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Public Bonds as Money Substitutes at Near-Zero Interest Rates: Disequilibrium Analysis of the Current and Future Japanese Economy

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Abstract: In the past quarter century, Japan's economy has seen rates of interest, including those on long-term public bonds, remain quite low despite colossal accumulation of public debt, while the price level has been mildly deflationary or almost constant despite rapid monetary expansion. In this chapter, these puzzling phenomena are interpreted using a simple disequilibrium analysis framework. The major reasons for adopting disequilibrium analysis are that 1) Japan's economy often fell into excess supply in both goods and labor markets after short-term rates of interest were controlled below 0.5% in mid-1995, and 2) public bonds markets were clearly in serious excess supply given the expectation that the primary fiscal balance was not going to turn into surpluses in the future relevant to those bonds being issued. In the proposed disequilibrium model, excess supply in goods, labor, and public bonds markets is absorbed by excess demand in money markets, induced by strong money demand at near-zero interest rates. In particular, strong money demand absorbs public bonds not as investment instruments, but as money substitutes.

This chapter also demonstrates that excess demand in money markets in disequilibrium analysis can be interpreted as public bond pricing bubbles in equilibrium analysis. Given the analogy between the two approaches, as long as a bubble is sustained, mild deflation and near-zero interest rates continue in spite of massive issues of public bonds and rapid expansion of money stocks. On the other hand, once a bubble bursts, money demand shrinks drastically, a wide range of interest rates rise suddenly, and the price level jumps abruptly. With the government's credible commitment to future fiscal reforms, a one-off price surge would stop immediately at a level two or three times higher than before, but without the reforms, the price process would be hyperinflationary.

Key words: disequilibrium analysis, strong money demand, zero interest rate policy, fiscal sustainability, the quantity theory of money, the fiscal theory of the price level, public bond pricing bubbles.

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1. Introduction

Two puzzling phenomena were observed in Japan's economy in the past quarter century; mild deflation despite rapid monetary expansion, and rapidly declining long-term yields despite colossal accumulation of public debt. These phenomena have frequently been presented as evidence of unconventional policy recommendations, which state that a government should borrow more and repay less for economic stimulus. Emphasizing 'repay less', for example, Blanchard (2019) and Blanchard and Tashiro (2019) claim that large-scale fiscal deficits will be sustainable as long as interest rates continue to be lower than economic growth. Those who advocate modern monetary theory (MMT) take this a step further and propose the redemption of maturing public bonds by issuing any amount of central bank money instead of levying heavy taxes.[3] What is more complicating, some MMT proponents, including Wray (2019), do not necessarily support the recent macroeconomic policies developed by the Japanese government and Bank of Japan (BOJ). They insist that the Japanese policies did not help at all to achieve a sustainable society with full employment.

In this chapter, we investigate whether unconventional policy recommendations such as 'borrow-more-repay-less' and 'repay-by-central-bank-money' are theoretically justifiable in the context of Japan's economy. To achieve this, we employ a simple disequilibrium analysis framework for two reasons. First, Japan's economy often fell into excess supply in both goods and labor markets after mid-1995, when the short-term interest rate was held below 0.5%. Second, public bond markets were clearly in serious excess supply given the expectation that the primary fiscal balance was not going to turn into surpluses in the near future.[4]

The Japanese government began to accumulate public bonds for economic stimulus from the early 1990s. The total of public bonds on issue, including Treasury bills (T-bills), Japanese government bonds (JGBs), and Fiscal Investment and Loan Program (FILP) bonds, was 173 trillion yen (40.5% of nominal GDP) at the end of fiscal year 1989, but this had increased to 411 trillion yen (86.4%) by the end of FY1999, and 1,025 trillion yen (186.9%) by the end of FY2018.

The BOJ, on the other hand, began to purchase long-term public bonds (JGBs and FILP bonds) aggressively after a zero interest rate policy (ZIRP) was implemented in February 1999. This continued even more intensively when quantitative and qualitative easing (QQE) was adopted in April 2013. The balance of the BOJ's own long-term bonds expanded from 40.1 trillion yen at the end of FY1998 to 475.6 trillion yen by the end of FY2018. This last sum represented 51.3% of the total issues of long-term public bonds. In the years from FY1999 to FY2018, the BOJ also expanded the BOJ note issue from 55.3 to 112.4 trillion yen, and the BOJ current reserves from 6.2 to 393.9 trillion yen.

Let us look further back to understand the situation surrounding Japan's economy. For the period from the mid-1990s, aggressive macroeconomic policies were implemented to escape from weak aggregate demand or excess supply in goods and labor markets. **Figure 4-1-1** depicts the output gap[5] and unemployment rate for the period between the first quarter of 1983 and the

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[3] See Wray (2015) and others for detailed descriptions of MMT and its policy recommendations.

[4] Armstrong and Okimoto (2016) survey the literature on fiscal sustainability in Japan. Imrohoroglu et al. (2018) update Imrohoroglu (2016) and present detailed simulations of the sustainability of Japan's fiscal conditions. The Fiscal System Council (2018) reports the long-term prospects for Japan's fiscal policies.

[5] Estimates by Kawamoto et al. (2017) are adopted for the estimated output gap in this chapter.

second quarter of 2019. Here, the output gap is defined as $\frac{potential\ output - actual\ output}{potential\ output}$. A positive (negative) gap implies excess supply (excess demand) in goods and labor markets. According to the output gap in this figure, Japan's economy often fell into a state of weak aggregate demand (excess supply) from 1993. In particular, it suffered from serious demand shortages in 1994, 1999, 2002, and 2009. The unemployment rate was also above 5% from 2001 to 2003 and from 2009 to 2010.

The consolidated government, consisting of the general government and the BOJ, financed large-scale fiscal stimulus by issuing to mainly private banks, public bonds, BOJ notes, and BOJ current reserves. According to **Figure 4-1-2**, the government's obligations to the public, excluding the BOJ's own public bonds, never exceeded 50% of nominal GDP before FY1994, but then began to rise rapidly. They exceeded 100% of nominal GDP in FY2002, and 150% in FY2009, and amounted to 180% in FY2013. Then, they increased more slowly, reaching 190% in FY2018. On the other hand, as shown in **Figure 4-1-3**, the primary fiscal balance consistently showed a heavy deficit. It recorded –9.4% of nominal GDP in FY1998, and –9.3% in FY2009. As suggested by these figures, the Japanese government behaved as if they had followed 'borrow-more-repay-less' policy recommendations faithfully.

The above unconventional policies were carried out without any side effects for the price level or interest rate. According to **Figure 4-1-4**, overnight call rates, which are representative short-term interest rates, stayed below 0.5% from October, 1995, and remained negative from March 2016. Long-term yields, which are measured by 10-year JGB yields, declined from 3.6% in April 1995 to below 3% in September 1996, and below 2% in October 1997. After they rose abruptly from 2003 summer to 2004 summer, they declined again, reaching –0.06% in March 2016. The consumer price index was almost constant with small variations. The price level was unresponsive to a decrease in the unemployment rate from July 2009 (5.5% in **Figure 4-1-1**) to February 2017 (below 3%), and it failed to increase considerably except for consumption tax hikes in April 2014 and October 2019.

However, any conventional economic reasoning behind the above puzzling phenomena is lacking, and thus, it is difficult to justify the unconventional policy recommendations on firm theoretical grounds. According to conventional theory, the current price level increases with current money stocks as in the quantity theory of money (QTM), and decreases with future fiscal surpluses as in the fiscal theory of the price level (FTPL). As explored above, however, the current price level does not have a close relationship with either of them.

However, it is indeed possible to explain partially these puzzling phenomena and to justify the unconventional policies loosely by a simple disequilibrium analysis framework, which is a bold departure from conventional equilibrium analysis. In this framework, strong money demand, induced by near-zero interest rates, plays an essential role in making unconventional predictions. For one example, additional issues of money are easily accommodated by excess (strong) money demand, thereby providing no stimulus to the price level. For another example, money and public bonds are close substitutes at near-zero rates in terms of returns, liquidity, and convenience. Accordingly, excess money demand can absorb public bonds as money substitutes, even if public bond supply far exceeds the present value of future fiscal surpluses. The two predictions from the disequilibrium approach offer compelling reasoning against the QTM and FTPL.

Practical policy implications are also available in the presence of strong money demand. Massive issues of public bonds by a government are first absorbed as money substitutes by strong money demand from private banks, and can then be purchased from private banks by a central

bank. Consequently, a central bank can *de facto* underwrite newly issued public bonds and refinance maturing ones without any direct transaction with a government, which is strictly prohibited by the Public Finance Act in Japan. Thus, 'repay-by-central-bank-money' is legitimately feasible in the presence of strong money demand.

Another important implication from the current disequilibrium approach concerns the accommodation of excess supply in goods and labor markets by excess demand in money/public bonds markets. In this context, the latter excess demand, driven by strong money demand at near-zero interest rates, creates a macroeconomic environment where the economy is likely to fall into a state of weak aggregate demand. Here, the above recommendations such as 'borrow-more-repay-less' and 'repay-by-central-bank-money' may be justifiable as policy operations for simultaneously mitigating both the excess demand and supply.

However, translating the disequilibrium approach into the equilibrium approach may carry alarming suggestions. The appearance of excess money demand as interpreted by the former is likely to be interpreted as the presence of a public bond pricing bubble by the latter. Consequently, the disappearance of strong money demand at above-zero interest rates is interpreted as the bursting of the bubble. With the bubble bursting at some point in the future, the price level and rate of interest will jump to the conventional level. With this eventually expected, the government needs to commit credibly to future fiscal reforms to forestall a price surge that would not stop at a level two or three times as high as before, but rather, lead to hyperinflation. In other words, 'borrow-more-repay-less' and 'repay-by-central-bank-money' are no longer relevant after strong money demand disappears at above-zero rates.

Here, a serious policy dilemma is posed. That is, a policy combination of 'borrow-more-repay-less' and 'repay-by-central-bank-money' is implemented to escape from a deflationary economy with near-zero interest rates, but such a particular economic environment is required as a precondition for these policies. Once the prerequisite of near-zero interest rates is lost, that is, once interest rates rise significantly above zero, the economy returns to a conventional situation in which the unconventional policy recommendations no longer work.

This chapter is organized as follows. In Section 2, a simple disequilibrium analysis framework is presented with an emphasis on strong money demand at near-zero interest rates. This is then compared with equilibrium analysis when the rate of interest is both near and above zero. In Section 3, the puzzling Japanese experience is interpreted using the disequilibrium approach, and the relevance of unconventional policy recommendations is examined with extreme care. Section 4 offers conclusions. In the Appendix, we examine how the BOJ *de facto* refinanced its own JGBs at maturity without violating strict legal restrictions.

2. A simple disequilibrium analysis framework

From 1995 up to the present, as discussed in Section 1, Japan's economy often fell into excess supply in goods and labor markets, and public bonds markets were judged to be in serious excess supply. Given these observations, we present a simple disequilibrium analysis framework where goods, labor, and public bonds markets are in excess supply, and money markets are in excess demand.[6] More concretely, the markets in excess supply, especially public bonds markets, are

[6] The theoretical framework presented in this section is out of the context of mainstream modern macroeconomics, where all markets are assumed to be in equilibrium simultaneously. Even within

absorbed by the excess demand in money markets. In addition, we demonstrate that in this context, disequilibrium analysis is closely related to equilibrium analysis. More concretely, monetary excess supply in disequilibrium analysis corresponds to public bond pricing bubbles in equilibrium analysis.

2.1. Strong money demand induced by near-zero interest rates

First, let us confirm that in orthodox monetary macroeconomic models, money demand is strong at near-zero interest rates, and is infinitely elastic at the limit of zero interest rates. A unit period household utility is typically specified as $u(c) + v\left(\frac{M}{P}\right)$, where utility from both consumption and real money balances is concave, and their marginal utility is convex. That is, $u'(c) \geq 0$, $u''(c) \leq 0$, $u'''(c) \geq 0$, $v'\left(\frac{M}{P}\right) \geq 0$, $v''\left(\frac{M}{P}\right) \leq 0$, and $v'''\left(\frac{M}{P}\right) \geq 0$. In addition, it is assumed that $\lim_{\frac{M}{P}\to\infty} v'\left(\frac{M}{P}\right) = 0$ and $\lim_{\frac{M}{P}\to\infty} v''\left(\frac{M}{P}\right) = 0$.

The first-order condition with respect to real money balances dictates that marginal utility from real money balances is equal to the level of nominal interest rates, which is evaluated in terms of the marginal utility of consumption.

$$v'\left(\frac{M^d(t)}{P(t)}\right) = i(t)u'\big(c(t)\big) \qquad (4\text{-}2\text{-}1)$$

A derivative of equation (4-2-1) with respect to $\frac{M^d(t)}{P(t)}$ and $i(t)$ with $c(t)$ constant is obtained as follows.

$$\frac{d\left(\frac{M^d(t)}{P(t)}\right)}{di} = \frac{u'\big(c(t)\big)}{v''\left(\frac{M^d(t)}{P(t)}\right)} < 0 \qquad (4\text{-}2\text{-}2)$$

Given equations (4-2-1) and (4-2-2), $u'(c) \geq 0$, $v''\left(\frac{M}{P}\right) \leq 0$, and $\lim_{\frac{M}{P}\to\infty} v''\left(\frac{M}{P}\right) = 0$, real money demand is stronger as nominal interest rates are lower, and it is the more elastic with respect to the lower interest rates. At the limit of zero interest rates, money demand is infinitely interest-elastic. Conversely, if interest rates deviate far from zero, then money demand is much less interest-elastic.

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modern economics, however, some schools of thought have taken disequilibrium phenomena in money markets seriously. Yeager (1986) surveyed orthodox monetarists, showing that they always considered monetary disequilibrium to be responsible for a systematic relationship between the general price level and monetary aggregates. On the other hand, Zahringer (2012) showed that in Austrian economics, disequilibrium in plural money markets was thought to cause business cycles in a complicated manner. Of course, the orthodox monetarists and the Austrians had sharp disagreements on disequilibrium approaches. In contrast to the orthodox monetarists, Austrian economics took relative prices, not the general price, seriously, and were extremely reluctant to aggregate individual variables to construct macroeconomic variables.

2.2. Excess supply in goods, labor, and public bonds markets and excess demand in money markets

A simple disequilibrium analysis framework is presented below. What is implied by 'disequilibrium' in this context is that markets are not in equilibrium *ex ante* or at the beginning of the period, but are cleared on short sides *ex post*, i.e. at the end of the period.

The consolidated government, which consists of a general government and a central bank, issues money ($M^s(t)$) and public bonds ($B^s(t)$) to households. Each household receives nominal interest rates $i(t)$ on its own public bonds $B_i^d(t-1)$, but pays lump-sum taxes $tax_i(t)$ in a real term. The government makes real government consumption expenditures $g(t)$, and hires workers from households $l_g^d(t)$ at real wages $w(t)$. Here, government consumption does not include expenditures on government employment.

Given the price level at time t, an intertemporal budget constraint from time $t-1$ to time t for the consolidated government is defined as follows. Here, the balance of money and public bonds is defined at the end of the period.

$$\frac{M^s(t)-M^s(t-1)}{P(t)}+\frac{B^s(t)-B^s(t-1)}{P(t)}+tax(t)=g(t)+i(t)\frac{B^d(t-1)}{P(t)}+w(t)l_g^d(t), \tag{4-2-3}$$

where $tax(t)=\sum_{i=1}^{N}tax_i(t)$, $B^d(t-1)=\sum_{i=1}^{N}B_i^d(t-1)$, and N denotes the number of households.

Private agents are represented by households and firms, with private banks and other financial institutions implicit. Each household supplies labor $l_i^s(t)$ at real wages $w(t)$, makes real consumption expenditures $c_i(t)$, and rents physical capital $k_i(t)$ at rental fees $r(t)$. Physical capital is depreciated at the rate of δ. In addition, each household pays lump-sum taxes $tax_i(t)$ to the government, and holds money $M_i^d(t)$ and public bonds $B_i^d(t)$, both of which are issued by the government. Thus, an intertemporal budget constraint from time $t-1$ to time t for household i is defined as follows.

$$\begin{aligned}&w(t)l_i^s(t)+[r(t)-\delta]k_i(t-1)+\frac{M_i^d(t-1)}{P(t)}+[1+i(t)]\frac{B_i^d(t-1)}{P(t)}\\&=c_i(t)+[k_i(t)-k_i(t-1)]+\frac{M_i^d(t)+B_i^d(t)}{P(t)}+tax_i(t)\end{aligned}$$

Aggregating the above budget constraint over all households leads to

$$\begin{aligned}&w(t)l^s(t)+[r(t)-\delta]k(t-1)+\frac{M^d(t-1)}{P(t)}+[1+i(t)]\frac{B^d(t-1)}{P(t)}\\&=\mathrm{c}(t)+[k(t)-k(t-1)]+\frac{M^d(t)+B^d(t)}{P(t)}+tax(t).\end{aligned} \tag{4-2-4}$$

On the other hand, each firm produces all-purpose goods $y_j(t)$, costlessly convertible to private and government consumption goods, and physical capital. Firm j pays rent on physical capital k_j^d at the real rental fee of $r(t)$, and hires workers from households l_j^d at the real wage of $w(t)$. Accordingly, the valued added by each firm is allocated between capital income and labor

income as follows.

$$y_j(t) = r(t)k_j^d(t-1) + w(t)l_j^d(t) \qquad (4\text{-}2\text{-}5)$$

Here, excess profits are assumed away for simplicity.

Given the real wage $w(t)$, labor supply from households $(l^s(t) = \sum_{i=1}^{M} l_i^s(t))$ meets labor demand from firms $(l^d(t) = \sum_{j=1}^{M} l_j^d(t))$ as well as from the consolidated government (l_g^d). M denotes the number of firms.

As mentioned before, money and public bonds markets as a whole are cleared by short sides at the end of the period. That is, $\sum_{i=1}^{N} B_i^d(t-1) + \sum_{i=1}^{N} M_i^d(t-1) = B^s(t-1) + M^s(t-1)$ holds.[7] In physical capital rental markets, on the other hand, $\sum_{j=1}^{M} k_j^d(t-1) = \sum_{i=1}^{N} k_i(t-1)$ always holds. Substituting these *ex post* market clearings into equations (4-2-3), (4-2-4), and (4-2-5) leads to the following relationship.

$$\left\{\sum_{j=1}^{M} y_j(t) - \left[\sum_{i=1}^{N}\left(k_i(t) - k_i(t-1) + \delta k_i(t-1)\right) + \sum_{i=1}^{N} c_i(t) + g(t)\right]\right\} + w(t)\left[\sum_{i=1}^{N} l_i^s(t) - \sum_{j=1}^{M} l_j^d(t) - l_g^d(t)\right]$$
$$= \frac{M^d(t) - M^s(t)}{P(t)} + \frac{B^d(t) - B^s(t)}{P(t)}$$

Using macroeconomic variables, the above equation is rewritten as[8]

$$\{y(t) - [inv(t) + c(t) + g(t)]\} + w(t)\left[l^s(t) - l^d(t) - l_g^d(t)\right] = \left[\frac{M^d(t)}{P(t)} - \frac{M^s(t)}{P(t)}\right] + \left[\frac{B^d(t)}{P(t)} - \frac{B^s(t)}{P(t)}\right] \qquad (4\text{-}2\text{-}6)$$

where the aggregate value added $y(t)$ is defined by $y(t) = \sum_{i=1}^{M} y_i(t)$, while gross investment $inv(t)$ is defined by $k(t) - k(t-1) + \delta k(t)$. Excess supply in goods and labor markets, implied by the left-hand side of equation (4-2-6) is denoted by $Ex_{gl}^s(t)$, or

$$Ex_{gl}^s(t) = \{y(t) - [inv(t) + c(t) + g(t)]\} + w(t)\left[l^s(t) - l^d(t) - l_g^d(t)\right]. \qquad (4\text{-}2\text{-}7)$$

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[7] As implied by equation (4-2-6), under the assumption that $\sum_{i=1}^{N} B_i^d(t-1) + \sum_{i=1}^{N} M_i^d(t-1) = B^s(t-1) + M^s(t-1)$, goods and labor markets are *ex post* cleared; $\{y(t-1) - [inv(t-1) + c(t-1) + g(t-1)]\} + w(t-1)\left[l^s(t-1) - l^d(t-1) - l_g^d(t-1)\right]\{y(t) - [inv(t) + c(t) + g(t)]\} = 0$.

[8] Equation (4-2-6) is interpreted to share characteristics of both beginning- and end-of-period formulations in assets markets equilibrium, both of which are proposed by Foley (1975) and others. In end-of-period models, the market-clearing conditions of not only goods markets, but also money and bonds markets are defined in terms of flow variables. Here, Walras's law holds for all of goods, money, and bonds markets. In beginning-of-period models, on the other hand, the market-clearing conditions of assets markets are defined in terms of stock variables. In the latter formulation, Walras's law does not hold. Accordingly, the market clearing conditions of goods markets can be separated from those of assets markets as in the IS–LM model. According to equation (4-2-6), the current setup shares the nature of end-of-period formulations in the sense that Walras's law holds for all of goods, labor, money, and public bonds markets, but it has the property of beginning-of-period formulations in that stock variables appear in the market clearing conditions of assets markets.

As equation (4-2-6) implies, this disequilibrium analysis framework allows us to interpret the current macroeconomic conditions as a situation where excess supply in goods and labor markets is absorbed by excess demand in money and public bonds markets. That is, $y(t) > inv(t) + c(t) + g(t)$ and $l^s(t) > l^d(t) + l_g^d(t)$ accompanies

$$\left[\frac{M^d(t)}{P(t)} - \frac{M^s(t)}{P(t)}\right] + \left[\frac{B^d(t)}{P(t)} - \frac{B^s(t)}{P(t)}\right] > 0. \qquad (4\text{-}2\text{-}8)$$

2.3. Excess demand in money markets at near-zero interest rates

Let us apply, step by step, the disequilibrium analysis discussed in Section 2.2 to interpret the macroeconomic phenomena explored in Section 1. First, money markets are assumed to be in excess demand as a result of strong money demand at near-zero rates. That is,

$$\frac{M^d(t)}{P(t)} > \frac{M^s(t)}{P(t)}. \qquad (4\text{-}2\text{-}9\text{-}1)$$

In this case, the QTM does not hold, because additional money supply can be absorbed by excess demand without any effect on the price level.

Next, public bonds are assumed to be supplied in excess of the present value of future fiscal surpluses ($b^f(t) = \frac{1}{P(t)}\sum_{\tau=1}^{\infty}\left\{\frac{P(t+\tau)[tax(t+\tau)-g(t+\tau)]}{\prod_{k=1}^{\tau}(1+i(t+k))}\right\}$). That is,

$$\frac{B^s(t)}{P(t)} > b^f(t) \qquad (4\text{-}2\text{-}9\text{-}2)$$

In this case, the standard FTPL does not hold, because deteriorations in future primary fiscal balances may not result in an increase in the price level.

To satisfy three inequalities, (4-2-8), (4-2-9-1), and (4-2-9-2), the following inequalities need to be satisfied.

$$\frac{M^d(t)}{P(t)} - \frac{M^s(t)}{P(t)} > \frac{B^s(t)}{P(t)} - b^f(t) > 0 \qquad (4\text{-}2\text{-}10)$$

Here, demand for public bonds as purely financial instruments is supposed to be up to the present value of future fiscal surpluses; $\frac{B^d(t)}{P(t)} = b^f(t)$.

As inequalities (4-2-10) imply, excess supply in public bonds markets ($\frac{B^s(t)}{P(t)} - b^f(t)$) is absorbed in part by excess demand in money markets ($\frac{M^d(t)}{P(t)} - \frac{M^s(t)}{P(t)}$). Then, how are inequalities (4-2-10) really possible? How should excess supply in public bonds markets be interpreted? One possible interpretation is that public bonds may serve as not financial instruments, but rather, as money substitutes at near-zero interest rates. Money and public bonds are close to each other in terms of financial returns, liquidity, and convenience. While yields on long-term JGBs were still above zero before the beginning of 2016, the expectation that long-term yields would decline toward zero was prevailing among market participants in the JGB markets. Thus, anticipating near-zero

yields in the near future, public bond investors held log-term JGBs. In this way, strong money demand, induced by near-zero interest rates, had absorbed not only traditional money, but also public bonds as money substitutes.

As equation (4-2-6) implies, excess demand in money markets now absorbs excess supply in public bonds, goods and labor markets. Considering public bonds as money substitutes or quasi goods at near-zero rates as opposed to financial instruments, equation (4-2-6) may be interpreted slightly differently. As goods demand shifts from genuine to quasi goods, aggregate demand becomes stagnant in primary goods markets. In this way, goods markets are likely to be in excess supply when public bonds are demanded as quasi goods at near-zero interest rates.

We have two comments on the above discussion. First, the proposition that excess demand in money markets absorbs excess supply in other markets depends crucially on the presence of strong money demand at near-zero interest rates. In such a situation, neither the QTM nor the FTPL ever holds; the current price level has no close relationship with current money stocks or future fiscal surpluses. In other words, as soon as short-term interest rates rise above the zero rate of interest, excess demand in money markets disappears. Accordingly, both the price level and the rate of interest need to adjust radically as the QTM, and fiscal discipline recovers itself instantaneously.

Second, when public bonds are held as money substitutes by private agents, in particular by private banks, a central bank can bypass the strict legal restriction by which it would otherwise be prohibited from directly underwriting newly-issued public bonds from a general government. That is, newly-issued public bonds are first purchased as money substitutes by private banks. Then, because private banks are indifferent between holding public bonds and money, a central bank purchases public bonds held by private banks by issuing the central bank's current accounts (a part of the monetary base). Consequently, the new issue of public bonds to private banks by a general government is replaced by the additional issue of money by a central bank. As discussed in the Appendix, through the same route, a central bank can escape another legal restriction by which a central bank is not allowed to refund its own long-term public bonds directly.

2.4. A comparison of disequilibrium and equilibrium analyses

Let us compare the disequilibrium approach, presented in Section 2.3, with a standard equilibrium analysis framework. For this purpose, the real rate of interest $\rho(t)$ is defined as follows.

$$1+\rho(t)=\frac{P(t-1)}{P(t)}[1+i(t)],$$

where public bonds yield interest at the end of the period. For example, the present value of future fiscal surpluses can be expressed in terms of the real rate of interest instead of the nominal rate as follows.

$$b^f(t)=\frac{1}{P(t)}\sum_{\tau=1}^{\infty}\left\{\frac{P(t+\tau)[tax(t+\tau)-g(t+\tau)-w(t+\tau)l_g^d(t+\tau)]}{\prod_{k=1}^{\tau}(1+i(t+k))}\right\}=\sum_{\tau=1}^{\infty}\left[\frac{tax(t+\tau)-g(t+\tau)-w(t+\tau)l_g^d(t+\tau)}{\prod_{k=1}^{\tau}(1+\rho(t+k))}\right]$$

A standard equilibrium analysis framework is presented as follows. Assuming that both public bonds and money markets are in equilibrium not only *ex post*, but also *ex ante*, or $B^s(t)=B^d(t)=\sum_{i=1}^{N}B_i^d(t),\ M^s(t)=M^d(t)=\sum_{i=1}^{N}M_i^d(t)$, the iteration of substitution of the consolidated

government's intertemporal budget constraint (4-2-3) from the present to the future leads to

$$\frac{B^S(t)+M^S(t)}{P(t)} = b^f(t) + \sum_{\tau=1}^{\infty}\left[\frac{1}{\prod_{k=1}^{\tau}(1+i(t+k))}\frac{i(t+\tau)M^S(t+\tau-1)}{P(t+\tau-1)}\right] + \lim_{\tau\to\infty}\left[\frac{1}{\prod_{k=0}^{\tau}(1+\rho(t+k))}\frac{B^S(t+\tau)+M^S(t+\tau)}{P(t+\tau)}\right]. \quad (4\text{-}2\text{-}11)$$

Note that in equation (4-2-11), the real fiscal surplus $(tax(t+\tau) - g(t+\tau) - w(t+\tau)l_g^d(t+\tau))$ is discounted by the real rate of interest $\rho(t)$, while the real seigniorage $(i(t+\tau)\frac{M^S(t+\tau-1)}{P(t+\tau-1)})$ is discounted by the nominal rate $i(t)$.[9] If $\lim_{\tau\to\infty}\left[\frac{1}{\prod_{k=0}^{\tau}(1+\rho(t+k))}\frac{B^S(t+\tau)+M^S(t+\tau)}{P(t+\tau)}\right]$ is positive, it is called a pricing bubble. Conversely, if the transversality condition is satisfied, and the bubble term is zero $(\lim_{\tau\to\infty}\left[\frac{B^S(t+\tau)+M^S(t+\tau)}{P(t+\tau)\prod_{k=0}^{\tau}(1+\rho(t+k))}\right] = 0)$, then the real balance of public bonds and money stocks is equal to the sum of the present value of future fiscal surpluses and seigniorage.

Equation (4-2-11) can be further simplified by the following three assumptions.

(1) The transversality condition holds, and $\lim_{\tau\to\infty}\left[\frac{B^S(t+\tau)+M^S(t+\tau)}{P(t+\tau)\prod_{k=0}^{\tau}(1+\rho(t+k))}\right] = 0$.

(2) Real money demand is assumed to be constant at m^{QTM}, and money markets are in equilibrium, $\frac{M^d(t)}{P(t)} = m^{QTM} = \frac{M^S(t)}{P(t)}$. [10] Consequently, the price level $P(t)$ is proportional to money stocks $M^S(t)$, and the QTM holds.

(3) If the nominal rate of interest is constant $(i(t) = i)$, then $\sum_{\tau=1}^{\infty}\left[\frac{i(t+k)}{\prod_{k=1}^{\tau}(1+i(t+k))}\right] = 1$.

Under the above three assumptions, equation (4-2-11) is rewritten as follows.

$$\frac{B^S(t)}{P(t)} + \frac{M^S(t)}{P(t)} = b^f(t) + m^{QTM} \quad (4\text{-}2\text{-}12)$$

By equation (4-2-12), fiscal discipline, $\frac{B^S(t)}{P(t)} = b^f(t)$, can be established at the price level determined by the QTM $(\frac{M^S(t)}{P(t)} = m^{QTM})$.

Let us return to the disequilibrium approach. Here, markets are assumed to be cleared in

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[9] Equation (4-2-3) is rewritten as follows.

$$\begin{aligned}\frac{B(t-1)+M(t-1)}{P(t-1)} &= \frac{P(t)[tax(t)-g(t)-w(t)l_g^d(t)]}{P(t)\frac{P(t-1)}{P(t)}[1+i(t)]} + \frac{i(t)M(t-1)}{P(t-1)[1+i(t)]} + \frac{B(t)+M(t)}{P(t)\frac{P(t-1)}{P(t)}[1+i(t)]} \\ &= \frac{1}{1+\rho(t)}\left[tax(t)-g(t)-w(t)l_g^d(t)\right] + \frac{1}{1+i(t)}\frac{i(t)M(t-1)}{P(t-1)} + \frac{1}{1+\rho(t)}\frac{B(t)+M(t)}{P(t)}\end{aligned}$$

As the above equation implies, the real seigniorage arises on the previous real money balance $(\frac{i(t)M(t-1)}{P(t-1)})$, and is accordingly discounted by the nominal rate of interest. On the other hand, the real fiscal surplus is defined at the current period $(tax(t) - g(t) - w(t)l_g^d(t))$, and is consequently discounted by the real rate of interest.

[10] Here, it is assumed that the nominal rate of interest is above zero, and real money demand is much less interest-elastic.

goods and labor markets for simplicity ($Ex_{gl}^{s}(t) = 0$). Thus, money and public bonds markets are cleared as a whole, but each market is still in disequilibrium ($\frac{M^d(t)}{P(t)} - \frac{M^s(t)}{P(t)} = \frac{B^s(t)}{P(t)} - b^f(t) > 0$). Then, the clearing condition in money and public bonds markets is rewritten as

$$\frac{B^s(t)}{P(t)} + \frac{M^s(t)}{P(t)} = b^f(t) + m^{QTM} + \left[\frac{M^d(t)}{P(t)} - m^{QTM}\right]. \qquad (4\text{-}2\text{-}13)$$

Let us compare the disequilibrium analysis equation (4-2-13) with the equilibrium analysis equation (4-2-11). If the present value of the future real seigniorage ($\frac{1}{P(t)}\left[\frac{i(t+\tau)}{\prod_{k=1}^{\tau}(1+i(t+k))}\frac{M^s(t+\tau)}{P(t+\tau)}\right]$) in equation (4-2-11) is approximated by normal money demand m^{QTM}, then strong money demand in excess of normal demand (which is named QTM demand) in disequilibrium analysis ($\frac{M^d(t)}{P(t)} - m^{QTM}$) corresponds to the pricing bubble in equilibrium analysis ($\lim_{\tau\to\infty}\left[\frac{1}{\prod_{k=0}^{\tau}(1+\rho(t+k))}\frac{B^s(t+\tau)+M^s(t+\tau)}{P(t+\tau)}\right]$).[11]

$$\frac{M^d(t)}{P(t)} - m^{QTM} \approx \frac{1}{P(t)}\lim_{\tau\to\infty}\left[\frac{B^s(t+\tau)+M^s(t+\tau)}{\prod_{k=0}^{\tau}(1+\rho(t+k))}\right] > 0$$

In this way, strong money demand in disequilibrium approach may be interpreted as the pricing bubble in equilibrium approach.

Here is another comparison. If the consolidated government reimburses seigniorage to households, then its budget constraint (4-2-3) is rewritten as

$$\frac{M^s(t)-M^s(t-1)}{P(t)} + \frac{B^s(t)-B^s(t-1)}{P(t)} + \left[tax(t) - \frac{M^s(t)-M^s(t-1)}{P(t)}\right] = g(t) + i(t)\frac{B^d(t-1)}{P(t)} + w(t)l_g^d(t).$$

Accordingly, when money and public bonds markets are all in equilibrium, the government's life-time budget constraint (4-2-11) is rewritten as follows.

$$\frac{B^s(t)}{P(t)} = b^f(t) + \lim_{\tau\to\infty}\left[\frac{1}{\prod_{k=0}^{\tau}(1+\rho(t+k))}\frac{B^s(t+\tau)}{P(t+\tau)}\right] \qquad (4\text{-}2\text{-}14)$$

[11] According to Saito (2020), revised as Chapter 5, if the transversality condition fails to hold in the equilibrium analysis of equation (4-2-11), then the bubble term, which is finitely positive at asymptotically zero rates of interest, contributes to appreciation of the real balance of public bonds $\frac{B^s(t)}{P(t)}$ and yields deflationary pressure on the current price level. Kobayashi (2019), Sakuragawa (2019), Murase (2020), and Brunnermeier et al. (2020) also demonstrate that deflationary pressure is generated by the unsatisfied transversality condition in the consolidated government's budget constraint. Hagedorn (2018) regards government bonds as net wealth in the sense that the bond valuation exceeds the present value of future fiscal surpluses, and presents a similar monetary model.

If money and public bonds markets are cleared as a whole in disequilibrium analysis, then $\frac{B^s(t)}{P(t)} = b^f(t) + \left[\frac{M^d(t)}{P(t)} - \frac{M^s(t)}{P(t)}\right]$ holds. In this case, a comparison between equilibrium and disequilibrium analyses indicates that the excess demand in money markets corresponds to the public bond pricing bubble in equation (4-2-14).

$$\frac{M^d(t)}{P(t)} - \frac{M^s(t)}{P(t)} = \lim_{\tau\to\infty}\left[\frac{1}{\prod_{k=0}^{\tau}(1+\rho(t+k))}\frac{B^s(t+\tau)}{P(t+\tau)}\right] > 0$$

As Saito (2020), revised as Chapter 5, demonstrates, the public bond pricing bubble $\lim_{\tau\to\infty}\left[\frac{1}{\prod_{k=0}^{\tau}(1+\rho(t+k))}\frac{B^s(t+\tau)}{P(t+\tau)}\right]$ in equation (4-2-14) is finitely positive in a deflationary economy with asymptotically zero rates of interest. A major reason for this finite positivity is intuitively clear. At the limit of deflationary equilibria with zero interest rates, the nominal balance of public bonds converges to a constant.[12] Accordingly, the real balance of public bonds appreciates at the rate of deflation, equivalent to the real rate of interest at the zero nominal rate. Thus, its present value, discounted by the real rate of interest, converges to a constant, because both the numerator and denominator in $\frac{1}{\prod_{k=0}^{\tau}(1+\rho(t+k))}\frac{B^s(t+\tau)}{P(t+\tau)}$ grow at the same rate. As a realistic interpretation, the consolidated government can roll over public bonds forever at zero interest rates.

For the same reason, as long as the nominal balance of money stocks converges to a constant in the limit ($\lim_{\tau\to\infty} M^s(t+\tau) = M^s$), another bubble term $\lim_{\tau\to\infty}\left[\frac{1}{\prod_{k=0}^{\tau}(1+\rho(t+k))}\frac{M^s}{P(t+\tau)}\right]$ is finitely positive as well. That is, as long as nominal seigniorage is zero in both $i(t+\tau)M^s(t+\tau-1)$ and $M^s(t+\tau) - M^s(t+\tau-1)$, the entire bubble term in equation (4-2-11) ($\lim_{\tau\to\infty}\left[\frac{B^s(t+\tau)+M^s(t+\tau)}{P(t+\tau)\prod_{k=0}^{\tau}(1+\rho(t+k))}\right]$) is finitely positive. In other words, if the nominal balance of the money supply continues to grow, and $M^s(t+\tau) - M^s(t+\tau-1)$ is always positive, then the bubble term explodes, and no equilibrium path can be found.

In this way, the disequilibrium case where excess supply in public bonds markets is absorbed by excess demand in money markets at near-zero interest rates can be interpreted as the equilibrium case where the pricing bubble term emerges in the government's budget constraint with the transversality condition unsatisfied ($\lim_{\tau\to\infty}\left[\frac{1}{\prod_{k=0}^{\tau}(1+\rho(t+k))}\frac{B^s(t+\tau)+M^s(t+\tau)}{P(t+\tau)}\right] > 0$). Here, both the QTM ($\frac{M^s(t)}{P(t)} = m^{QTM}$) and the FTPL ($\frac{B^s(t)}{P(t)} = b^f(t)$) fail to hold, and the current price level has no close relationship with current money stocks or future fiscal surpluses.

Conversely, with an increase in short-term interest rates, probably above 0.5%, strong money demand will disappear, leading to the bursting of the pricing bubble. This means that money demand instantaneously shrinks to normal QTM demand (m^{QTM}), and fiscal discipline $\frac{B^s(t)}{P(t)} = b^f(t)$ needs to be reimposed at the price level determined by the QTM.

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[12] If both the nominal rate of interest and the price level converge to zero in the limit, $B(t) - B(t-1)$ also converges to zero in equation (4-2-3).

Now, let us interpret the current condition of the Japanese money markets using the insights developed above. The money (notes and reserves) issued at near-zero rates by the BOJ can be classified into two categories. The first category, denoted by $M_0^s(t)$, includes the BOJ notes and legal reserves, both of which carry zero interest rates even if market rates of interest rise above zero. The second category, denoted by $M_+^s(t)$, includes the reserves issued beyond the legal reserves, which bear a nominal rate of interest $i_t(t)$ in a situation with non-zero market rates. Thus, the second category of money is included in public bonds, more precisely, floating-rate public bonds from the viewpoint of the consolidated government.

Accordingly, once the short-term rate of interest is above zero, money and public bonds markets need to clear as follows.

$$\frac{M_0^s(t)}{P(t)} = m^{QTM} \qquad (4\text{-}2\text{-}15)$$

$$\frac{B^s(t)+M_+^s}{P(t)} = b^f(t) \qquad (4\text{-}2\text{-}16)$$

Equation (4-2-15) implies that as money demand abruptly shrinks upon an increase from zero in interest rates, the price level immediately jumps to the level determined by the QTM. Equation (4-2-16), on the other hand, shows that fiscal discipline needs to be established at the QTM price level by fiscal reforms that will lead to future fiscal surpluses. As discussed in detail in Section 3.3, if the consolidated government fails to commit to strict fiscal reforms, then the price surge will not be one-off, and the price process may end in hyperinflation.

3. The past and future of Japan's economy from the viewpoint of disequilibrium analysis

In Section 3.1, Japan's economy in the past quarter century is interpreted using the disequilibrium approach presented in Section 2. Section 3.2 explores the origins of strong money demand. The two alternatives are 'demand for central bank's notes and reserves' and 'demand for public bonds as money substitutes' in the near-zero interest rate environment. Japan's future possibilities are investigated as an abrupt transition from an unconventional disequilibrium situation to a conventional equilibrium situation in Section 3.3.

3.1. Excess supply in goods and labor markets and massive issues of money and public bonds

In this subsection, we carefully examine (i) how the consolidated government reduced excess demand in money/public bonds markets by aggressively issuing money ($\frac{M^s(t)}{P(t)}$) and public bonds ($\frac{B^s(t)}{P(t)}$) in the right-hand side of equation (4-2-6), (ii) how it dissolved excess supply in goods and labor markets ($Ex_{gl}^s(t)$) in the left-hand side of equation (4-2-6) by expanding government consumption ($G(t)$) and employment ($L_g^d(t)$), and (iii) how it simultaneously coordinated the former fiscal and monetary policy with the latter economic stimulus.

Let us first estimate the scale of excess supply in goods and labor markets. Given $\frac{potential\ output-actual\ output}{potential\ output}$ as the definition of output gap, the scale of excess supply in goods

markets can be computed by $real\ GDP \times \frac{output\ gap}{1-output\ gap}$. Similarly, the scale of excess supply in labor markets can be calculated by $real\ labor\ income \times \frac{unemployment\ rate}{1-unemployment\ rate}$. Here, the natural rate of unemployment is heroically assumed to be 2%, and the actual unemployment rate is adjusted by 2%, while real labor income is approximated by the nominal compensation of employees (reported in the System of National Accounts [SNA]), adjusted by the household final consumption deflator excluding imputed rents (again, reported in the SNA).

Figure 4-3-1 plots excess supply in goods and labor markets respectively, and adds the total excess supply in goods and labor markets relative to real GDP. After goods markets were clearly in excess demand in years FY1988 to FY1992, they frequently experienced a serious excess supply situation. In particular, the relative scale of excess supply rose in years FY1993 to FY1994, FY1998 to FY1999, FY2001 to FY2002, and FY2008 to FY2009. On the other hand, it declined considerably from FY2010.

Given that either or both money markets and public bonds markets are in disequilibrium at near-zero rates, it is difficult to identify money demand ($\frac{M^d(t)}{P(t)}$) and public bonds demand ($\frac{B^d(t)}{P(t)} = b^f(t)$) separately. Thus, an increment in the issues of money and public bonds ($[M^s(t) + B^s(t)] - [M^s(t-1) + B^s(t-1)]$) is regarded as a proxy for a reduction in excess demand in money/public bonds markets.

Figure 4-3-2 plots the series of the nominal balance of public bonds, excluding the BOJ's own JGBs, and the monetary base, consisting of BOJ notes and reserves, and adds the increment to the issues of money and public bonds, relative to nominal GDP, as well as that of excess supply in goods and labor markets, relative to real GDP. According to this figure, the consolidated government aggressively issued to the private sectors, public bonds up to FY2012, and increased the monetary base from FY2013, thereby attempting to reduce excess demand in money/public bonds markets.

Figure 4-3-3 depicts the scale of government consumption and employment, relative to real GDP, both of which are included in the government final consumption in the SNA. According to this figure, the government constantly expanded government consumption and employment from the mid-1990s.

Let us examine **Figure 4-3-2** year-by-year in more detail. In response to a rise in excess supply in goods and labor markets in FY1993 to FY1994, and FY1998 to FY2002, the government issued very large amounts of public bonds in the following years while concurrently expanding government consumption, thereby attempting to dissolve both excess demand and excess supply simultaneously. On the other hand, in response to an excess supply surge from FY2008 to FY2009, the consolidated government first issued public bonds up to FY2012, and then replaced them with BOJ reserves after FY2013.

The above aggressive policy response to the excess supply expansion in goods and labor markets forms a sharp contrast with the passive response to the excess demand surge from FY1988 to FY1992. In the latter period, the consolidated government did not reduced its issues of money and public bonds and was reluctant to scale down aggregate demand. Accordingly, that excess demand situation continued for as long as 5 years.

There is one more remark on the above analysis. According to equation (4-2-6), excess supply in goods and labor markets corresponds one-to-one to excess demand in money/public bonds markets; however, this neat equality was not observed in practice during the period of our study.

Inside and outside lags may be responsible for this inconsistency; that is, it takes some time for a government to form a particular policy, and for such a policy to yield noticeable effects on the macroeconomy.

3.2. The BOJ's issues of money and its purchases of public bonds in the near-zero interest rate environment

As discussed in Section 2, strong money demand from the public, induced by near-zero rates of interest, absorbs not only conventional money such as central bank notes and reserves, but also public bonds as money substitutes. In this subsection, we examine how such strong money demand is revealed partly as 'demand for BOJ notes and reserves' and partly as 'demand for JGBs as money substitutes'.

Because the public (mainly the private banks) are almost indifferent between holding money and investing public bonds at near-zero rates, no particular equilibrium path can be picked up theoretically. In the case of Japan's money and public bonds markets, strong money demand was revealed as follows.

(1) After short-term interest rates fell below 0.5% in mid-1995, the private banks began to make very large purchases of long- and ultra-long-term JGBs. They anticipated that long-term yields would decline toward near-zero quickly. (Sections 3-2-1 and 3-2-3)
(2) Aggressive BOJ purchases of JGBs initially helped to refinance its own JGBs at maturity, but they later contributed to an expansion of the BOJ's holdings of JGBs. (Section 3.2.3 and Appendix)
(3) While the balance of BOJ notes expanded gradually from mid-1995, the balance of BOJ reserves swelled from early 2009, and accelerated after the BOJ implemented QQE in April 2013. (Section 3.2.2)
(4) Under QQE, private banks exchanged their own JGBs for deposits at the BOJ excess reserves. (Section 3-2-3)

In this way, strong money demand was initially revealed as 'demand for JGBs as money substitutes' with the expectation by the private banks of quick declines in long-term yields. Then, 'demand for JGBs' was later replaced by 'demand for BOJ excess reserves'. It is often fallaciously believed that the BOJ underwrote new issues of JGBs from the beginning. However, it was 'demand for JGBs as money substitutes' from the private banks that initially helped large-scale public finance, whereas it was the private banks' 'demand for BOJ reserves' that later replaced their earlier 'demand for JGBs'.

From FY1999, the BOJ was indeed forced to accept a challenging target for purchases of long-term JGBs by the government. The target for purchases of JGBs with shorter than 3-year maturity was initially set at 0.4 trillion yen per month, but was raised to 0.6 trillion yen in August 2001, 0.8 trillion yen in December 2001, 1.0 trillion yen in February 2002, 1.2 trillion yen in December 2008, and 1.8 trillion yen in March 2009. In October 2010, another 1.5 trillion yen per month was added to the above target. Under QQE starting in April 2013, the maturity of JGBs was extended from 3 years to 7 years, while the monthly target was raised to 7 trillion yen. In October 2014, maturity was further extended to 10 years, while the monthly target was raised to between 8 and 12 trillion yen.

As discussed in detail in the Appendix, the above very large BOJ purchases of JGBs

contributed mostly to the redemption of the BOJ's own JGBs at maturity before QQE began in April 2013. After that, they contributed largely to increments in the BOJ's own JGBs by replacing 'demand for JGBs as money substitutes' from the private banks.

3.2.1. Creation of the near-zero interest rate environment

Now, let us look back in more detail at the dramatic changes in the rate of interest starting in the 1990s. As demonstrated in **Figure 4-1-4**, the short-term rate of interest declined quickly in the first half of the 1990s. The uncollateralized overnight call rates, which are inter-bank rates and the most representative short-term rates, peaked at 8.28% in March 1991, and dropped to 0.47% in October 1995. When the BOJ adopted a ZIRP in February 1999, the call rate was between 0.02% and 0.03%. When the BOJ terminated the ZIRP in August 2000, the call rate increased to above 0.2%.

As shown in **Figure 4-3-4**, when the BOJ began quantitative easing (QE) in March 2001, the call rate was set at almost zero, or between 0.000% and 0.002%. When the BOJ terminated QE in March 2006, the call rate rose to around 0.5%. Upon the collapse of Lehman Brothers in September 2008, however, the call rate declined to 0.3% in October 2008, and to 0.1% in December 2008. It had been below 0.1% since March 2009. As the BOJ adopted a negative interest rate policy (NIRP), the call rate had been between –0.04% and –0.07% since February 2013.

Near-zero rates extended to not only short-term interest rates, but also to medium-, long-, and even ultra-long-term yields. According to **Figure 4-3-5**, the yield spreads, measured in terms of n-year yields versus 1-year yields, tended to shrink except for the period between 2003 summer and 2004 summer.[13] For example, 10-year versus 1-year yield spreads peaked at above 1.5% in July 2004, but shrank consistently after that. They stayed at around 1% from 2008 to 2011, and dropped to below 0.5% in mid-2014. Since the BOJ implemented NIRP in February 2016, the yield spread has been below 0.3%.

In this way, not only T-bills, but also medium-, and (ultra) long-term JGBs became closer substitutes for interest-free money.

3.2.2. Aggressive issues of the BOJ notes and reserves

As mentioned above, strong money demand, induced by near-zero rates, was revealed partly as 'demand for the BOJ notes and reserves'. As shown in **Figure 4-3-6**, while the call rate stayed below 5% from FY1986 to FY1989, the balance of the BOJ notes expanded by 3 trillion yen per year. It expanded much faster when the call rate was near-zero from FY1995 to FY2005. After the call rate increased with the termination of QE in FY2006, the BOJ notes increased slowly, but it expanded again after the BOJ set the call rate at below 0.1% in FY2009.

On the other hand, the private banks, which are much more sensitive to interest rates than are households, want to keep their BOJ reserves at the legally required level as long as the call rate is quite low, but still above zero. As shown in **Figures 4-3-4** and **4-3-6**, the private banks never held excess reserves at the BOJ in the second half of the 1990s, when the call rate was still above zero. When the call rate was quite close to zero under the ZIRP (from February 1999 to August 2000) and QE (from March 2001 to March 2006), the balance of BOJ reserves expanded temporarily,

[13] According to Nakayama et al. (2004), rapid rises in long- and ultra-long-term yield spreads in mid-2004 were triggered by an increase in US long-term yields, and the market participants' expectation that QE would be terminated quite soon (though it actually ended in March 2006).

but shrank again to the legal reserve limit upon their termination.

In October 2008, the BOJ introduced the Complementary Deposit Facility (CDF), in which 0.1% interest was added on the excess reserves (the BOJ reserves in excess of the legal reserves). Thus, the private banks had an incentive to deposit beyond the legal reserves, as long as the market rate was below 0.1%.

As shown in **Figure 4-3-4**, the call rate was still above 0.1%, when the CDF was introduced in October 2008. Accordingly, the BOJ reserves never exceeded the legal reserve limit. After March 2009, however, the call rate was below 0.1%, and excess reserves emerged at the BOJ. The balance of BOJ reserves was 17.3 trillion yen in FY2010, and 23.7 trillion yen in FY2012.

In particular, the balance of BOJ reserves expanded annually by around 70 trillion yen after the QQE was introduced in April 2013 (see **Figure 4-3-6**). However, when the BOJ introduced a NIRP in February 2016, 0.1% interest was no longer added to the excess reserves newly deposited by the private banks, and even –0.1% interest was even added on a part of the excess reserves. From FY2016, the balance of BOJ reserves expanded much more slowly; they increased by 67.3 trillion yen in FY2016, 35.5 trillion yen in FY2017, and 15.6 trillion yen in FY2018.

3.2.3. Aggressive purchases of long-term JGBs by the BOJ

As discussed above, strong money demand from the private sector (the private banks) was initially revealed as 'demand for public bonds as money substitutes', rather than as 'demand for BOJ notes and reserves'. According to **Figure 4-3-7**, an increment in the BOJ's own JGBs (black solid line) occupied only a part of the annual issues of JGBs (blue bar) before FY 2012, except for FY2001. In FY2001, the BOJ could finance large-scale purchases of JGBs by additional excess reserves from initiating QE. As shown in **Figure 4-3-8**, the balance of non-BOJ's own JGBs (blue bar) grew much faster than the balance of the BOJ's own JGBs (a red bar).

When the BOJ adopted QQE in April 2013, the above trend was reversed. That is, 'demand for public bonds as money substitutes' was replaced by 'demand for BOJ notes and money'. While the government raised the issues of JGBs by 34.6 trillion yen in FY2013, 44.5 trillion yen in FY2013, and 34.3 trillion yen in FY2015, the BOJ expanded its purchase of JGBs by 73.2 trillion yen, 73.5 trillion yen, and 89.8 trillion yen, respectively (see **Figure 4-3-7**). Consequently, the balance of the BOJ's own JGBs increased from 127.9 trillion yen at the end of FY2012 to 486.0 trillion yen at the end of FY2018, but the balance of non-BOJ's own JGBs shrank from 731.2 to 538.9 trillion yen in the same period (**see Figure 4-3-8**).

As shown in **Figure 4-3-9**, under QQE starting from FY2013, the BOJ purchased long-term JGBs from private banks, but sold them T-bills (short-term bonds). Accordingly, the holdings of long-term JGBs concentrated more and more on the BOJ. In FY2018, the balance of the BOJ's own long-term JGBs (475.6 trillion yen) dominated the balance of non-BOJ's own long-term JGBs (451.8 trillion yen).

3.3. The outlook for demand for money and public bonds

In this subsection, we explore how the price level would behave if strong money demand disappeared abruptly at above-zero interest rates.

In the disequilibrium framework presented in Section 2.3, excess supply in goods and labor markets is accommodated by excess demand in money/public bonds markets. Accordingly, real money demand ($\frac{M^d(t)}{P(t)}$) corresponds to not only real money supply in a narrow sense ($\frac{M^s(t)}{P(t)}$), but also

real public bonds as money substitutes ($\frac{B^s(t)}{P(t)} - b^f(t)$), where the BOJ's own JGBs are excluded in $B^s(t)$, and excess supply in goods and labor markets ($Ex_{gl}^s(t)$). More concretely, the following real money demand function is obtained from equations (4-2-6) and (4-2-7).

$$\frac{M^d(t)}{P(t)} = \frac{M^s(t)}{P(t)} + \left[\frac{B^s(t)}{P(t)} - b^f(t)\right] + Ex_{gl}^s(t) \qquad (4\text{-}3\text{-}1)$$

Equation (4-3-1) may be standardized by real output ($y(t)$) as

$$\frac{M^d(t)}{P(t)y(t)} = \frac{M^s(t)}{P(t)y(t)} + \left[\frac{B^s(t)}{P(t)y(t)} - \frac{b^f(t)}{y(t)}\right] + \frac{Ex_{gl}^s(t)}{y(t)}, \qquad (4\text{-}3\text{-}2)$$

where real GDP and the household final consumption deflator are used for $y(t)$ and $P(t)$.

How is the above real money demand function drawn? Among the variables on the right-hand side of equation (4-3-2), both $M^s(t)$ and $B^s(t)$ are directly observable, and excess supply in goods and labor markets ($Ex_{gl}^s(t)$) can be computed as discussed in Section 3.1. Here, the present value of future fiscal surpluses ($b^f(t)$), equivalent to demand for JGBs as investment instruments, is estimated by the following heroic approximation. First, real demand for JGBs as money substitutes is assumed to be zero up to FY1994, when interest rates were well above zero. That is, $\frac{B^s(t)}{P(t)} - b^f(t) = 0$ before FY1994. Second, demand for JGBs as investment instruments, standardized by real GDP ($\frac{b^f(t)}{y(t)} = \hat{b}^f(t)$), is assumed to be constant from FY1995 on, and it may be approximated by the FY1983–FY1994 average of the real balance of public bonds. That is, $\hat{b}^f(t) \approx 0.392$ after FY1995. The second assumption is justified later more carefully.

In **Figure 4-3-10-1**, real money demand specified by equation (4-3-2) is drawn against the call rate ($i(t)$). According to this figure, real money demand is almost constant at around 9% of real GDP when the call rate is above 0.5%, but is almost infinitely elastic when the call rate is below 0.5%.

Given the above shape of real money demand in a broad sense, the following four policy scenarios exist for the consolidated government as demonstrated in **Figure 4-3-10-2**.

Scenario 1: The (consolidated) government maintains near-zero interest rates, and then attempts to reduce excess supply by issuing very large volumes of money and public bonds.
Scenario 2: The government maintains near-zero interest rates, but then gradually retires money and public bonds from markets.
Scenario 3: The government fails to maintain near-zero rates. Then, the price level jumps with shrinking money demand and the government implements fiscal reforms as a result of the disappearance of strong money demand for public bonds as money substitutes.
Scenario 4: The government fails to maintain near-zero rates, but also fails to commit to future fiscal reforms. Then, the price process escalates toward hyperinflation.

In the past quarter century, the Japanese government and BOJ have developed Scenario 1-like fiscal and monetary policies. A dilemma associated with Scenario 1 is that it had been adopted

to escape from a deflationary economy with near-zero interest rates, but required that economic environment as a precondition. Because Scenario 1 was adopted for such a lengthy period, it may be difficult for the government to admit the policy dilemma, hindering a switch from Scenario 1 to Scenario 2 in the near future.

What would happen if the government made mistakes in either monetary or fiscal policy? In Scenario 3, the BOJ fails to maintain near-zero interest rates, but the government succeeds in committing to strict fiscal reforms. Below, we investigate how much the price level would adjust, and to what extent fiscal reforms would be required, if Scenario 3 were adopted.

For this purpose, as discussed in Section 2.4, the BOJ notes and reserves are divided into interest-free money ($M_0^s(t)$) and potentially interest-bearing public bonds ($M_+^s(t)$). $M_0^s(t)$ includes BOJ notes and the legal reserves, both of which are interest-free by nature, while $M_+^s(t)$ includes JGBs and BOJ excess reserves, the latter of which are floating-rate bonds. Once interest rates take off from zero, both excess reserves and conventional public bonds constitute interest-bearing public bonds for the consolidated government.

As in equation (4-3-2), nominal variables are adjusted by both the household final consumption deflator ($P(t)$) and real GDP ($y(t)$), while real variables are adjusted by real GDP. Thus, equation (4-3-1) is rewritten as follows.

$$\frac{M^d(t)}{P(t)y(t)} + \frac{b^f(t)}{y(t)} = \frac{M_0^s(t)}{P(t)y(t)} + \left[\frac{B^s(t)}{P(t)y(t)} + \frac{M_+^s(t)}{P(t)y(t)}\right] + \frac{Ex_{gl}^s(t)}{y(t)}.$$

If the BOJ is unable to control interest rates at near-zero, then strong money demand disappears immediately. Accordingly, there is no room for money demand to accommodate swollen money and public bonds supply. The real balance of interest-free money stocks needs to shrink to normal money demand as follows.

$$\frac{M_0^s(t)}{P(t)y(t)} = \frac{m^{QTM}(t)}{y(t)} = \hat{m}^{QTM}, \qquad (4\text{-}3\text{-}3)$$

where it is assumed that normal real money demand ($m^{QTM}(t)$) has unit income-elasticity, and that not $m^{QTM}(t)$, but $\frac{m^{QTM}(t)}{y(t)}$ is constant at $\hat{m}^{QTM}$. Consequently, the price level is upward adjusted immediately so that equation (4-3-3) can hold, while the nominal rate of interest jumps to the long-run inflation rate plus the real discount rate. In other words, the QTM applies immediately at above-zero interest rates.

The real balance of interest-bearing public bonds, on the other hand, needs to fall until is is consistent with the present value of future fiscal surpluses at the price level determined by equation (4-3-3) or the QTM.

$$\frac{B^s(t)+M_+^s}{P(t)y(t)} = \frac{b^f(t)}{y(t)} = \frac{1}{P(t)}\sum_{\tau=1}^{\infty}\frac{P(t+\tau)[T(t+\tau)-G(t+\tau)]}{y(t+\tau)\prod_{k=1}^{\tau}(1+i(t+k))} \qquad (4\text{-}3\text{-}4)$$

In other words, equation (4-3-4) holds, causing the government's strong commitment to fiscal reforms.

To sum up, once the rate of interest takes off from zero, and strong money demand disappears

immediately, the QTM, represented by equation (4-3-3), is immediately in force, while equation (4-3-4) has to hold strictly without any public bond pricing bubble unlike in equations (4-2-11) and (4-2-14).

Then, how should $\widehat{m}^{QTM}$ in equation (4-3-3) and $\frac{b^f(t)}{y(t)}$ in equation (4-3-4) be computed?

Figure 4-3-11 plots the series of the real balances of interest-free money stocks ($\frac{M_0^s(t)}{P(t)y(t)}$) and interest-bearing public bonds ($\frac{B^s(t)+M_+^s}{P(t)y(t)}$). According to this figure, both real balances remained almost constant in the period between FY1983 and FY1994, during which time, interest rates were well above zero. As shown in **Figure 4-3-1**, excess demand in goods and labor markets and excess supply in money/public bonds markets were present in the period FY1988 to FY1992; that is, $\frac{M_0^s(t)}{P(t)y(t)} + \frac{B^s(t)+M_+^s}{P(t)y(t)} > \widehat{m}^{QTM}(t) + \frac{b^f(t)}{y(t)}$. Thus, the FY1983–FY1994 average of these series may be reasonably interpreted as the upper limit of $\widehat{m}^{QTM}$ and $\frac{b^f(t)}{y(t)}$. It is accordingly assumed that $\widehat{m}^{QTM} \leq 8.9\%$ and $\frac{b^f(t)}{y(t)} \leq 39.2\%$.

Let us now take the value of the two real balances at the end of FY2018; $\frac{M_0^s(t)}{P(t)y(t)} = 22.1\%$ and $\frac{B^s(t)+M_+^s}{P(t)y(t)} = 166.2\%$. If the price level is determined by equation (3-3), it needs to be at least 2.5 times as high as before with real output constant ($\frac{22.1\%}{8.9\%} \approx 2.5$). Given the price level to satisfy equation (4-3-3), equation (4-3-4) fails to hold; interest-bearing public bonds markets remain in excess supply ($\frac{B^s(t)+M_+^s}{P(t)y(t)} > \frac{b^f(t)}{y(t)}$). However, if the present value of future fiscal surpluses ($b^f(t)$) is multiplied by 1.7, then equation (4-3-4) strictly holds ($\left(\frac{166.2\%}{39.2\%}\right)/\left(\frac{22.1\%}{8.9\%}\right) \approx 1.7$). In this way, with the government's strong commitment to future fiscal reforms, the price level would jump only once before rising gradually according to monetary growth or the QTM.

In Scenario 4, the government fails to commit to future fiscal reforms. In the absence of any fiscal reform, equation (4-3-4) can only be satisfied by the price level rising rapidly at least 4.2 times its prior level ($\frac{166.2\%}{39.2\%} \approx 4.2$). In this case, equation (4-3-3) fails to hold at the price level determined by equation (4-3-4), and excess demand emerges in interest-free money markets, or $\frac{M_0^s(t)}{P(t)y(t)} < \widehat{m}^{QTM}$. Then, the hyperinflationary process is initiated to fix excess money demand; inflation accelerates, interest rates continue to rise, and real money demand shrinks toward zero.

Another scenario, theoretically narrowly justifiable, but practically highly unlikely, is that excess supply in interest-free/interest-bearing public bonds markets ($\left[\frac{M^d(t)}{P(t)y(t)} + \frac{b^f(t)}{y(t)}\right] - \left\{\frac{M_0^s(t)}{P(t)y(t)} + \left[\frac{B^s(t)}{P(t)y(t)} + \frac{M_+^s(t)}{P(t)y(t)}\right]\right\} < 0$) would be absorbed by excess demand in goods and labor markets ($\frac{Ex_{gl}^s(t)}{y(t)} < 0$). One serious problem of this scenario is that the excess demand needs to be extremely large to

accommodate the excess supply. Given the above assumptions, the size of excess supply in goods and labor markets would be 140.2% of real GDP; $(8.9\% - 22.1\%) + (39.2\% - 166.2\%) = -140.2\%$. Therefore, although this scenario is obviously unrealistic, it has often been implicitly discussed among Japanese politicians and bureaucrats in the context of pro-growth economic policy-making.

4. Conclusion

Let us return to our original question. Are unconventional policies such as 'borrow-more-repay-less' and 'repay-by-central-bank-money' theoretically justifiable? Our answer is both yes and no.

In some way, those policies are justifiable to the extent that the mildly deflationary environment with near-zero rates continues for a lengthy period. Large-scale economic stimulus financed by massive issues of money and public bonds surely works to reduce excess supply in goods and labor markets and excess demand in money/public bonds markets simultaneously. Without any noticeable effect on the price level, strong money demand, induced by near-zero interest rates, can absorb not only central bank notes and reserves, but also public bonds as money substitutes. Such policy consequences exhibit a striking contrast to conventional implications from the QTM and FTPL.

However, unconventional policies carry inherent contradictions. In the presence of strong money demand, the economy is likely to fall into a state of weak aggregate demand. Unconventional policies may treat this weakness temporarily, but they never remedy it fundamentally. In addition, frequent repetition of these policies contributes to a very large shift of financial resources from the private to the public sector. The private deposit-taking banks, including the Japan Post Bank (*Yucho Ginko* in Japanese), loaned less to the private sector, but more to the government and BOJ in the form of JGBs and BOJ notes and reserves. According to **Figure 4-4-1**, the loans to the public sector accounted for only 5.7% of the total assets at the end of FY1994, but exceeded 20% at the end of FY2007 and 28% at the end of FY2014.

An even more fundamental dilemma is that the unconventional policies are implemented to escape from a deflationary economy with near-zero rates, but require such a particular economic environment as a precondition. As discussed in detail in Section 2, once an economy takes off from a deflationary state, strong money demand disappears immediately. In this case, there is no room for money demand to absorb large issues of money stocks or public bonds. While the rate of interest was below 0.5%, very large real balances of interest-free money stocks (BOJ notes and legal reserves) and potentially interest-bearing public bonds (JGBs and BOJ excess reserves) were accumulated. In a normal economy with interest rates above 0.5%, however, it would be impossible to accommodate that level of money stocks and public bonds without price surging or strict fiscal reforms. If the government failed to commit credibly to future fiscal reforms, then the price path would be hyperinflationary.

One of the most important policy implications in this chapter is that the public often feel that they were relieved from any future tax obligation thanks to the unconventional policies, but they will eventually have to repay the very large amount of public bonds on issue. With a price surge, the public would sacrifice considerable purchasing power, whereas with strict fiscal reforms, they would pay taxes anyway. Without any successful fiscal reform, they might even lose purchasing power irretrievably as a consequence of hyperinflation.

Appendix: How did the BOJ *de facto* refund its own JGBs at maturity?

In this Appendix, we show that strong money demand, together with rapidly declining yields on long-term JGBs, helped the BOJ to refund *de facto* its own JGBs at maturity, without violating any strict restriction imposed by the Public Finance Act. Under the Public Finance Act, the BOJ is prohibited from directly refinancing long-term JGBs for the government.[14]

The BOJ usually finances a purchase of T-bills, long-term JGBs, and other bonds through either increments to the BOJ's current accounts (CAs), which are largely reserve deposits, or additional issues of BOJ notes. Accordingly, the BOJ's net purchases of JGBs almost match increases in the monetary base, which consists of the BOJ notes and CAs. As **Figure 4-A-1** shows, however, the BOJ's net purchases of JGBs and other government liabilities has exceeded changes in the monetary base considerably since FY1999. In particular, the former surpassed the latter by more than 100 trillion yen from FY2013. As shown below, these differences have contributed to the BOJ's *de facto* refinancing of its own JGBs at maturity.

What was happening to the above transactions among the BOJ, government, and private banks is explained as follows.

(1) The government issued new JGBs to private banks to raise funds for redemption of the BOJ's own JGBs at maturity.
(2) The BOJ received funds from the government as a result of redemption of its own JGBs, and appropriated those funds for purchases of JGBs from private banks.

The above transactions among the BOJ, government, and private banks meant that a net purchase of JGBs by the BOJ was recorded positive in the Market Operations Statistics (MOS), which is compiled by the Financial Markets Department of the BOJ, but changes neither in the BOJ CAs nor in the balance of the BOJ's own JGBs appeared in the MOS. Withdrawals from the CAs, which are accompanied by new issues of JGBs to private banks by the government, is cancelled out by payments on the CAs, which results from purchases of the same amount of JGBs by the BOJ. In addition, the JGBs maturing at the BOJ were replaced by those purchased from the private banks by the BOJ. Consequently, the BOJ's net purchases of JGBs were positive in spite of no change in the BOJ CAs under the BOJ's *de facto* refinancing of its own JGBs at maturity.

Why did the private banks participate in such an irregular refunding of JGBs by the BOJ? Again, strong money demand, driven by near-zero interest rates, helped substantially. The private banks could temporarily absorb newly issued JGBs as money substitutes. In addition, given that long-term yields on JGBs were expected to decline quickly toward zero, the private banks could enjoy capital gains by holding long-term JGBs for an even brief period.

Let us describe more precisely how the above *de facto* refinancing by the BOJ was recorded in the MOS using **Figure 4-A-2**. The MOS records transactions among the BOJ, government, and private banks in terms of changes in the BOJ CAs.

An increase in BOJ notes (*ginko-ken yoin* in Japanese) is recorded negative because the BOJ notes are withdrawn from the BOJ CAs by the private banks ((8) in **Figure 4-A-2**). **The BOJ's net**

[14] However, the Public Finance Act allows the BOJ to underwrite and refund T-bills for the government directly.

purchases of T-bills, JGBs, and other bonds (*kin-yu chosetsu*), on the other hand, are recorded positive because the BOJ makes payments on the CAs ((1), (1'), and (1")).

An increase in the Treasury Funds (TFs), caused by payments of taxes and public insurance premiums by private agents, and funds raised by issuing JGBs to the public including the private banks ((2)), is recorded negative as a result of withdrawals from the CAs by private banks, while a decrease in the TFs, caused by fiscal expenditures, and redemption of JGBs held by private agents ((3)), is recorded positive as a result of payments on the CAs by the government.

Usually, **net changes in the TFs** (*zaisei tou yoin*) are almost zero because an increase in the Funds is approximately cancelled out by its decrease during a given fiscal year.[15] However, when the government issues JGBs to redeem the BOJ's own JGBs at maturity, (i) net changes in the TFs need to be positive, (ii) most of the increase in TFs goes to the BOJ's own accounts to facilitate redemption ((5)), (iii) the remainder is put into government deposits at the BOJ ((6)), and (iv) the BOJ finally finances its purchase of JGBs from the private banks by the above increases in its own accounts and government deposits. As shown in **Figure 4-A-3**, the BOJ's net purchases of JGBs minus increases in the BOJ CAs (black line in **Figure 4-A-3**) are matched exactly by decreases in the TFs minus the BOJ note issues (red line).

Let us now explain the same transactions using the Treasury Funds Statistics (TFS), which are compiled by Policy Research Institute, Ministry of Finance (MOF). The TFS record transactions between the government and BOJ in terms of changes in the TFs.

Payments on the BOJ's accounts for the redemption of the BOJ's own T-bills and JGBs by the government are recorded negative in the TFS. Regarding T-bills, however, the BOJ is allowed to underwrite T-bills for the government directly, and this is recorded positive as a result of payments on the TFs by the BOJ. As shown in **Figure 4-A-4**, the redemption of T-bills from the TFs by the government was dominated by the refinancing of T-bills on the TFs by the BOJ up to FY1997.

The TFS cover not only the BOJ's transactions with the general account of the government, but also those with its various special accounts. Redemption of the BOJ's own JGBs by the special accounts is also recorded negative, whereas sales of JGBs to the BOJ by the special accounts are recorded positive. As shown in **Figure 4-A-4**, the redemption was sometimes dominated by the sales of the transactions between the BOJ and the special accounts.

How had the BOJ expanded holdings of T-bills and JGBs, and refunded them at maturity, given the extremely strong money demand? As demonstrated above, the BOJ usually finances an increase in T-bills and JGBs by an increase in the monetary base, while it *de facto* refinances its own JGBs at maturity by the redemption-purchase operations, where purchases by the BOJ immediately follow redemption by the government in *de facto* refunding JGBs.

According to the MOS (**Figure 4-A-3** and **Table 4-A-1**), the BOJ had expanded its holdings of JGBs by an increase in the CA (more precisely, excess reserves in the CA), which amounted to about 70 trillion yen from FY2013. On the other hand, the BOJ had refunded its own JGBs by the redemption-purchase operations. The scale of the operations, which can be measured by changes in the Treasury Funds, amounted to 30 trillion yen from FY 1999, and exceeded 100 trillion yen from FY2013.

On the other hand, according to the TFS (**Figure 4-A-4** and **Table 4-A-2**), the BOJ's own T-bills and JGBs had been aggressively redeemed from FY2001 to FY2005, and even more

[15] Note that the BOJ's taxes and payments on the government accounts ((5) in Figure A-2) are excluded from net changes in the TFs.

aggressively since FY2013. Such large-scale redemptions allowed the BOJ to refund its own JGBs *de facto* by the redemption-purchase operations. In addition, the BOJ partly refinanced its own JGBs with government deposits, which increased from FY1999 to FY2000, and from FY2015.

Tables 4-A-3 and **4-A-4** report changes in T-bills and JGBs holdings as well as the scale of their redemption, the latter of which is measured by the BOJ's net purchases of T-bills and JGBs minus changes in its holdings of T-bills and JGBs. The scale of redemption relative to the balance at the previous year is also reported in both tables. This relative scale can be interpreted as the redemption period. For example, if this relative scale is 25%, its inverse implies a 4-year redemption period.

As shown in **Table 4-A-3**, the BOJ's own T-bills were aggressively redeemed from in FY2002 to FY2005, and from FY2013. Accordingly, the BOJ reduced its holdings of T-bills. Note that the relative scale of redemption was often larger than 100% because T-bills were usually redeemed in less than 1 year.

As shown in **Table 4-A-4**, however, the BOJ greatly expanded its holdings of long-term JGBs since FY2013. Before FY2012 when the BOJ's holdings of long-term JGBs were less than 100 trillion yen, the relative scale of redemption ranged between 20% and 50%, implying that the BOJ's own long-term JGBs were redeemed in 2–5 years. This implied redemption period is consistent with the fact that the BOJ purchased only long-term JGBs with shorter than 3-year duration before FY2012.

While the BOJ expanded holdings of long-term JGBs from 91.3 trillion yen at the end of FY2012 to 459.6 trillion yen at the end of FY2018, the scale of redemption grew comparatively slowly. Accordingly, the relative scale of redemption declined from 26.5% in FY2012 to 11.9% in FY2018, implying that the BOJ's own long-term JGBs were redeemed in about 9 years. This extended redemption period suggests that the BOJ held JGBs with duration much longer than 3 years since FY2013.

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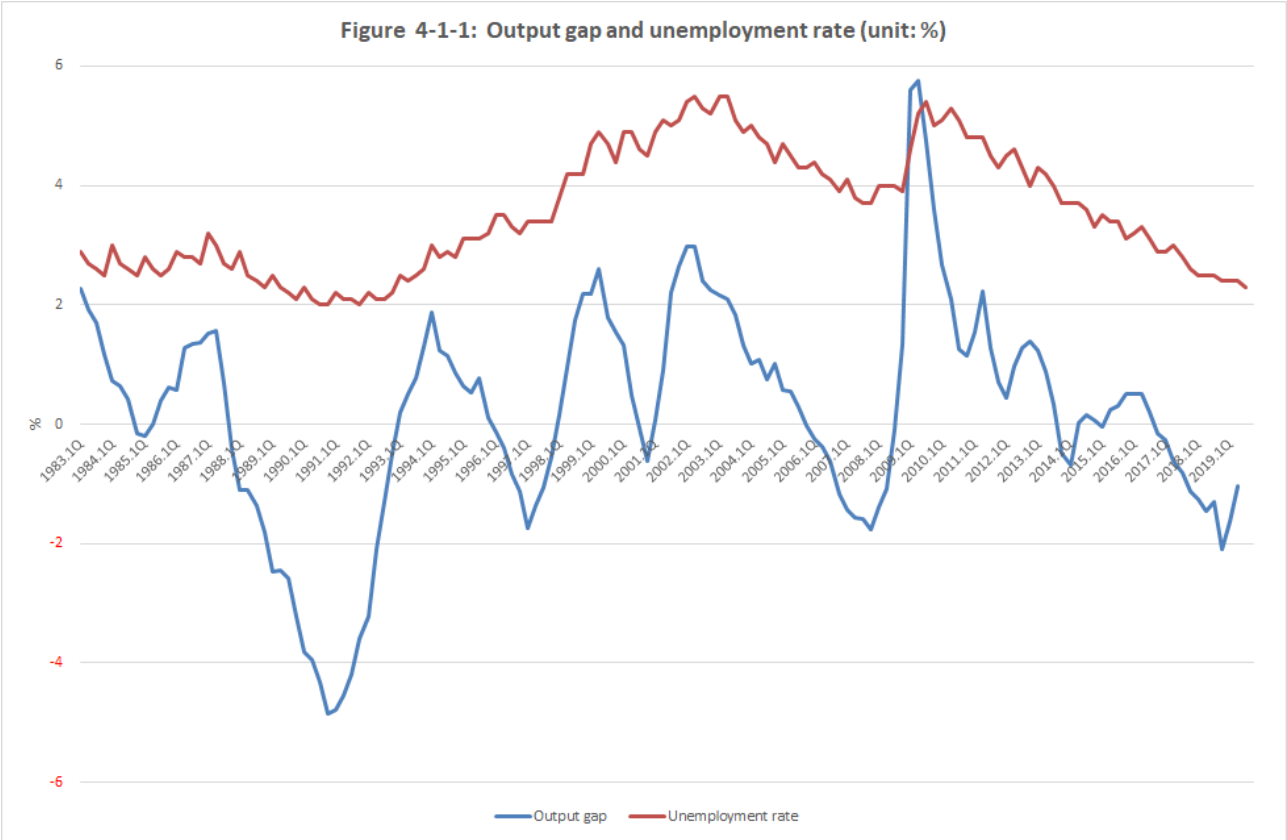
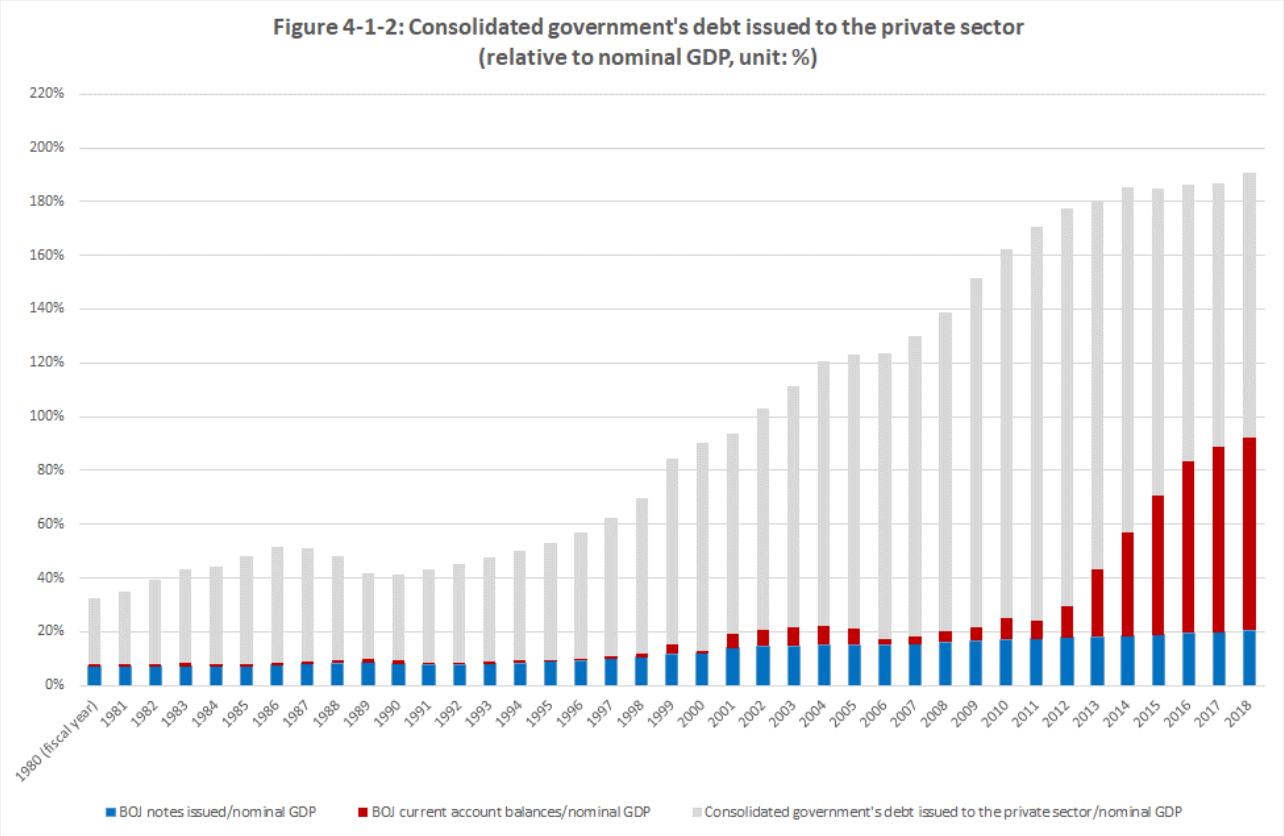


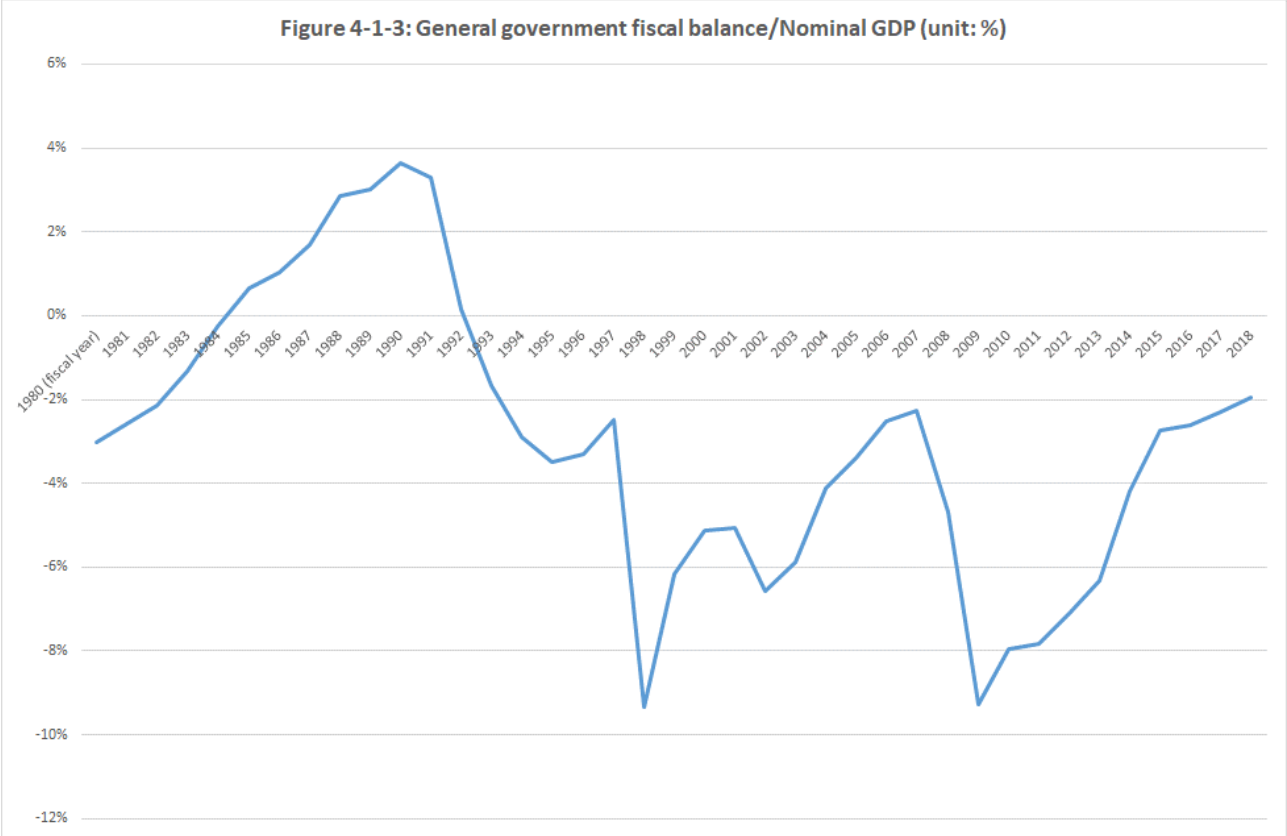
Notes:

1. Estimates for the output gap are from Kawamoto et al. (2017), and their updates, compiled by the Research and Statistics Department, BOJ, and are available at https://www.boj.or.jp/en/research/research_data/gap/index.htm/. The output gap is defined as $\frac{potential\ output - actual\ output}{potential\ output}$.
2. The unemployment rate is compiled by the Statistics Bureau of Japan, Ministry of Internal Affairs and Communications.



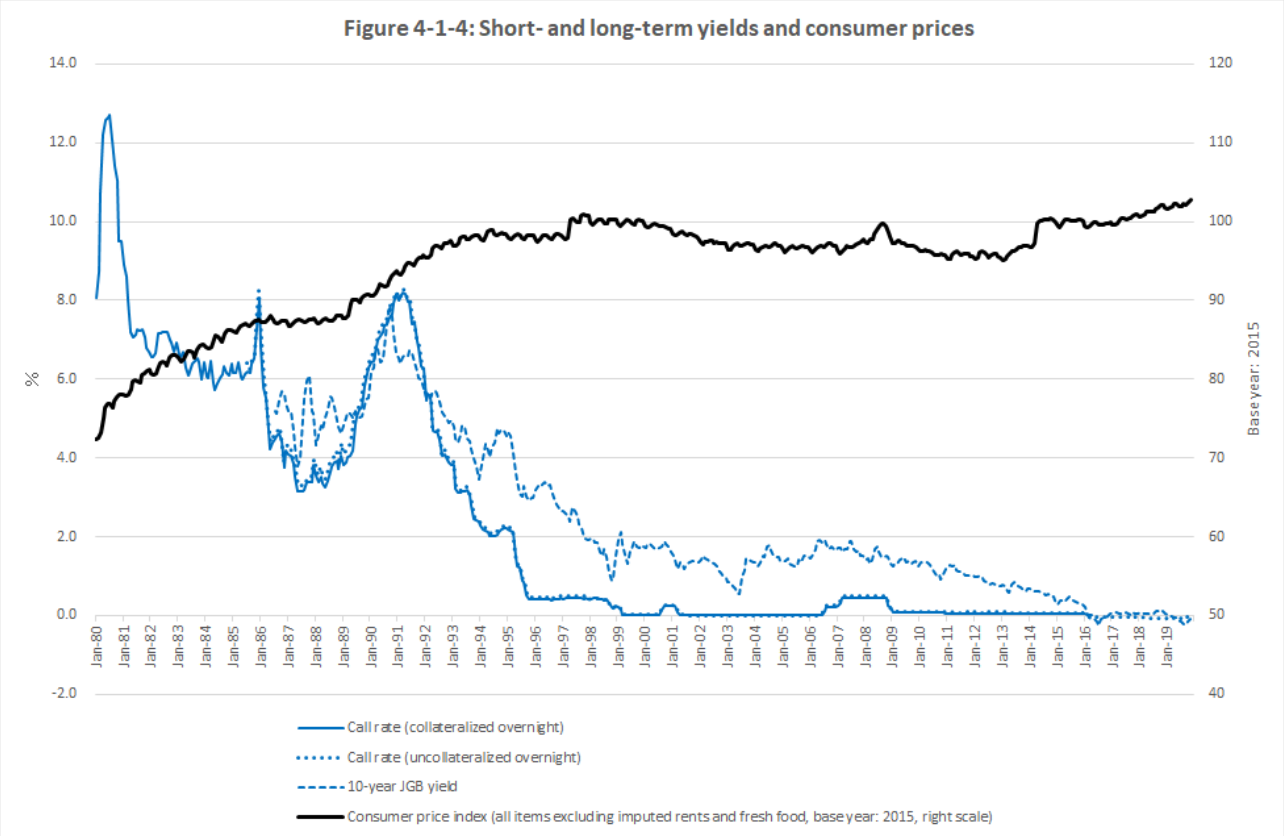
Notes:

1. The Flow of Funds Accounts Statistics for the general government and BOJ are compiled by the Research and Statistics Department, BOJ.
2. Nominal GDP is based on the annual report of the national accounts, which is compiled by the Economic and Social Research Institute, Cabinet Office of Japan.



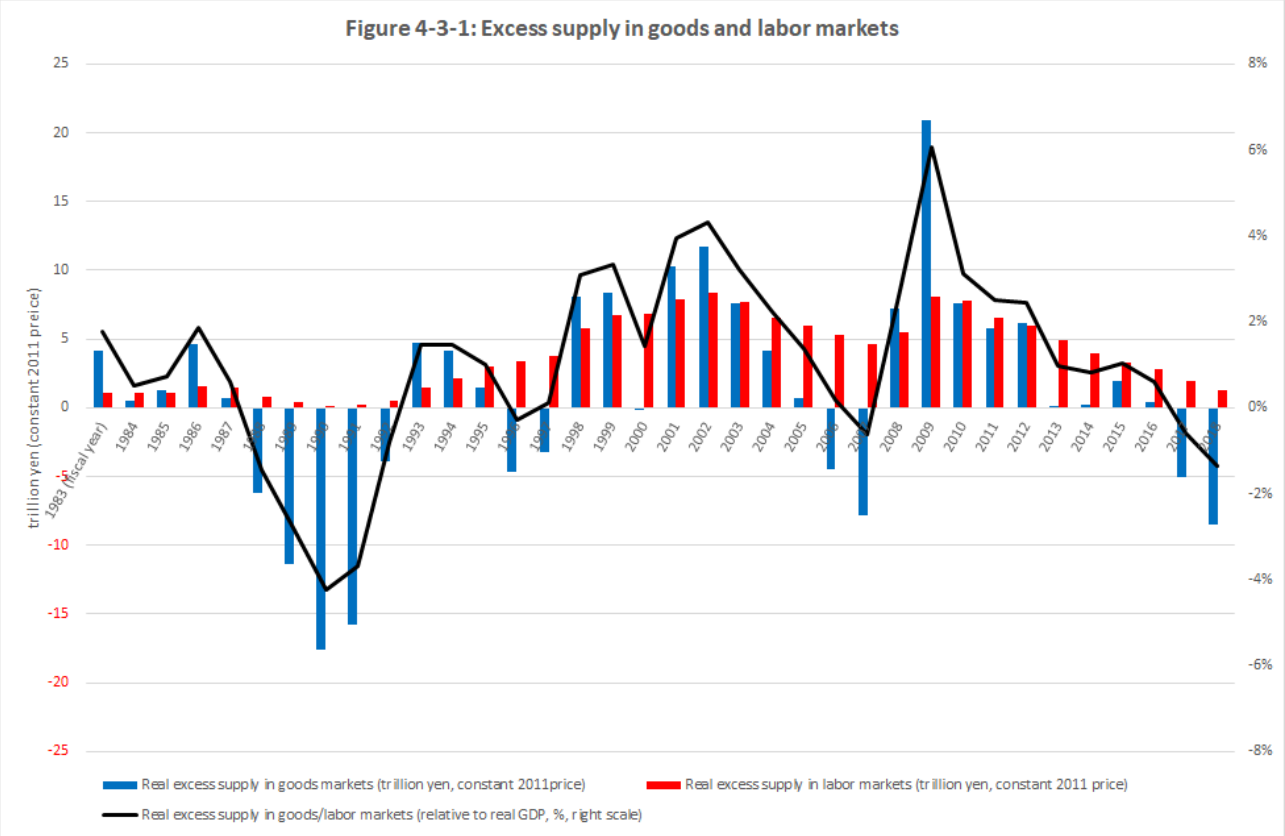
Note:

1. The general government fiscal balance is estimated by the Economic and Social Research Institute, Cabinet Office of Japan.



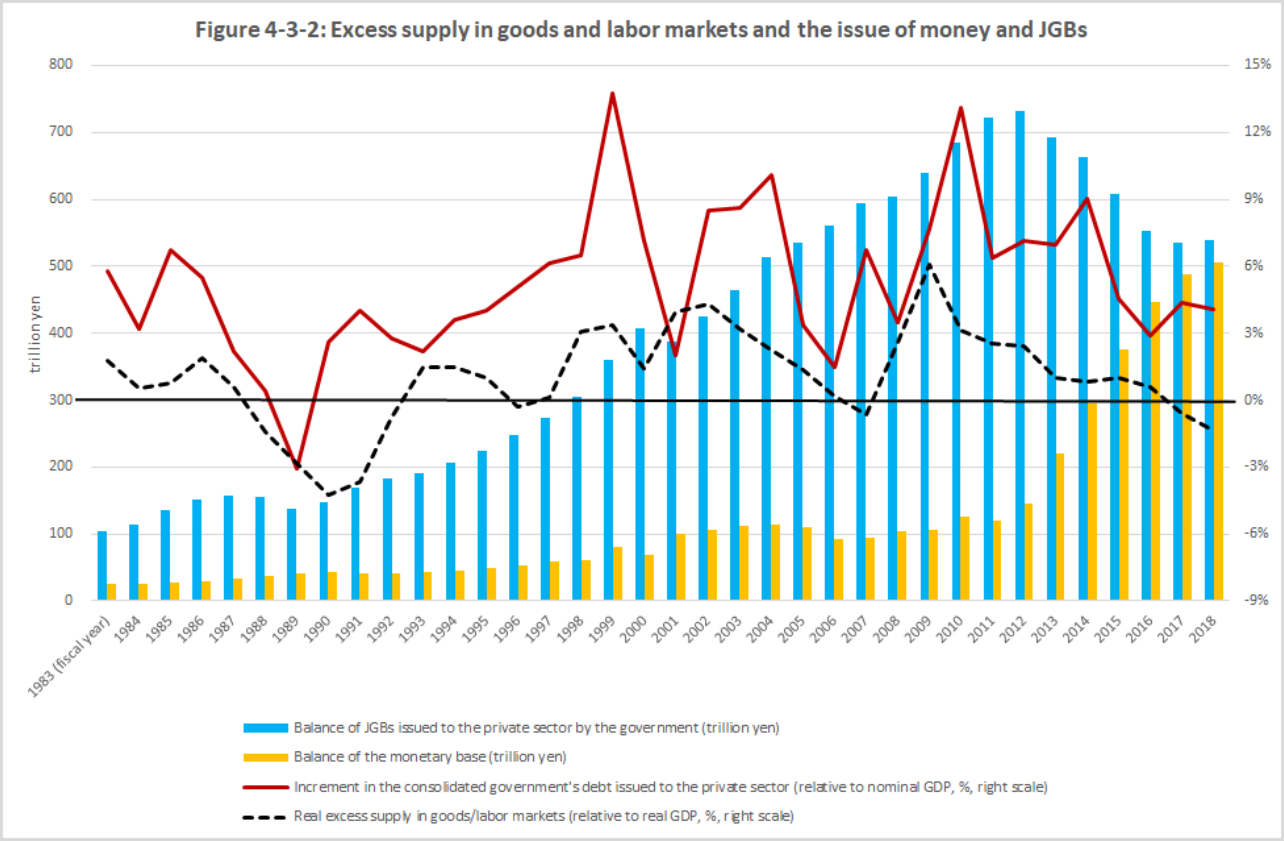
Notes:

1. The overnight call rates, collateralized and uncollateralized, are compiled by the Research and Statistics Department, BOJ.
2. Hamacho SCI (a private investment general partnership) computes the monthly averages of the JGB yields from their daily data, which are reported by the MOF.
3. The consumer price index is compiled by the Statistics Bureau of Japan, Ministry of Internal Affairs and Communications.

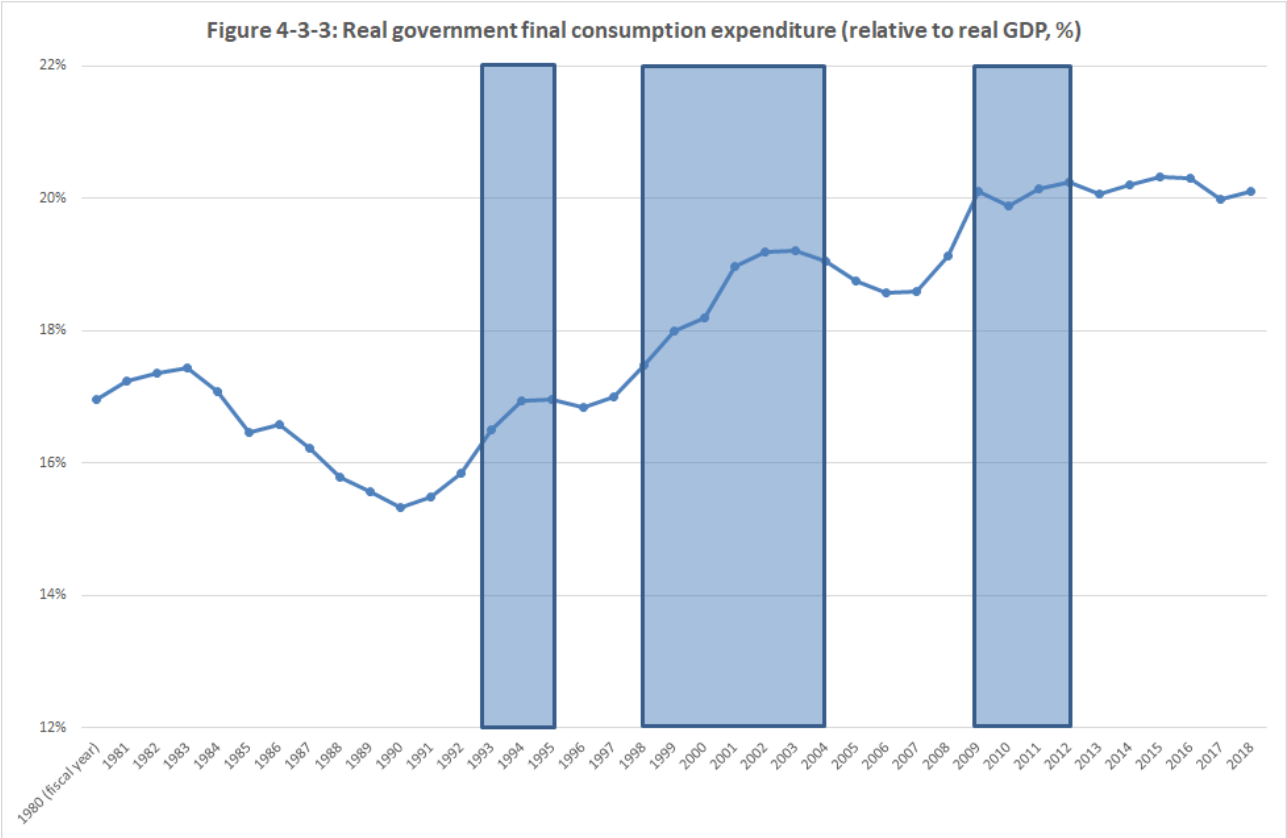


Notes:

1. Real excess supply in goods markets is computed by real GDP multiplied by $\frac{GDP\ gap}{1-GDP\ gap}$, where the GDP gap is defined by $\frac{potential\ GDP-actual\ GDP}{potential\ GDP}$, and estimated by Kawamoto et al. (2017) and their updates. See Note 1 in Figure 1-1.
2. Real excess supply in labor markets is computed by real labor income multiplied by $real\ labor\ income \times \frac{adjusted\ unemployment\ rate}{1-adjusted\ unemploymenr\ rate}$, where the adjusted unemployment rate is set at the actual unemployment rate minus 2%, and the compensation of employees, compiled by the Economic and Social Research Institute, Cabinet Office of Japan, is employed for real labor income.

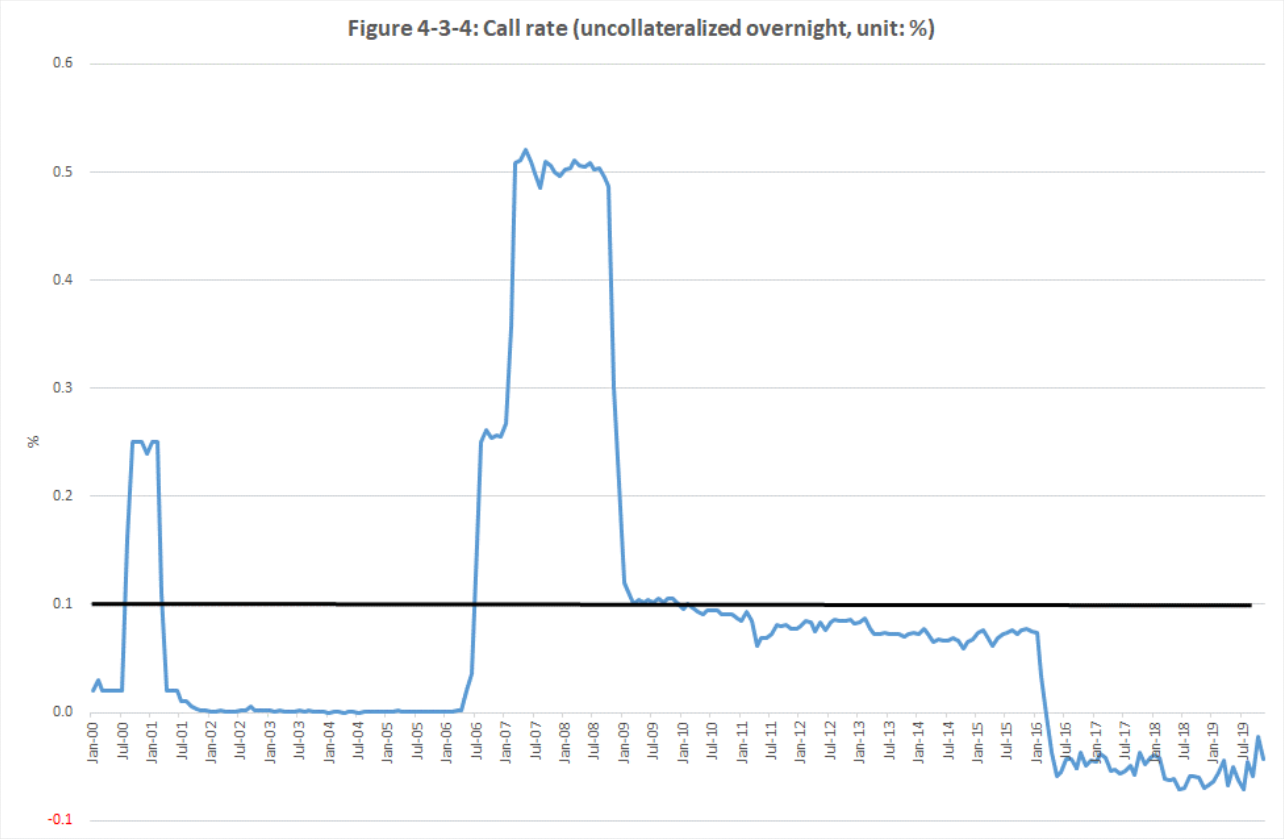


Note:
See Note 1 in Figure 1-2 and Notes 1 and 2 in Figure 3-2 for the data sources.

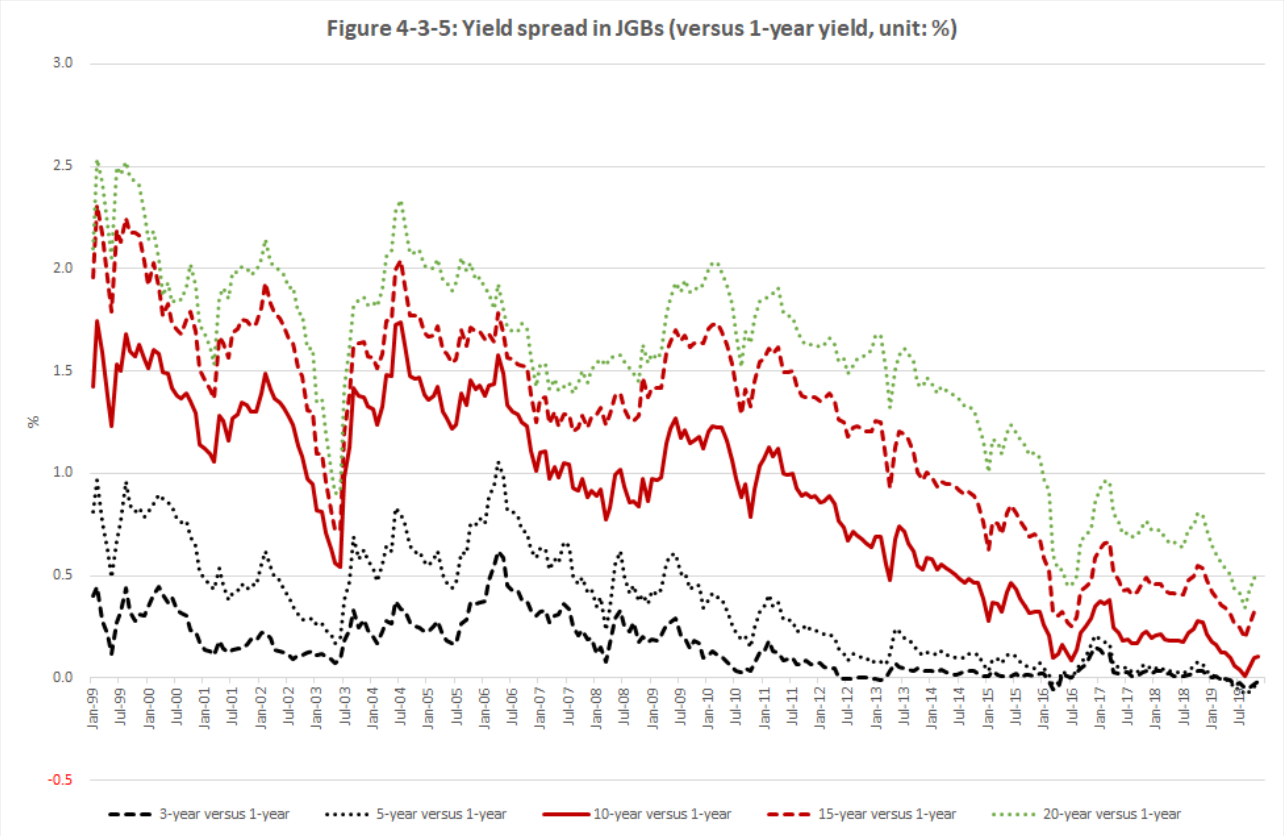


Note:

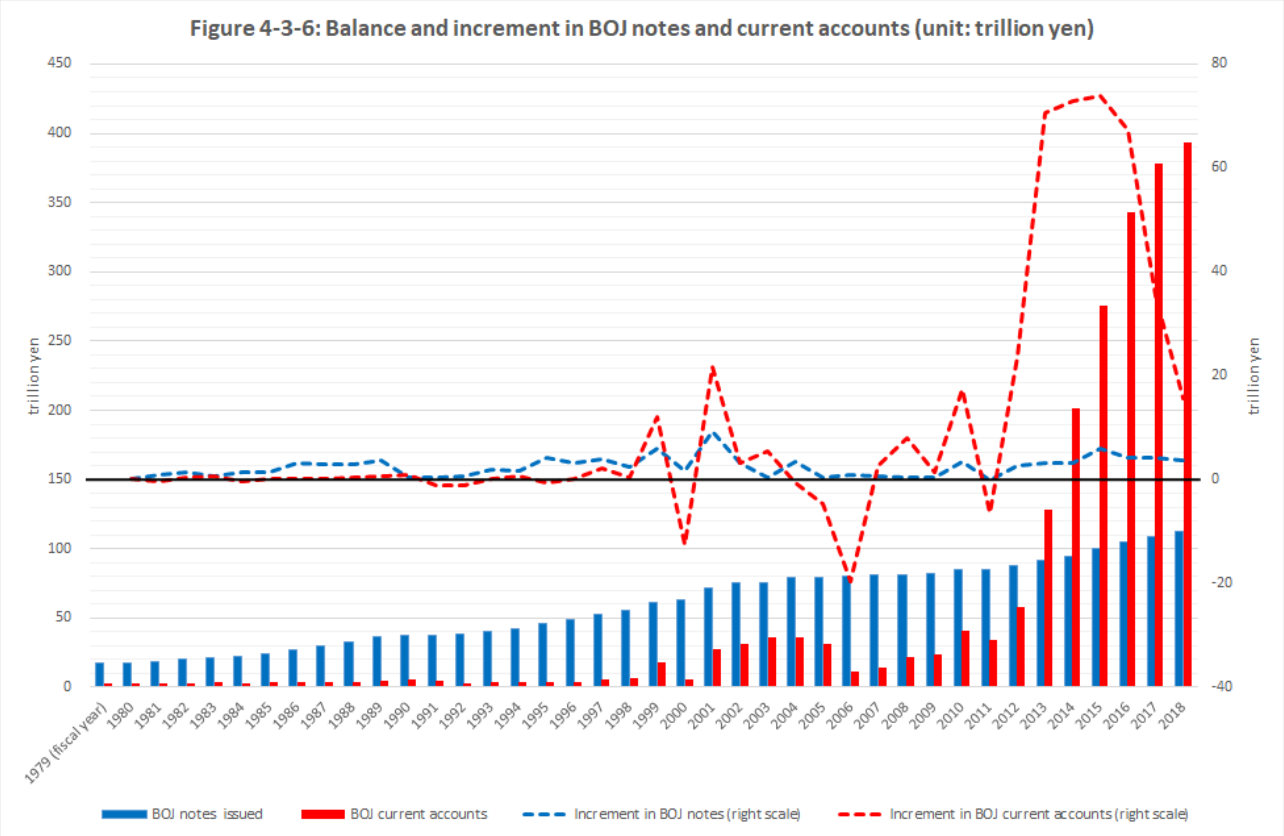
1. Government final consumption expenditure is estimated by the Economic and Social Research Institute, Cabinet Office of Japan.
2. Blue blocks imply the period in which there emerged excess supply in goods and labor markets.



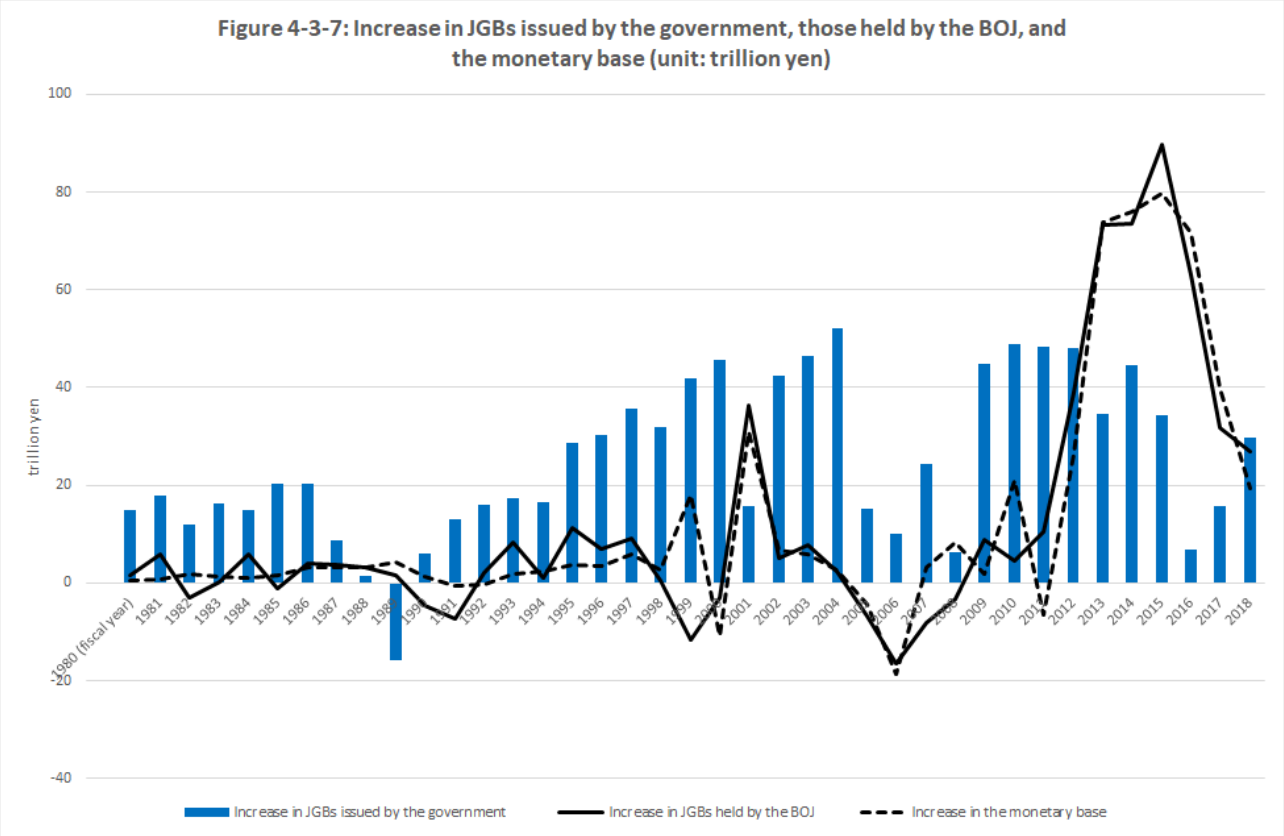
Note:
1. See Note 1 in Figure 1-4 for the data sources.



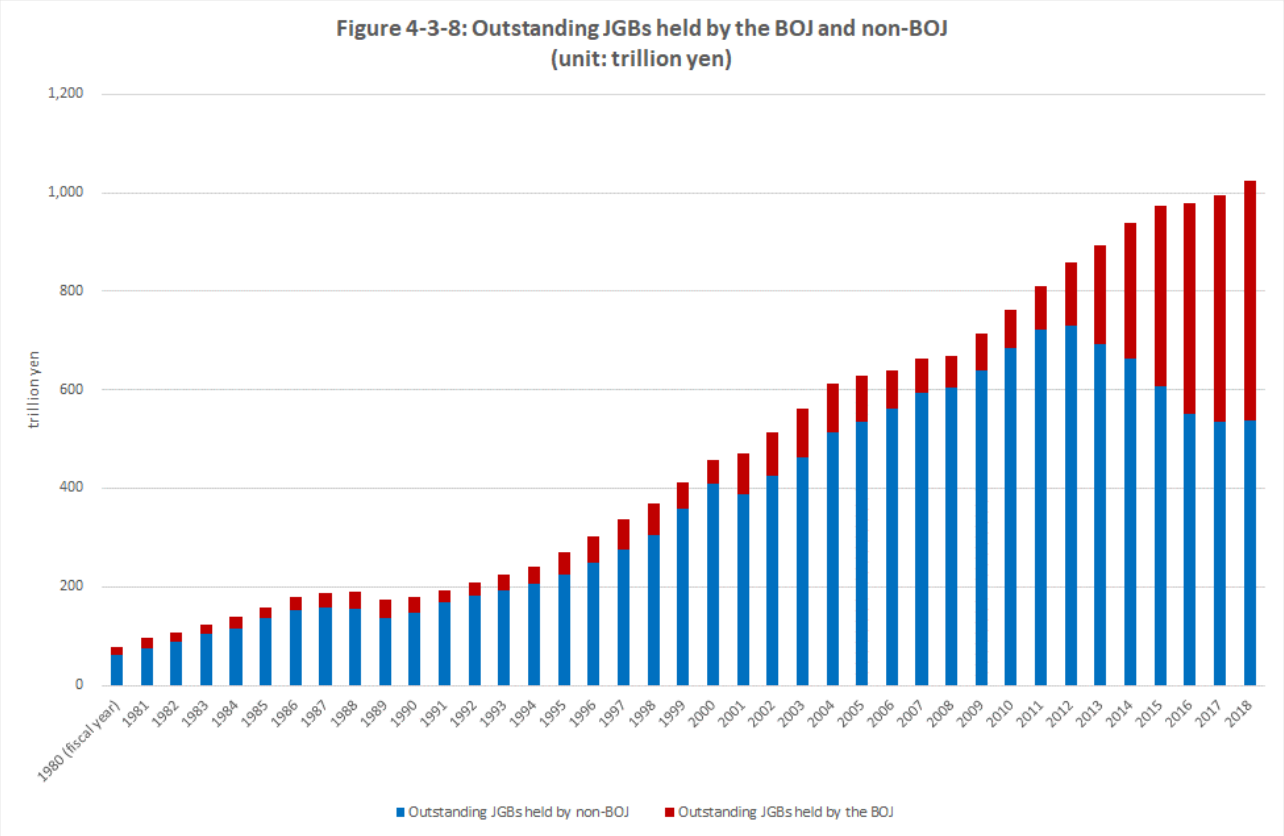
Note:
1. See Note 2 in Figure 1-4 for the data sources.



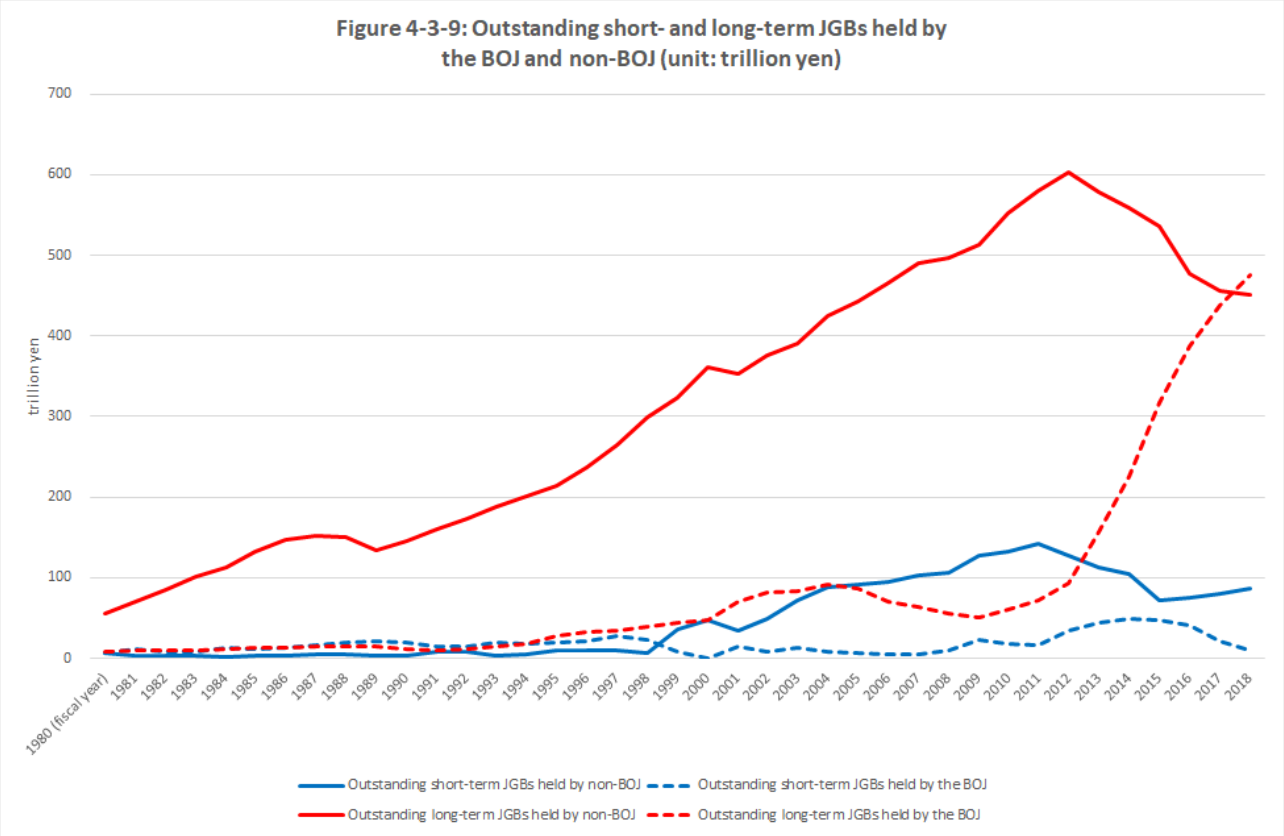
Note:
1. See Note 1 in Figure 1-2 for the data sources.



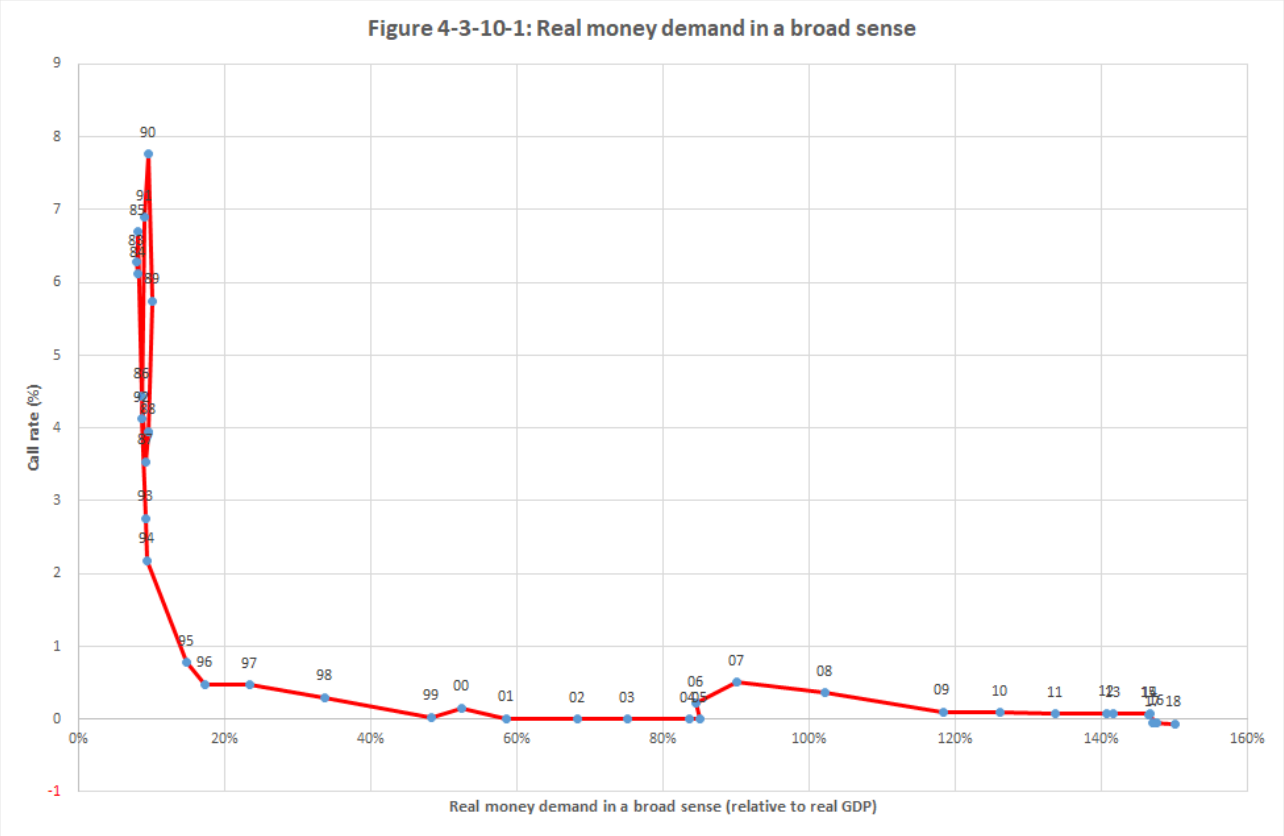
Note:
1. See Note 1 in Figure 1-2 for the data sources.



Note:
1. See Note 1 in Figure 1-2 for the data sources.

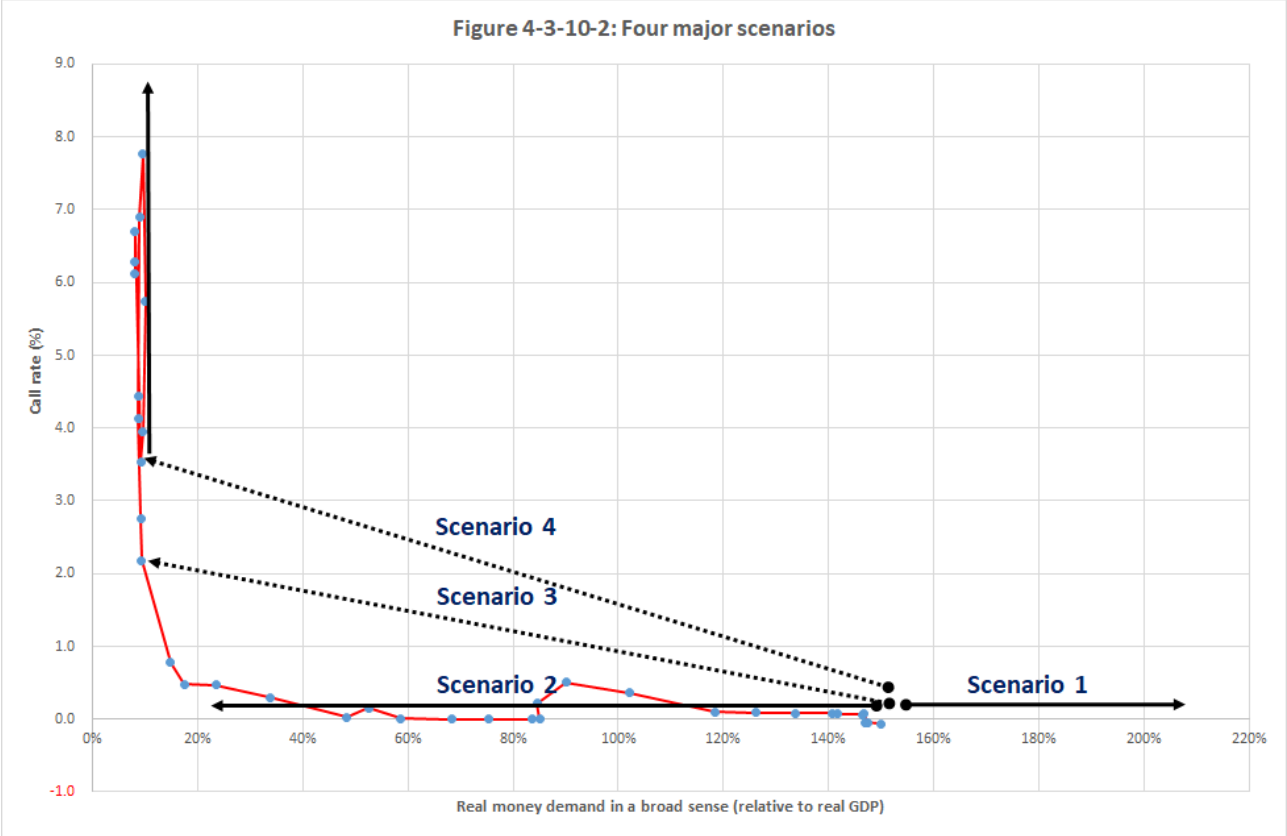


Note:
2. See Note 1 in Figure 1-2 for the data sources.



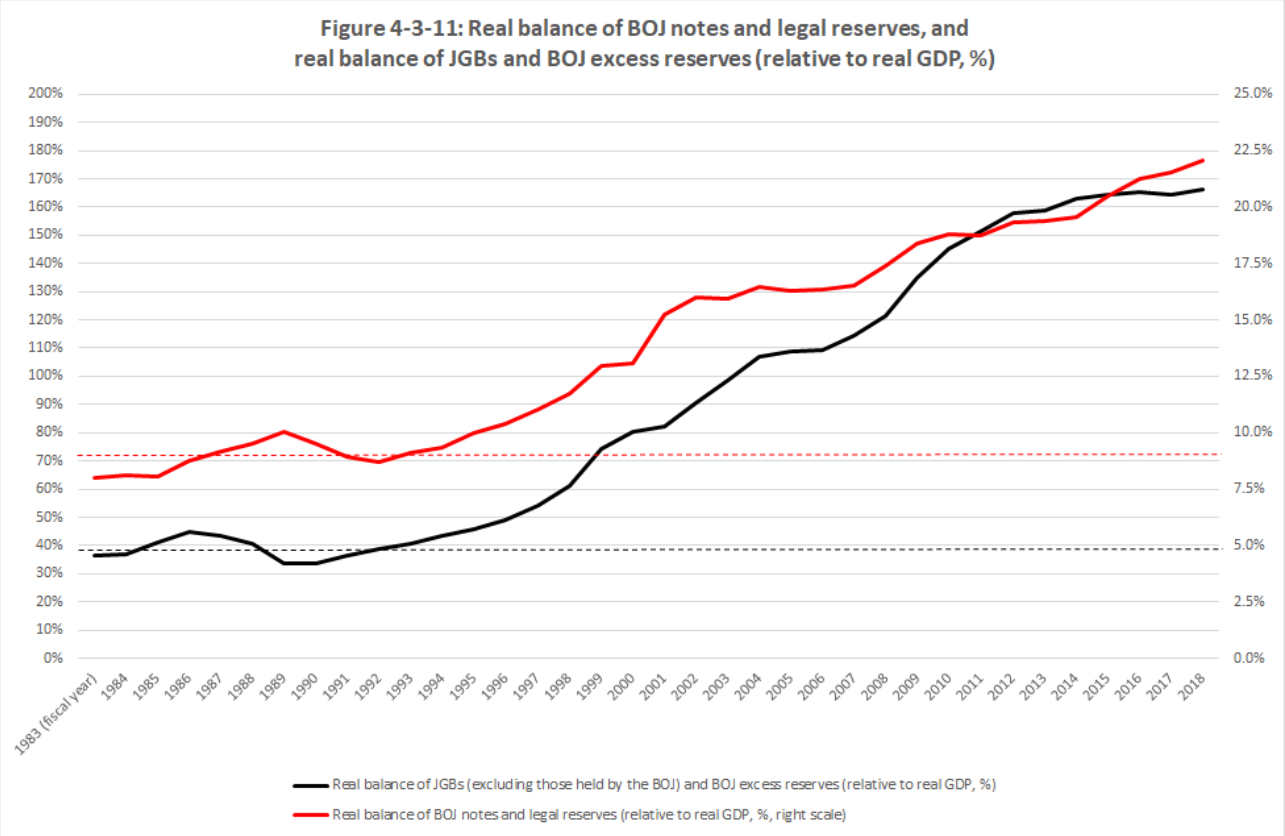
Note:

1. See Note 1 in Figure 1-1, Note 1 in Figure 1-2, and Note 1 in Figure 1-4 for the data sources.



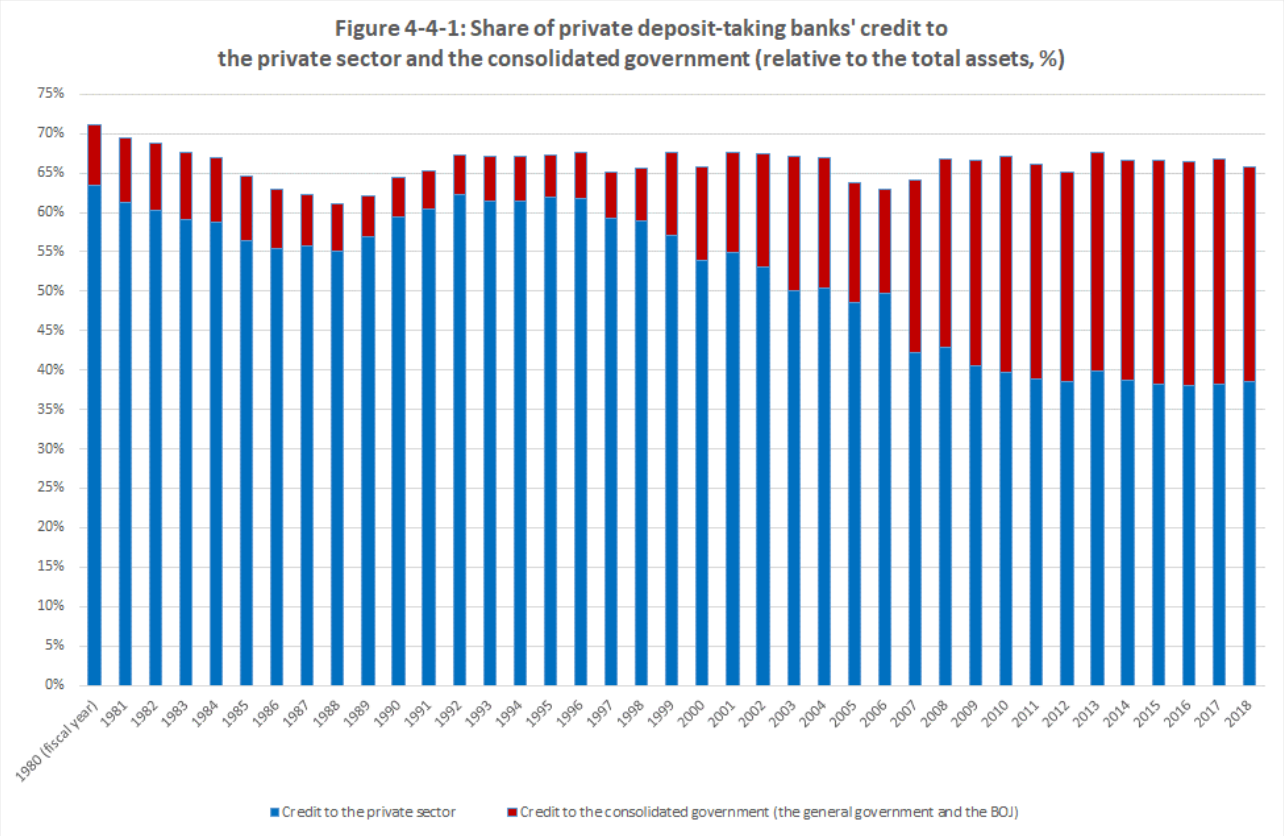
Note:

1. See Note 1 in Figure 4-3-10-1.

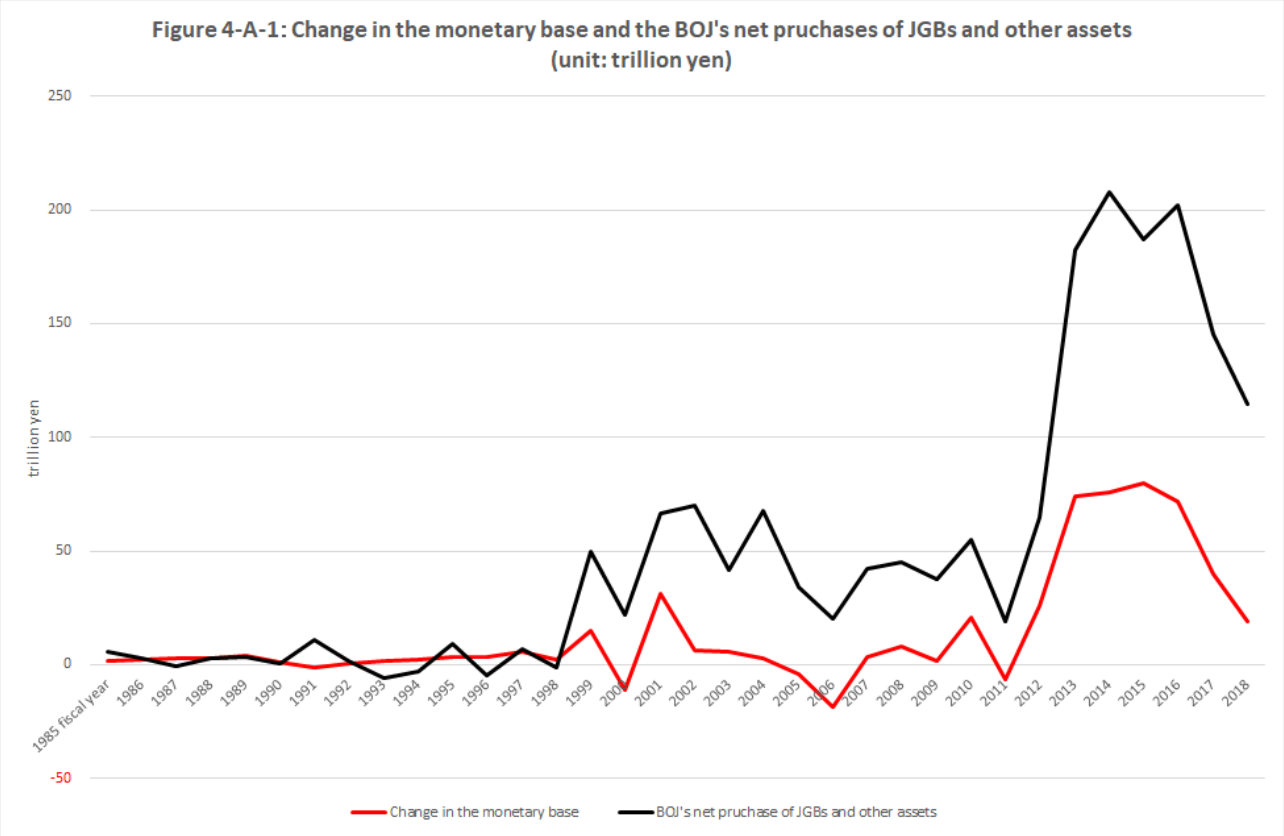


Notes:

1. See Note 1 in Figure 1-1, Note 1 in Figure 1-2, and Note 1 in Figure 1-4 for the data sources.
2. Nominal balances are deflated by the household final consumption expenditure excluding imputed housing rents.
3. The black dotted line represents the FY1983–FY1994 average of relative real demand for JGBs, while the red dotted line represents that of relative real money demand.



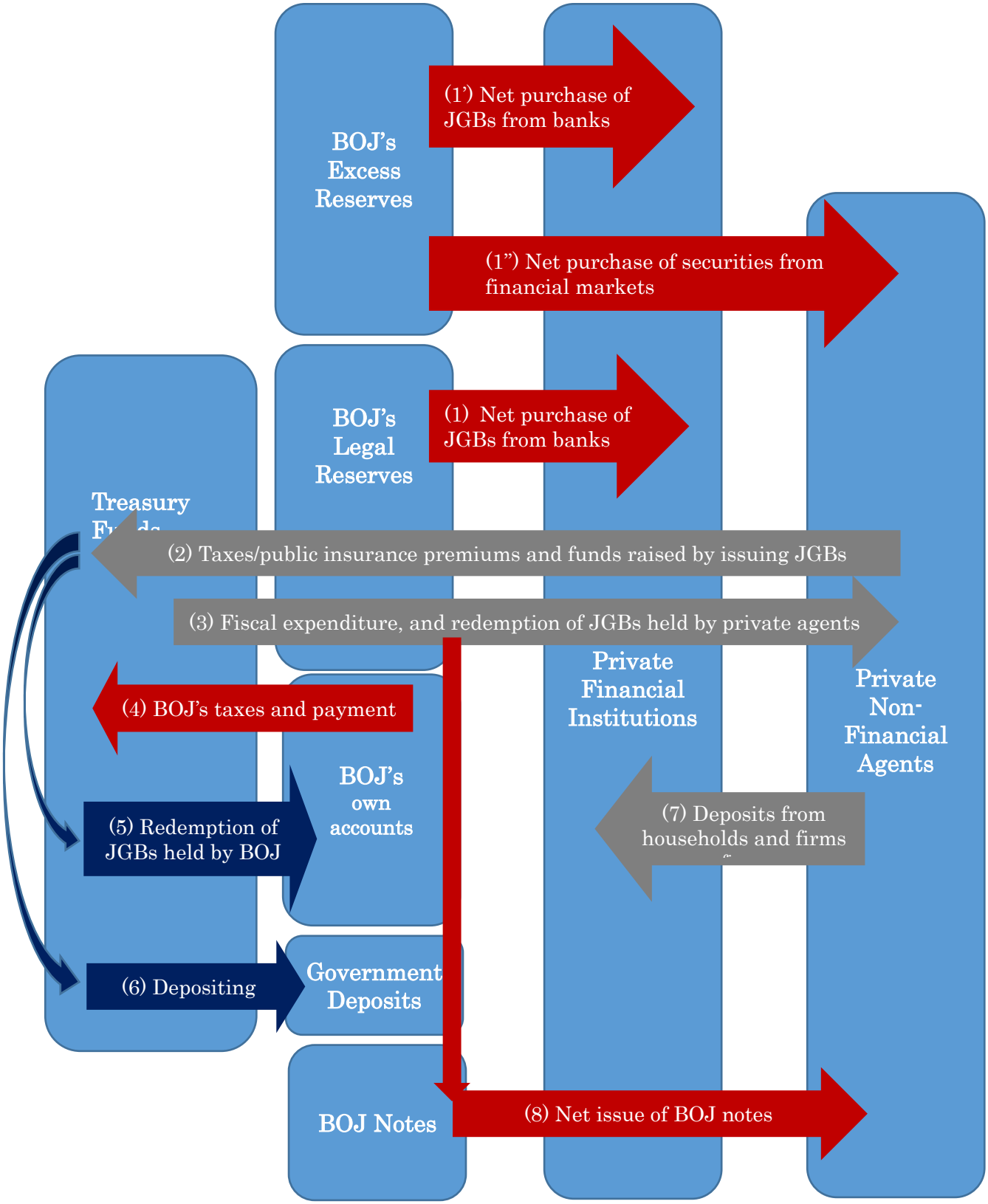
Notes:
1. See Note 1 in Figure 1-2 for the data sources.
2. The private deposit-taking banks exclude Japan Post, but include the Japan Post Bank.



Note:

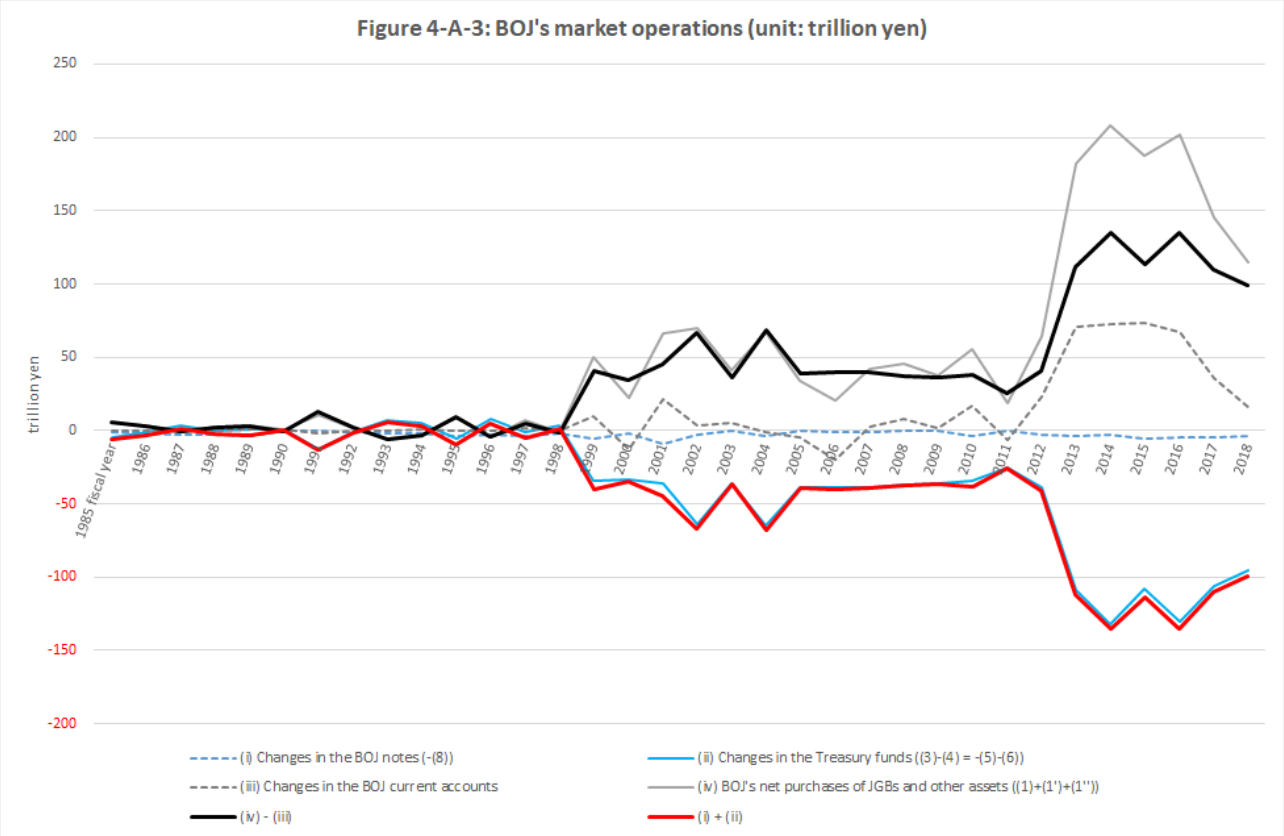
1. The Market Operations Statistics, which are compiled by the Financial Markets Department, BOJ (2004–2016, 2017–2019), report the sources of changes in current accounts at the BOJ.

Figure 4-A-2: : Relationship between the National Treasury and the private sector, which is intermediated by the BOJ



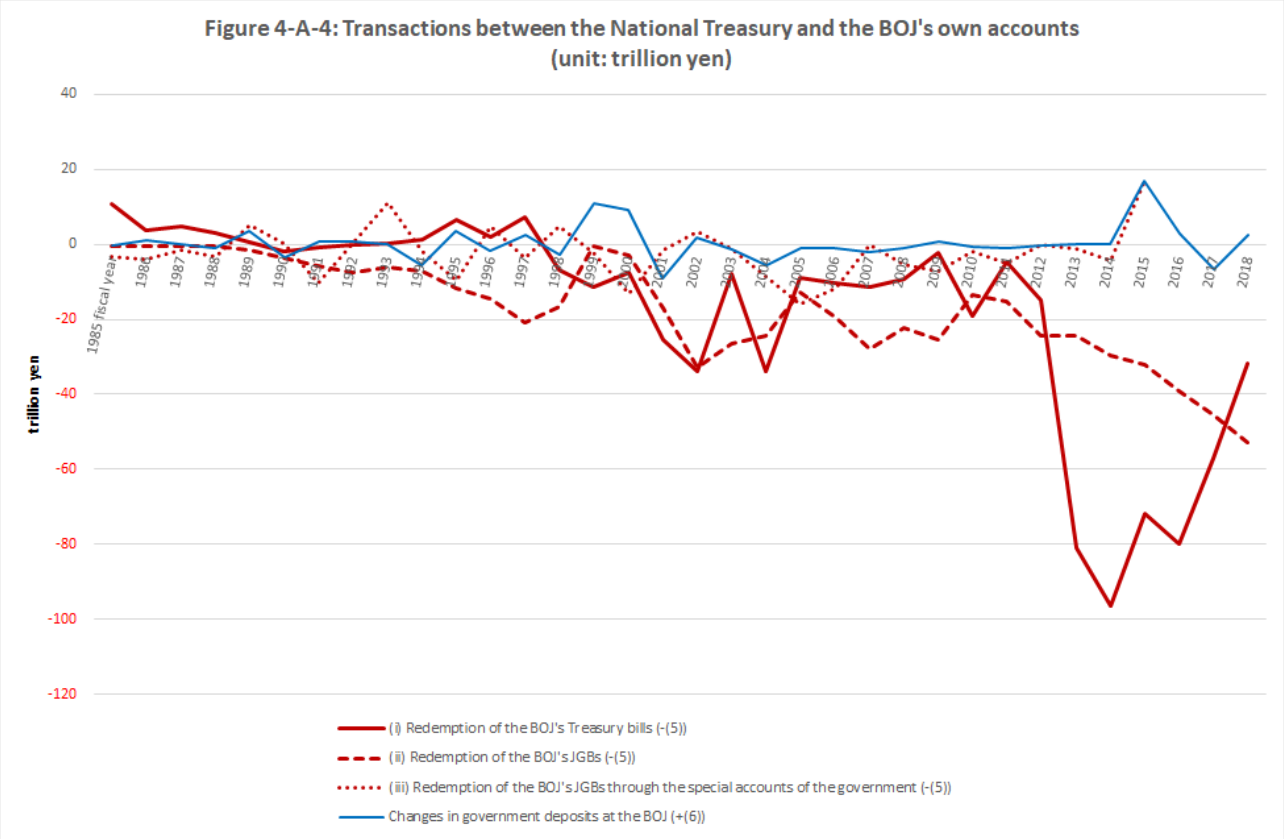
Note:

1. The author constructed this figure based on the Policy Research Institute, MOF (1981–2018), and the Financial Markets Department, BOJ (2008).



Note:

1. See the Financial Markets Department, BOJ (2004–2016, 2017–2019) for the MOS (Market Operations Statistics).



Note:
1. See the Policy Research Institute, MOF (1981–2018) for the TFS (Treasury Funds Statistics).

Table 4-A-1: The BOJ's market operations (unit: trillion yen)

	2000 fiscal year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
(i) Changes in the BOJ notes (-(8))	-1.6	-9.2	-3.2	-0.3	-3.3	-0.3	-0.9	-0.6	-0.4	-0.5	-3.6	0.1	-2.5	-3.3	-3.0	-5.9	-4.2	-4.2	-3.6
(ii) Changes in the Treasury funds ((3)-(4) = -(5)-(6))	-33.2	-35.7	-63.5	-35.7	-65.0	-38.4	-38.8	-39.0	-36.9	-35.8	-34.3	-25.4	-38.7	-108.4	-132.1	-107.4	-130.6	-105.8	-95.7
(iii) Changes in the BOJ current accounts	-12.5	21.8	3.3	5.4	-0.6	-4.6	-19.5	2.6	7.9	1.3	17.3	-6.3	23.7	70.5	72.9	73.9	67.3	35.5	15.6
(iv) BOJ's net purchases of JGBs and others ((1)+(1')+(1''))	22.2	66.7	70.0	41.5	67.7	34.2	20.2	42.1	45.3	37.5	55.2	19.0	64.9	182.1	208.1	187.2	202.1	145.5	114.9

Note:
1. The data sources are the same as those in Figure 4-A-3.

Table 4-A-2: Transactions between Treasury funds and the BOJ's own accounts (unit: trillion yen)

	2000 fiscal year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
(i) Redemption of the BOJ's Treasury bills (-(5))	-7.4	-25.6	-33.8	-7.8	-34.0	-8.9	-10.5	-11.3	-9.3	-2.4	-19.0	-4.6	-14.8	-80.8	-96.4	-71.8	-80.0	-57.1	-31.7
(ii) Redemption of the BOJ's JGBs (-(5))	-3.0	-16.9	-32.9	-26.6	-24.4	-12.6	-19.4	-27.8	-22.4	-25.6	-13.7	-15.1	-24.4	-24.4	-29.7	-32.1	-39.3	-45.3	-52.9
(iii) Redemption of the BOJ's JGBs through the special accounts of the government (-(5))	-13.1	-1.5	3.5	-1.2	-8.5	-15.9	-11.6	0.0	-5.4	-7.3	-1.9	-5.2	-0.1	-1.3	-4.3	17.2			
(iv) Taxes and payments from the BOJ (+(4))	1.1	1.3	1.4	0.5	0.1	0.4	0.5	0.8	0.6	0.3	0.3	0.0	0.5	0.7	0.7	0.9	0.4	0.6	0.7
Changes in government deposits at the BOJ (+(6))	9.0	-9.1	1.7	-1.5	-5.5	-1.0	-1.0	-2.0	-1.1	0.6	-0.7	-1.2	-0.3	0.2	0.1	17.0	3.0	-6.6	2.4

Note:
1. The data sources are the same as those in Figure 4-A-4.

Table 4-A-3: Scale of changes in Treasury bills held by the BOJ, and their redemption

	Changes in Treasury bills held by the BOJ		Scale of redemption of Treasury bills held by the BOJ	
	changes (trillion yen)	relative to the balance at the previous year	scale (trillion yen)	relative to the balance at the previous year
2002 fiscal year	-7.1	-19.1%	63.8	171%
2003	4.3	14.3%	34.1	113%
2004	-0.8	-2.3%	44.0	128%
2005	-0.9	-2.6%	25.0	74%
2006	-5.6	-17.1%	24.9	76%
2007	-6.7	-24.6%	24.6	91%
2008	1.1	5.3%	19.4	95%
2009	1.2	5.8%	19.6	91%
2010	-4.7	-20.5%	20.4	89%
2011	-1.6	-8.9%	7.1	39%
2012	17.4	105.3%	14.8	89%
2013	10.2	29.9%	80.8	238%
2014	5.5	12.4%	96.4	218%
2015	-2.4	-4.8%	71.8	145%
2016	-6.7	-14.2%	80.1	169%
2017	-18.8	-46.4%	57.1	141%
2018	-11.4	-52.4%	31.7	146%

Note:
1. The scale of redemption of the BOJ's own T-bills and JGBs is computed by the BOJ's net purchase of T-bills and JGBs, available from the Market Operations Statistics, minus changes in T-bills and JGBs held by the BOJ, available from the Flow of Funds Accounts Statistics.

Table 4-A-4: Scale of changes in JGBs held by the BOJ, and their redemption

	Changes in JGBs held by the BOJ		Scale of redemption of JGBs held by the BOJ	
	changes (trillion yen)	relative to the balance at the previous year	scale (trillion yen)	relative to the balance at the previous year
2002 fiscal year	9.1	18.4%	4.3	7.4%
2003	7.1	12.1%	7.7	11.7%
2004	-0.1	-0.2%	14.7	22.4%
2005	-5.0	-7.6%	19.5	32.2%
2006	-11.2	-18.6%	25.6	52.0%
2007	-2.4	-4.8%	16.9	36.0%
2008	-4.2	-9.0%	19.7	46.2%
2009	7.6	17.7%	14.5	28.8%
2010	8.9	17.7%	14.0	23.7%
2011	11.6	19.6%	15.9	22.5%
2012	20.7	29.2%	24.2	26.5%
2013	62.8	68.8%	25.2	16.4%
2014	66.0	42.8%	30.6	13.9%
2015	81.8	37.1%	33.1	11.0%
2016	75.2	24.9%	40.6	10.8%
2017	49.4	13.1%	46.8	11.0%
2018	33.0	7.7%	54.5	11.9%

Note:
1. See Note 1 in Table 4-A-3 for the data sources.