growth rate is lower than financial return rate, so that the notional return rate is lower than financial return rate. The current young and future generations have lower lifetime consumption, while the generations who are already old when NDC is introduced can enjoy higher lifetime consumption. Thus, intergenerational inequality will remain under NDC as in ordinary defined benefit pension financed by PAYGO.
While the report of World Bank (1994) suggested the funded individual accounts for the second pillar of public pension system, the recent report of World Bank (Holzmann and Palmer (2006)) recommends NDC for the second pillar. Barr and Diamond (2008, 2016) also recommend NDC for China and Chile.

(2) NDC and A Ponzi Game with GDP-linked Bonds

Instead of NDC pension in the last section, suppose that the government issues one-period GDP-linked bonds during the period t and tries to roll over by issuing new one-period GDP-linked bonds (namely play a Ponzi game of GDP-linked bonds) in a simple two period OLG model. Further, suppose that the predetermined interest rate of GDP-linked bonds \( i_{\text{GDP}} \) explained above is zero, so that the interest rate of GDP-linked bonds \( i_{\text{GDP}} \) equals to the nominal economic growth rate \( g \) from (6).

For a while, assume that only available assets are GDP-linked bonds. Then, an individual will purchase GDP-linked bonds \( b_t \) out of her wage income \( w_t \) during her young period in order to have life cycle savings, and receive \((1+i_{\text{GDP}})b_t\) from the government during her old period. The government finances the necessary revenue to pay the principal and interest rate by issuing new one-period GDP-linked bonds. The total amount of GDP-linked bonds \( B_t \) evolves following:

\[
B_{t+1} = (1 + i_{\text{GDP}})B_t
\]

The GDP liked bonds issued during the period \( t+1 \) will be purchased out of the wage \( w_{t+1} \) by the next generation. From (13), the per capita GDP-linked bonds during the period \( t+1 \) \( b_{t+1} \) are:

\[
b_{t+1} = \frac{B_{t+1}}{N_{t+1}} = \frac{(1 + i_{t_{\text{GDP}}})B_t}{(1 + n)N_t} = \frac{(1 + i_{t_{\text{GDP}}})}{(1 + n_t)} b_t
\]

(14)

By dividing the both sides of (14) by the wage income \( w_{t+1} \), we can show that the ratio of per capita GDP-linked bonds and wage income is constant as in (15) below.

\[
\frac{b_{t+1}}{w_{t+1}} = \frac{B_{t+1}}{w_{t+1}N_{t+1}} = \frac{(1 + i_{t_{\text{GDP}}})B_t}{(1 + \gamma_t)w_t(1 + n_t)N_t} = \frac{(1 + i_{t_{\text{GDP}}})}{(1 + \gamma_t)(1 + n_t)w_t} \frac{b_t}{w_t}
\]

(15)
If we denote $d_t/w_t=c$ and compare with (10), it is easy to understand that this Ponzi scheme of GDP-linked bonds in the economy with GDP-linked bonds as only available assets is equivalent to NDC in the same OLG model.

Now consider a more realistic case where other assets exist in the OLG model above. Suppose that there is an asset whose return rate is constant at $R$, and $R$ is higher than the economic growth rate $g_t$ as in dynamically efficient economies. Also, the supply of this asset is sufficiently large to fulfill demand of the young generation for life cycle savings. Since the return rate from GDP-linked bonds is lower than $R$, no individuals have incentive to hold GDP-linked bonds in their portfolio. In this setting, GDP-linked bonds in this Ponzi scheme, which is equivalent to NDC, are not tradable.

Instead of assuming that GDP-linked bonds cannot be sold except at the book value, suppose that GDP-linked bonds are tradable and the predetermined interest rate can be positive. Also, suppose that individuals are risk neutral for simplicity. Individuals purchase GDP-linked bonds only when the arbitrage condition below holds.

$$R = i_{\text{pred}} + g^*$$

(17)

In dynamically efficient economies, the predetermined interest rate should be positive to satisfy this arbitrage condition. If individuals are risk averse, further higher return rate is demanded for GDP-linked bonds. This means that a Ponzi scheme of GDP-linked bonds is unsustainable, since the total amount of GDP-linked bonds will increase with higher speed than the economic growth rate. It is well known result of unsustainability of a Ponzi scheme in dynamically efficient economies. NDC is equivalent to a Ponzi scheme of non-tradable GDP-linked bonds, but not equivalent to a Ponzi scheme of tradable GDP-linked bonds.

(3) Implications of Non-Equivalence between NDC and Tradable GDP-linked Bonds

Non-equivalence between NDC and tradable GDP-linked bonds has some important implications.

1. Even when investors are risk neutral, in dynamically efficient economies, non-tradable GDP-linked bonds cannot be sold with their book value, unless the government forces the individuals to accept the offers. If individuals are risk averse, the decrease
of expected lifetime utility is larger because of GDP related risks. NDC imposes the burden to young generations as traditional PAYGO DB pension.

2. As discussed in the previous section, the holding of GDP-linked bonds by the citizens of the issuing country is the most inefficient way of risk sharing of GDP related risk. It is most efficient to share GDP related risks among the investors of the other countries. GDP related risk of NDC, which is similar to GDP related risk of GDP-linked bonds, is borne by the citizens who suffer loss most when negative GDP shocks are realized.

3. However, from the point of view of governments, NDC may be relatively easy way to restore fiscal sustainability. If government tries to restore fiscal sustainability by issuing tradable GDP-linked bonds, the government should pay appropriate risk premium as long as investors are risk averse. However, in the case of NDC, government can impose GDP related risks without paying the appropriate risk premium. It is equivalent to mandatory purchase of GDP-linked bonds without fair return rate.

5. **Policy Implications for Japanese Pension Reform Debate**

(1) **Macroeconomic Indexation**

Japanese public pension system is in principle a traditional defined benefit pension financed mainly by pay-as-you-go method (PAYGO DB). In order to respond to its fiscal unsustainability due to rapid aging, Japanese government decided to introduce the “macroeconomic indexation” for the benefit formula. In the macroeconomic indexation, benefit is indexed automatically by wage (or price) growth rate minus “macroeconomic slide” during the adjustment period. Macroeconomic slide is 0.3%, which is set with consideration to increase of life expectancy and decrease of contributors (namely workers) due to aging. Due to this macroeconomic slide, the replacement ratio (defined as the ratio of standard annual benefit paid by Employee’s Pension Insurance and average after-tax income of insured male workers) will decrease gradually during the adjustment period. After the adjustment period ends, the replacement rate will remain fixed at a determined level. However, if the replacement ratio after the adjustment period is projected to be less than 50%, then the current adjustment mechanism will be reconsidered. On the other hand, macroeconomic indexation was not fully applied when post-adjustment benefit can be lower than the current level. This limitation prevented
effective adjustment of replacement rate since deflation continued in Japanese economy. From 2018, the unadjusted macroeconomic indexation in the past years will be applied as long as the post-adjusted benefit is higher than the current level.

In order to consider the effects of notional defined contribution pension, suppose that wage rate grows with the rate of productivity growth $\gamma$. Also, suppose that macroeconomic indexation reflects working population decrease with the speed of $-n$ (where $n$ is the population growth rate which turns to be negative in Japan.) Roughly speaking, under macroeconomic indexation, benefit amount will increase with the rate of $\gamma(-n) = \gamma + n$, which equals to the economic growth rate. Then the gross return rate of public pension during the adjustment period equals to the economic growth rate. It means that macroeconomic indexation is similar to temporary NDC during the adjustment period.

However, there are some significant difference between macroeconomic indexation and NDC.

First, while NDC has individual accounts for the insured, there is no such account for Japanese public pension. Since the direct relation between contribution and benefit is not as clear as in the case of individual accounts, distortionary effects of contribution are larger in Japanese public pension.

Second, macroeconomic indexation is a temporary measure to restore fiscal sustainability of Japanese pension system. After the adjustment period ends, the replacement rate will be fixed. Macroeconomic indexation is not a permanent automatic adjustment mechanism like NDC.

Third, since the initial macroeconomic indexation did not adjust benefit level during the deflation, fiscal situation of public pension continued to get worse. Different from NDC, automatic adjustment mechanism did not work in a deflationary economy.

(2) Pension Reform Argument in Japan

The fiscal situation of Japanese pension system is reviewed every 5 years. While Japanese government’s fiscal review in 2014 concludes that fiscal sustainability can be restored as planned without the decrease of replacement ratio below 50%, many researchers criticize that its projection is too optimistic since it is based on very optimistic economic growth projection.

In response to possible future problem of Japanese pension system, several policy reforms are proposed. One approach of the reform proposals is gradual reform. In this approach, while the basic framework (defined benefit pension financed by pay-as-you-go
method) is maintained, parameters of the framework are adjusted. For example, it is proposed that the minimum age of receiving full amount of benefit from 65 years old to 70 years old. Various other gradual approaches were also proposed.

On the other hand, some economists (Suzuki (2014), Oguro (2014)) propose fundamental reforms rather than gradual reforms. Their proposals are the reform from the current defined benefit pension financed by pay-as-you-go method to the funded public pension. While it is well known that this kind of reform causes so called “double burden” problem (young workers should bear the burden of contribution not only for themselves but also for benefit payment to the existing old retirees,) those economists argue that the smoothing of the burden over generations is possible by issuing ordinary government bonds.

(3) Policy Implications of the Equivalence between NDC and Non-Tradable GDP-linked Bonds

As macroeconomic indexation is similar to temporary NDC, the equivalence between NDC and non-tradable GDP-linked bonds has the following important implications to Japanese pension reform debate.

First, the fundamental reform proposals with the burden smoothing using ordinary government bonds are not desirable from the viewpoint of fiscal sustainability. During the adjustment period, macroeconomic indexation stabilizes the debt (including public pension liability) to GDP ratio as GDP-linked bonds do. One the other hand, different from GDP-linked bonds, ordinary government bonds do not have such automatic stabilization effects. Thus, if defined benefit public pension with macroeconomic indexation is replaced by ordinary government bonds, the fiscal balance including the fiscal balance of public pension will be more vulnerable to serious negative GDP shocks. Since Japanese public debt-GDP ratio is very high, Japanese fiscal sustainability is already threaten now. It is not desirable to add additional ordinary government debt in order to smooth “double burden” due to the fundamental pension reform.

Second, we should also ask whether the fundamental reform replaced by new issue of tradable GDP-linked bonds instead of ordinary bonds is desirable or not. With well-designed GDP-linked bonds, there is no fiscal sustainability problem even with negative GDP shocks after GDP-linked bonds replace the existing defined benefit pension. However, we should remind that NDC is similar to not tradable GDP-linked bonds but non-tradable GDP-linked bonds. Different from mandatory NDC, tradable GDP-linked bonds cannot be sold without appropriate risk premium. If global investors purchase
most of GDP-linked bonds, the required risk premium may not be very high since GDP risks of the issuing county can be internationally diversified. However, if foreign investors are limited as in the case of the current Japanese government bonds, then the required risk premium can be large. Further, before investors get familiar with GDP-linked bonds, additional “novelty premium” may be demanded by investors. If the required risk premium and novelty premium are very large, the fiscal burden will be heavier, and larger primary surplus is necessary in order to restore the sustainability of Japanese fiscal policy.

Third, in Japanese public pension reform debate, while there is some gradual approach and fundamental proposals, there are only a few arguments for fundamental reform to permanent NDC. Since the adjustment with macroeconomic indexation is similar to temporal NDC, it is natural to consider the possibility of introduction of NDC in Japan. One important step to transform the existing public pension into NDC is to establish individual accounts. Introduction of individual accounts will reduce distortionary effects on labor supply. Another important step is to replace the adjustment by macroeconomic indexation with the adjustment based on notional return rate. If the notional return rate is equal to productivity growth (wage increase) plus (working) population growth rate, it will fluctuate similarly with macroeconomic indexation. In addition to with other gradual adjustments including the increase of the minimum age to receive pension benefit, the automatic adjustment based on notional return rate will be not only useful to restore fiscal sustainability, but also more easily understandable than the adjustment based on macroeconomic adjustment. On the other hand, since the finance method of NDC is still pay-as-you-go, intergenerational inequality remains to be large. Further, risk-averse future generations should bear the expected utility loss caused by GDP related risks. One possible solution is more aggressive fiscal consolidation by consumption tax increase and drastic cut of wasteful expenditure. If unfairly heavy fiscal burden of future generations in Japan is reduced by those fiscal consolidation measures, total intergenerational inequality caused by public pension and other fiscal policies will decrease.

6. Concluding Remarks

In the first half of this paper, we consider the possibility of GDP-linked bonds in Japan.

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6 One exception is Takayama (2006)’s brief assessment of possibility and desirability of NDC in Japan.
After considering the detailed plan of GDP-linked bonds in Japan, we consider the effects of GDP-linked bonds to the debt limit. We find that introduction of GDP-linked bonds raises the debt limit significantly in Japan. However, since risk premium and novelty premium can be very large now, the gradual approach to GDP-linked bonds is recommended.

In the second half of the paper, we point out that NDC (notional defined contribution pension) is similar to non-tradable GDP-linked bonds, so NDC is effective to keep fiscal sustainability of public pension. At the same time, NDC may not provide fair return rate since it does not include risk premium demanded by tradable GDP-linked bonds holders. The “‘macroeconomic indexation’” adjustment of the current Japanese public pension has similar characteristic to temporal NDC. The fundamental pension reform proposal replacing Japanese existing public pension by funded defined contribution pension and smoothing the double burden by issuing ordinary government bonds may damage fiscal sustainability.

While GDP-linked bonds may have an important role in restoring fiscal sustainability and important implications on Japanese pension reform, there exists only a limited discussion about GDP-linked bonds among economists and policy makers in Japan. It is desirable that more Japanese economists and policymakers participate in the policy discussion about GDP-linked bonds at international institutions and academics. We hope that this paper stimulates active discussion of the possibility of GDP-linked bonds in Japan.
References

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(in Japanese)