NBER WORKING PAPER SERIES

WHAT ABOUT JAPAN?

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Working Paper 31850
http://www.nber.org/papers/w31850

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
November 2023, Revised March 2025

We would like to thank Manuel Amador, Ben Hebert, Arvind Krishnamurthy, Peter DeMarzo, Bengt Holmstrom, Selahattin Imrohoroglu, Jane Li, Jonathan Payne, Makoto Saito, Toshitaka Sekine, Fabrizio Perri, Oleg Itskhoki and other participants of the Stanford Finance lunch, St. Louis Fed Brown-Bag seminar, Academia Sinica seminar, GRIPS seminar, SFS Cavalcade North America 2024, Spring 2024 Midwest Macro Meeting, IMF-CARF-TCER-Waseda University 2024 Conference, 2024 SED Annual Meeting, the SITE session on fiscal sustainability and 2024 Japan Project Meeting. The views expressed here are those of individual authors and do not necessarily reflect the official positions of the Federal Reserve Bank or the National Bureau of Economic Research.

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JEL No. E63, F30

ABSTRACT

Over the last decade, the Japanese public sector has primarily borrowed at floating rates while investing in longer-duration risky assets, earning an annual return exceeding 6% of GDP above its funding costs. We quantify the impact of Japan's low-rate policies on its government and households. The government duration mismatch expands fiscal space when real rates fall, helping the government fulfill promises to older households. A typical younger Japanese household does not have enough duration in its portfolio to continue to finance its spending plan and will be worse off. Low-rate policies tend to tax younger and less financially sophisticated households.

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1 Introduction

In many developed countries, the population is aging and shrinking. As society ages, the rate of economic growth may decline and the social security deficit could rise, leading these countries to face the prospect of sustained deficits. Additionally, central banks in the past several decades have dramatically expanded their balance sheets.

Japan has been at the leading edge of these developments. The general government runs large deficits, mostly driven by a secular increase in social security spending as a result of Japan's aging population. Japan was also the first country to undertake quantitative easing (QE) in 2001 in response to the combination of low inflation rates and depressed economic activity. To understand Japan's fiscal situation, we need to view all of these developments together since they are intertwined.

Since 1998, the general government of Japan has run large primary fiscal deficits of 5.1% of GDP. Some economists have argued that governments may be able to run deficits indefinitely provided that the real growth rate of their economy always exceeds the real return on government debt (Blanchard, 2019; Mehrotra and Sergeyev, 2021). Japan is not in the fiscal Goldilocks region. Since 1997, the real return on Japanese government debt has exceeded the growth rate by 1.27%. The local and central government's debt has grown from 89% in 1997 to more than 226% of GDP in 2023.[1]

For decades, many economists have concluded that Japan is not on a fiscally sustainable path (Doi et al., 2007; Sakuragawa and Hosono, 2010; Doi et al., 2011; Imrohoroglu and Sudo, 2011; Hoshi and Ito, 2014; Hansen and Imrohoroglu, 2016; Kitao, 2015; Imrohoroglu et al., 2016; Hsu and Yamada, 2019; Imrohoroglu et al., 2019). However, Japan's inflation remained low until recently and there has been no debt crisis.[2] In fact, Japan is the only major developed economy that has a higher debt-to-GDP ratio than the U.S. without experiencing a debt crisis.

How has Japan accomplished this? The Bank of Japan has undertaken a huge expansion of its balance sheet with short-term liabilities funding long-term and even risky assets, thus earning a significant excess return. This expansion blurs the line between the Bank of Japan (BoJ) and public financial institutions. To address this, we consolidate the balance sheets of all these entities. We find that the Japanese public sector has dramatically expanded both the liability and asset side of its balance sheet, and it has harvested a substantial excess return due to its maturity, currency, and risk mismatches.

[1] The government debt includes T-bills, government bonds and loans. See Table 14

[2] For Japan's fiscal sustainability, Broda and Weinstein (2004) offer a more optimistic view that only small changes in the tax-to-GDP ratio are needed. Bamba and Weinstein (2021) further argue that current tax rates are consistent with fiscal sustainability.

At the end of 2023, the Japanese public sector had liabilities of 276% GDP. More than 40% of its liabilities have no duration: 91% of GDP is held in bank reserves at the BoJ, and another 22% of GDP is held in cash. Only 108% is held in government bonds and T-bills. QE has effectively added a floating-for-fixed interest rate swap of 98% GDP to the government's consolidated balance sheet, shortening the duration of the Japanese government's liabilities. The Japanese public sector thus borrows from Japanese households through the banking sector, mostly at floating rates, and then invests in longer-duration, risky assets to harvest risk premia, leading to a duration mismatch on the government balance sheet.

On the other hand, the government's risky assets, totaling around 95% of GDP, have significantly higher duration. Primarily through its public pension funds and foreign reserves, the Japanese government invests 39% of GDP in domestic equities and 57% of GDP in foreign securities, including equities, without hedging its currency risk (effectively engaging in an unhedged carry trade).

This risky investment strategy was largely implemented after 2012. According to our estimates, between 2013 and 2023, the Japanese government realized an excess rate of return of approximately 4.66% per annum above its funding cost by going long on long-duration, risky domestic and foreign assets, primarily financed through short-duration funding in the form of bank reserves, T-bills, and bonds. This strategy has generated an average net return of 6.25% of GDP from risky investments over the past decade (2013–2023). Even over the entire sample period (1998–2023), the return net of funding costs averaged 2.28% of GDP per year.

As a result, the net debt, liabilities minus assets, of the entire public sector has only grown from 24.7% to 94.3% of GDP, a 70% of GDP increase, despite the fact that the cumulative primary fiscal deficit of the general government exceeded 133% of GDP during the same periods. This outcome occurs because the public sector is able to borrow at a very low rate despite the substantial risks on its balance sheet. We estimate that the return on debt is at least 180 bps per annum lower than what is warranted by the risks on its its balance sheet. We refer to this as the government debt valuation wedge. The low borrowing rate could result from a combination of factors, including low rate policies and quantitative easing (QE), financial regulation, low financial literacy among segments of the population, an underdeveloped retail financial market, and the lingering effects of the stock and housing market crashes of the early 1990s.

To quantify the drivers of these excess returns, we explore two counterfactual scenarios. The first counterfactual considers a scenario without QE. We rely on two conservative assumptions: (1) the returns on JGBs after 2012 would have been 2% higher than the actual return, and (2) the BoJ did not use bank reserves to purchase any JGBs. We find that the net return after 2012 decreases from 6.25% of GDP to 2.75% of GDP. In the second counterfactual, we put the government and the financial sector on the same footing by requiring the government to hedge all of its foreign currency risk, which decreases the net return from 6.25% to 3.11% of GDP. The combined counterfactual results in a net return of -0.38% of GDP, down from 6.25% of GDP. These counterfactuals identify the main drivers of the net returns earned by the government.

We then discuss the implications for the Japanese government's fiscal space. To be fully hedged against interest rate risk, the duration of the government's net debt, liabilities minus assets, would have to equal the duration of its primary surpluses, which accrue in the distant future. Think of the government issuing zero-coupon bonds that match the expected surpluses period by period. Instead, the duration of its debt is short, as a result of QE, and further reinforced by its long position in high-duration risky assets. As a result of this duration mismatch on its consolidated balance sheet, a decrease in real rates creates extra fiscal capacity, because its net debt position has negative duration, but its future surpluses have a long duration.[3] Conversely, when rates increase, the Japanese government's fiscal capacity is quickly eroded.

If the objective is to keep its promises to older Japanese households, then the Japanese government has a strong incentive to promote low-rate policies. A decline in real rates creates substantial extra fiscal capacity because of the short duration of the government's liabilities and the longer duration of its investments and projected budget surpluses, while a rise in rates would remove fiscal capacity. We then explore the welfare consequences of the lower real rates for Japanese households. The stand-in Japanese household's balance sheet does not have enough duration on its balance sheet to match the duration of future net-consumption claims. As a result, while the Japanese government is positioned to benefit from lower real rates, most households are not.

As a result of QE and yield curve control (YCC) policies, the consolidated Japanese government is borrowing from Japanese households at floating rates: Japanese households have invested around 189% of GDP in short-duration bank deposits, but only 63% of GDP in equities and 90% of GDP in private pension and insurance products. On the liability side, Japanese households have 62% of GDP in loans. Given the low duration of the stand-in Japanese household's wealth, the majority of younger households are worse off as a result of a decline in long-term real rates induced by financial repression. As the BoJ has stepped up its large-scale asset purchases, it further reduces the household's net duration and increases the welfare costs.

Moreover, the median young Japanese household does not participate in financial markets and hence has little or no duration in its financial holdings, but still has to finance its future consump-

[3] The duration of its net debt is actually negative, because the duration of its asset position far exceeds the duration of its liability position.

tion upon retirement out of savings. We use the metrics developed by Greenwald et al. (2022) and Fagereng et al. (2022) to analyze the welfare consequences of financial repression. The welfare effects of lower real rates depend on the duration of the household's financial wealth relative to the duration of its excess consumption plan, where excess consumption is defined as the part of the household's consumption to be financed out of its financial investments. For the median young Japanese household, the duration of financial wealth falls short of its excess consumption duration, and the lower real rates induced by financial repression will shrink the household's consumption possibility set (Greenwald et al., 2022).[4] This is not the case for more financially sophisticated households who participate in financial markets. In that sense, Japan's low-rate policies transfer wealth from the young, less financially sophisticated to the older, more financially sophisticated Japanese households.

The demographic transition in advanced economies (Auclert, 2019), in addition to the slowdown (Eggertsson et al., 2016) and the increase in inequality (Mian et al., 2020), has all contributed to the secular decline in real interest rates. However, given the duration mismatch in Japan, the government has a strong incentive to implement low-rate policies because lower real rates can substantially amplify the government's fiscal space. Low real rates are not just a symptom of the transition, but they are also a policy outcome favored by governments of countries in transition. Conversely, a rise in real rates would have serious fiscal repercussions.

2 Related Literature

When governments take measures to allow themselves to borrow at below-market rates, this is referred to as financial repression (Reinhart et al., 2011; Chari et al., 2020). During the European debt crisis, private banks were persuaded by governments to load up on sovereign debt of their countries (Acharya and Steffen, 2015; De Marco and Macchiavelli, 2016; Ongena et al., 2019). This was widely interpreted as a manifestation of financial repression. However, since the 2008 financial crisis, banks in advanced economies have dramatically increased the size of their balance sheets relative to the size of their economies. These central banks have mostly used their balance sheet capacity to purchase government bonds.

Japan was a front-runner in this regard. The recent expansion of central bank balance sheets can be interpreted as a new wave of financial repression (see Hall and Sargent, 2022, for a comparison of the pandemic and two World Wars).[5] Hansen and İmrohoroğlu (2023) found that the BoJ's

[4] These households are net buyers of financial assets, which will appreciate in value (Fagereng et al., 2022).

[5] Moreover, financial repression could come in various forms, including macro-prudential regulation that favors government bonds, direct lending to the government by domestic pension funds and banks, and moral suasion used to

large-scale asset purchases together with low interest rates do help fiscal stabilization but only temporarily. As shown by Koeda and Kimura (2021), the two factors, market supply of government bonds and short-term interest rate, explain the continued decline in the long-term interest rate for the past two decades. Clearly, these two factors are either controlled or heavily influenced by the BoJ. We reinterpret the BoJ's large-scale asset purchases and YCC experiment through the lens of financial repression. After the capital market liberalization, the Japanese government used large-scale asset purchases to substitute bank reserves held at the BoJ for cheap deposits at the postal savings bank (banking branch of Japan Post) and pension reserves as a alternative source of low-cost funding. We believe our paper is the first to quantify the effects of these low rate policies by measuring the government debt valuation wedge. To do so, we rely on the approach to government debt valuation developed in Jiang et al. (2024).

Our paper contributes to the literature on fiscal sustainability in low-rate environments (Blanchard, 2019; Mehrotra and Sergeyev, 2021; Ball and Mankiw, 2021; Aguiar et al., 2021; Mian et al., 2021). Even though the real rate of return on its debt exceeds its growth rate, the Japanese government keeps rolling over deficits by investing in riskier assets and collecting risk premia, much like the U.S. has been running current account deficits while investing in risky assets abroad (Gourinchas and Rey, 2007).[6] The Japanese government is leveraged up, not unlike underfunded public pension funds in the U.S. who gamble for resurrection (Myers, 2018; Giesecke et al., 2022; Giesecke and Rauh, 2022). In the long run, the Japanese low-rate approach is not sustainable without financial repression. The Japanese government has made risk-free promises to pensioners and to bondholders, but it is funded by risky tax revenue and risky investments. This risk mismatch is not apparent, because the bond portfolio, the promises to pensioners, have not been fully marked to market because of financial repression.

Our work is connected with the growing literature on the covered interest rate parity (CIP) deviations in currency markets. Regulators may play a key role in keeping arbitrageurs from closing the gap by imposing capital requirements on financial institutions (Du et al., 2018a). In the case of Japan, we show that CIP deviations directly help the government's low-rate policies by reducing the hedged return gap between foreign and domestic investments. Hébert (2020) analyzes CIP and other law of one price deviations as the footprint of interventions by regulators who address externalities. We show that governments can use financial regulation to deliver CIP

increase domestic bank holdings of government bonds. Chari et al. (2020) derive conditions under which forcing banks to hold government debt may be optimal, because it acts as a commitment device.

[6] The more recent work by Atkeson et al. (2022) documented that the U.S. net foreign asset position declined sharply after 2007, indicating that the U.S.'s exorbitant privilege had ended. The increasingly risk-taking behavior of the Japanese government after 2010 could have contributed to the end of this privilege by increasing its U.S. equity holdings.

deviations as a tool of financial repression.

The Japanese government is engaged in a massive global currency carry trade by borrowing at below-market rates in Japanese yen and investing in high-interest rate currencies abroad. In historical data, the currency carry trade breaks down at longer maturities. Shorting longer-maturity bonds of low-interest currencies to go long in bonds of high-interest rate currencies does not produce excess returns over longer samples, because the low (high) currency risk premia are offset by large (small) local currency term premia in low (high) interest rate countries (see Lustig et al., 2019).[7] However, since the global financial crisis, when central banks have started large-scale asset purchases, currency carry-trade profits have turned positive at longer maturities, since central banks have compressed the local currency term premia in low-interest rate currencies (Andrews et al., 2020). This is consistent with financial repression.

There is a growing literature that studies the effects of monetary policy on the distribution of wealth. Auclert (2019)'s work studies the effects of transitory, nominal interest rate shocks on the balance sheet of households and the distribution of wealth. In their seminal paper, Doepke and Schneider (2006) examine the redistributive effects of inflation in an overlapping generations model. Our work is closer to Greenwald et al. (2022) and Fagereng et al. (2022) , who study the effects of permanent shocks to real rates on household consumption and welfare. Piazzesi and Schneider (2010) measure the interest rate risk exposure of different sectors of the U.S. economy. We use a different approach to measure the interest rate risk exposure of the household and government sector in the Japanese economy. We also explore the welfare implications of low-rate policies using this apparatus. While there is a large literature on financial repression, there is less analysis of its welfare implications.

Our paper is organized as follows. Section 3 briefly discusses the example events of financial repression in the past few decades. We then consolidate the balance sheet of the Japanese central government with local government, central bank, public financial institutions (fiscal investment loan fund mostly), and public pension funds (social security fund mostly). Section 4 describes the dynamics of the debt-to-output ratio of the Japanese government and the net debt-to-output ratio of the consolidated government as a function of past returns, past deficits, and past growth rates. Section 5 develops a novel measure of financial repression. In section 6, we document the large duration mismatch on the consolidated government's balance sheet, largely as a result of QE. The large duration mismatch implies that a lower borrowing cost caused by financial repression could greatly expand the fiscal capacity of the government. Section 7 analyzes the household balance sheet. We measure interest rate risk exposure on households' balance sheets and analyze

[7] This finding is consistent with long-run UIP.

the welfare consequences of low-rate policies for Japanese households. Section 8 concludes our study.

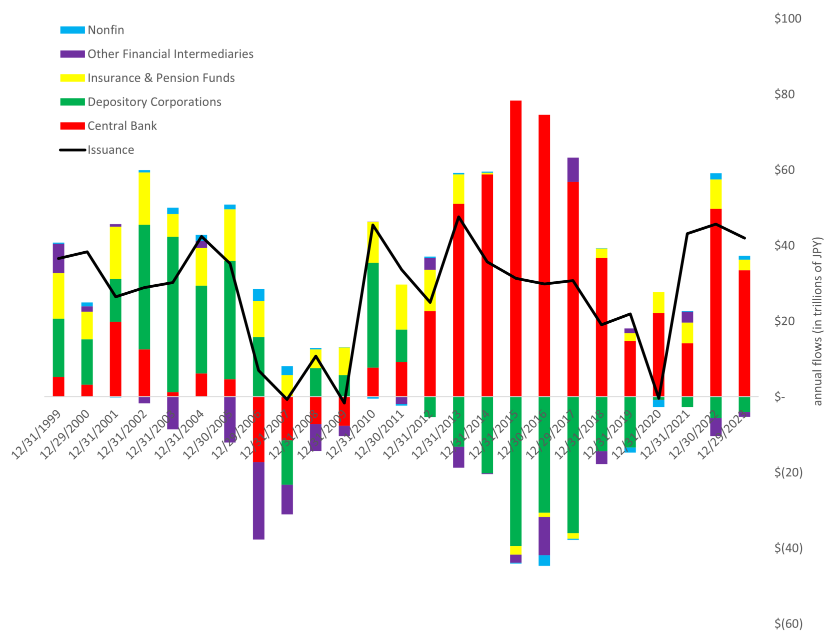
3 The Japanese Government's Carry Trade

Japan's post-war economy was heavily bank-dependent. The government tightly controlled the banking sector. Until the 90s, Japanese capital markets were undeveloped and capital market transactions were prohibitively costly for Japanese households. Direct participation in the stock market was expensive even in the late 90s. Commissions on trades were fixed and regulated. Until the late 90s, U.S.-style mutual funds were not allowed. Investment trusts typically underperformed, because they had an incentive to generate fee income for the parent companies by trading (Hoshi and Kashyap, 1999). Japanese household savers were effectively trapped in the banking sector. Even today, participation rates in asset markets are quite low: only 23% of Japanese households own bonds, stocks, or mutual funds.

At the time, the postal savings bank was the largest deposit-taking institution in the world. Before 2001, the deposits of households at the postal savings bank as well as the pension reserves were required to fully fund the Fiscal Investment and Loan Program (FILP), a large government-run lending program (Doi and Hoshi, 2002). Its loan portfolio exceeded 100% of GDP in 2001. During the 90s, a number of measures were taken to gradually increase options for savers. Interest rate ceilings on deposits were gradually removed by 1994. By 1999, commissions for stock trading had been liberalized and households obtained cheaper access to the stock market. In 2001 Japan abolished the FILP funding requirement imposed on the postal savings bank and the public pension reserves. Instead, the FILP started to tap the bond market directly.

The banking sector remained large in the late 90s partly because Japanese savers kept supplying deposits to the banking system, even when on the demand side the commercial borrowers were tapping into capital markets directly as a result of financial market liberalization. Just as Japan completed the liberalization of its capital markets, the central bank embarked on a bold new path. The Japanese government effectively replaced the cheap funding it had obtained through the postal savings bank prior to the capital-market liberalization with bank reserves held at the BoJ. Japan had been stuck in a low-growth regime since the mid-90s. In April 1999, the BoJ committed to holding short-term rates at zero until the deflationary concerns were dispelled. In 2001, the BoJ shifted gears and started large-scale asset purchases to try to stimulate the economy. The BoJ coined the phrase *quantitative easing* to describe this policy. Its main stated objective was to increase bank reserves. The underlying assumption was that the banks would deploy these re-

Figure 1: Annual Purchases of Japanese Government Bonds (Excluding T-bills)



Source: Japan's Flow of Funds.

serves in lending to firms and households.[8] Since 2012, the BoJ has stepped up its large-scale asset purchases as part of the Abenomics ambitious government spending program.

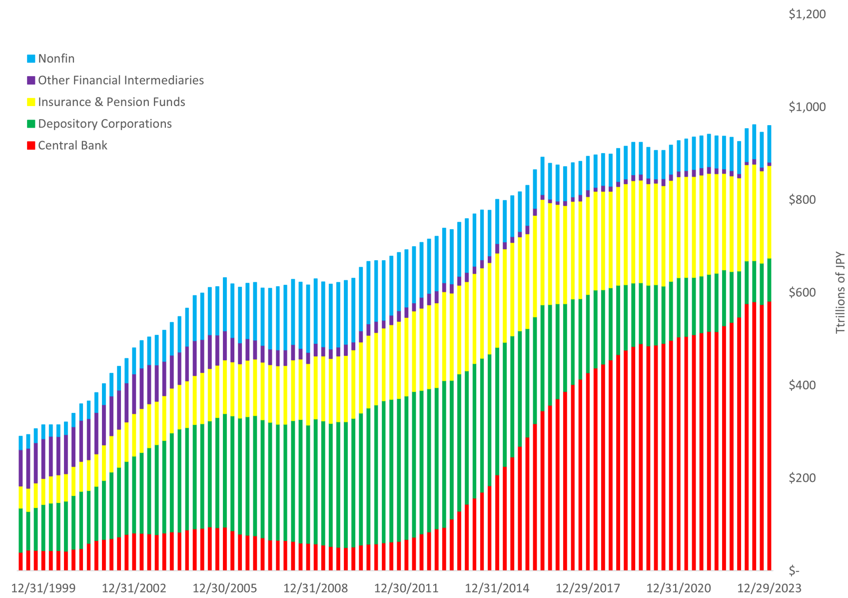
In 2016, the BoJ shifted to a policy of explicit YCC. The BoJ capped long-term yields explicitly. It set a target for the 10-year yield at zero percent. The BoJ was ready to purchase the necessary bonds to implement this cap, effectively putting a floor on the price of bonds.[9] Figure 1 plots the purchases of long-dated bonds. Over the past decade, the BoJ has crowded out private investors, including banks and the non-financial sector, in the market for long-dated Japanese government bonds by buying more than the government's issuance of bonds each year. Figure 2 plots the bond holdings in levels. By the end of 2023, the BoJ owned 581 trillion yen in JGBs (excluding T-bills), more than half of outstanding bonds. While the government had removed all of the interest rate ceilings as part of the capital market liberalization, the government had effectively imposed a new cap on interest rates through YCC.

To understand the impact of these policies on public finances, we construct the consolidated government balance sheet. We consolidate the Bank of Japan, the public financial institutions, and the general government, which includes the central government, the local government, and the

[8]Later, Federal Reserve Chair Bernanke sought to use the term credit easing to describe large-scale asset purchases in the U.S., but the term never caught on (Bernanke, 2022, pp.144).

[9]The BoJ was hopeful that it would not have to buy as many bonds by sending this signal to the bond markets, i.e. that the market would produce the target yield. That scenario has not materialized.

Figure 2: Japanese Government Bond Holdings (excluding T-bills)



Source: Japan's Flow of Funds.

public pension funds.

3.1 Consolidating the Government Balance Sheet

Table 1 provides a snapshot of the consolidated balance sheets of 1997, 2012 and 2023. The first and last year were chosen to represent the start and the end of our dataset. The year 2012 marks the beginning of a significant policy shift implemented under Abenomics. In 2023, the consolidated government invested 95.3% of GDP in risky securities, while borrowing 275.6% of GDP. The consolidated government takes a long position of 56.6% of GDP in foreign securities and 38.7% of GDP in domestic equities. To fund its operations, the consolidated government issues T-bills and bonds (107.7% of GDP) as well as bank reserves (91.1% of GDP).

Table 2 shows a snapshot of the balance sheet of the BoJ, which has purchased one GDP of bonds and issued reserves in 2023.[10] Since 2010, the BoJ has increasingly entered into an interest rate swap, paying floating rates on bank reserves and receiving fixed rates on the bonds it has purchased. The current underlying notional is about one GDP. This has dramatically shortened the duration of the Japanese government's consolidated liabilities. In doing so, the Japanese government set the stage to reap the full benefits of financial repression. These floating rate payments

[10] The balance sheet of central and local government, public pension funds and public financial institutions are reported separately at Tables 14, 15, and 16, in the Appendix.

Table 1: Consolidated Government Balance Sheet

% of GDP, Year End	1997	2012	2023	97 to 23 Diff
Assets				
Deposits	5.9%	8.5%	18.0%	12.1%
Loans	102.8%	63.1%	60.8%	-42.1%
Domestic Equities	10.7%	20.9%	38.7%	28.0%
Foreign Securities	7.5%	29.7%	56.6%	49.1%
Other Assets	8.4%	7.9%	7.2%	-1.1%
Sum	**135.2%**	**130.1%**	**181.3%**	**46.1%**
Liabilities				
Currency	10.8%	18.3%	21.7%	10.9%
Bank Reserves	0.6%	9.5%	91.1%	90.4%
Bonds & T-Bills	41.8%	162.3%	107.7%	65.9%
Loans	55.1%	48.5%	36.0%	-19.1%
Deposits FILF	46.4%	1.1%	1.6%	-44.9%
BoJ External Debt	0.0%	0.1%	7.5%	7.5%
Other Liabilities	5.2%	8.7%	10.1%	4.9%
Sum	**159.9%**	**248.5%**	**275.6%**	**115.7%**
Net Liabilities	**24.7%**	**118.4%**	**94.3%**	**69.6%**

Unit: % of GDP. Source: Japan Flow of Funds and National Accounts of Japan

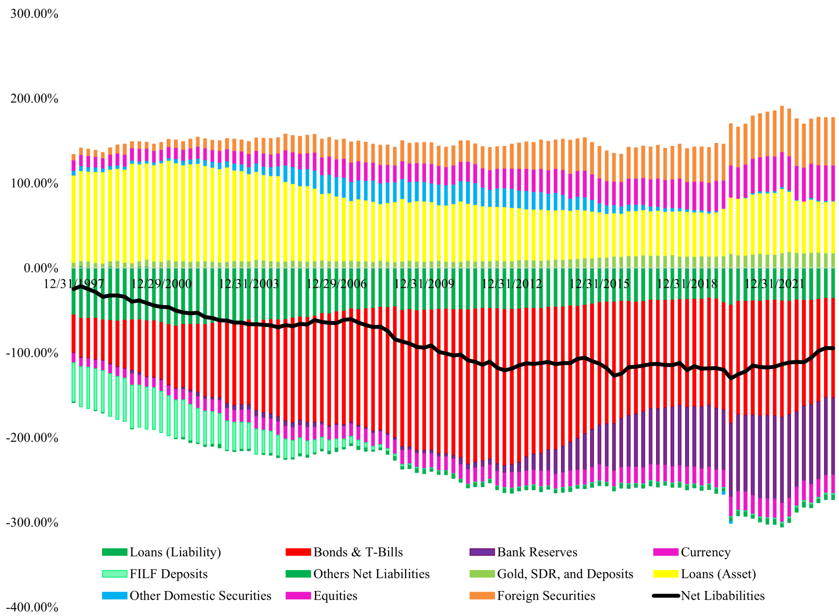
are ultimately passed onto depositors. In this sense, the BoJ has massively reduced the duration on the balance sheet of Japanese households, who mostly hold deposits, as we are about to show.

The investments in the risky assets are mostly undertaken by the Japanese government pension funds after the year 2012. In 2013, a government panel recommended a major reallocation into risky assets for all of the government-run pension funds (Hoshi and Yasuda, 2015).[11] The BoJ also rapidly increased its risky asset position from less than 1% of GDP in 2012 to 10.7% of GDP in 2023. These risky long positions (including domestic equities and foreign securities) are shown in the consolidated government balance sheet in Table 1 : They have grown from 18% of GDP to 50% of GDP from 1997 to 2012 and then raised rapidly to 95% of GDP in 2023. Between 2012 and 2023, the government has increased its exposure to equities by 85%, and it has increased its exposure to foreign risky assets above 90%. The 52% of GDP domestic and foreign equity position of the government is more than 80% of the total Japanese-household equity holdings, which is at 63% of GDP.

Figure 3 further shows the quarterly evolution of the consolidated balance sheet during the sample periods. The evolution on the liability side exactly reflects the phases of financial repression discussed in the beginning of this section. In 1997, around 46% of GDP in funding came from

[11] The public pension funds include the Government Pension Investment Fund (GPIF), the National Public Service Personnel Mutual Aid Fund, the Local Service Personnel Mutual Aid Fund, and the Private School Personnel Mutual Aid Fund.

Figure 3: Consolidated Japanese Government Balance Sheet



Unit: % of GDP. Source: Japan's Flow of Funds.

deposits with the FILP through the postal savings bank. As this source of funding gradually dried up in the wake of the 2001 reform, the Japanese government issued more government bonds and other fixed income securities instead, but eventually, after 2010, the government replaced these deposits with bank reserves held at the BoJ–through large-scale asset purchases–as a source of funding. These reserves currently make up about 91% of GDP.

4 Accounting for Japan's Debt-to-Output Dynamics

Next, we move on to accounting for the dynamics of net debt on the consolidated government's balance sheet. During our sample periods, we find that the government has earned an additional 2% of GDP on its investments.

4.1 Japan Is Not in the Goldilocks Region

The debt-to-output ratio is a valuation ratio for the entire portfolio of outstanding Treasuries. Following Hall and Sargent (2011), we can decompose variation in the debt-to-output ratio in terms of variation in returns and variation in primary surpluses. Let G_t denote nominal government spending before interest expenses on the debt, T_t denote nominal government tax revenue. We start from the flow government budget constraint in a deterministic environment:

$$G_t - T_t + D_{t-1}R_t^D = D_t, \tag{1}$$

where R_t^D denotes the gross return on the entire portfolio of marketable debt D_{t-1}. By iterating backwards, we obtain the following expression for the debt-to-output ratio.[12] We can impute variation in the debt-to-output ratio of a country to its history of output growth, inflation, and interest rates.

Proposition 4.1. *The debt-to-output ratio can be stated today as a function of cumulative past returns* $R_{t-j,t}^D$*, past nominal growth* $X_{t-j,t}$*, as well as past primary deficit/output ratios* $\frac{G_{t-j}-T_{t-j}}{Y_{t-j}}$*:*

$$\frac{D_t}{Y_t} = \sum_{j=0}^{t} \left(\frac{G_{t-j} - T_{t-j}}{Y_{t-j}} \right) \frac{R_{t-j,t}^D}{X_{t-j,t}} + \frac{R_{0,t}^D}{X_{0,t}} \frac{D_{-1}}{Y_{-1}},$$

where $R_{t-j,t}^D = \prod_{k=1}^{j} R_{t-j+k}^D$ *and* $X_{t-j,t} = \prod_{k=1}^{j} X_{t-j+k}$*.*

Proof. Please refer to Appendix A.1 □

High deficits, high returns, and low nominal output growth in the past all contribute to a high debt-to-output ratio today.[13] In the steady state, if the real growth rate of the economy, denoted by x, is higher than the bond returns, denoted by r^D, then the debt-to-output ratio will not explode even when the government runs permanent deficits. When the $r^D < x$, the government can roll over its debt in perpetuity and run steady-state deficits ($G > T$) with a constant debt/GDP ratio. This can be seen clearly in the steady state version of government budget constraint:

$$\frac{x - r^D}{1 + x} \frac{D}{Y} \quad = \quad \frac{G - T}{Y}. \tag{2}$$

Recently, Blanchard (2019) and Mehrotra and Sergeyev (2021) study these dynamics of the debt-to-output ratio in a low interest rate environment and evaluate the implications of low rates for government debt sustainability. In this environment, it appears as if there may be no fiscal cost to debt. In dynamically inefficient economies characterized by $r^D < x$, governments may have a free lunch. Ball and Mankiw (2021); Aguiar et al. (2021) study the effect of government debt on capital accumulation and efficiency in dynamically inefficient economies that are not subject to

[12] As we are about to show in the next subsection, equation (1) is not suitable to analyze the case of Japan because of its omission of government financial assets.

[13] Hall and Sargent (2011) decompose the U.S. post-war debt-to-output dynamics over longer horizons into components due to the nominal returns on Treasuries, U.S. output growth, and U.S. inflation. They emphasize the role of higher-than-average output growth and inflation after the World War II in bringing the debt-to-output ratio back down.

aggregate risk. Furman and Summers (2020) also study debt dynamics in a low-rate environment. They advertise the government's interest cost as a fraction of GDP as a sufficient statistic to gauge fiscal sustainability.

Over the past two decades, Japan has not been operating in the Goldilocks $r^D < x$ region described by Blanchard (2019) and Mehrotra and Sergeyev (2021). Bond returns were low, but GDP growth was even lower. Table 3 reports the returns on the outstanding portfolio of Japanese government bonds and T-bills, Japanese inflation, and Japanese GDP growth. The top panel reports the nominal bond returns ($r^{D,n}$) and nominal GDP growth rates (x^n). Between 1997 and 2023, the average nominal growth rate and the average nominal inflation rate were close to zero.[14] The average nominal return on Japanese bonds and T-bills is 1.66% per annum. The bottom panel reports real returns. The real return on the portfolio of Japanese bonds and T-bills is 1.30% per annum, much higher than the real growth rate of 0.03% per annum. The bottom panel shows the gap between real returns and real growth. Over the whole sample, this $r^D - x$ gap was 1.27%. The gap decreased from 2.29% between 2000 and 2009 to 0.84% between 2010 and 2019, as real bond returns decreased while real growth increased.

4.2 Consolidated Government Debt Dynamics Accounting

One missing piece in the government budget constraint shown in equation (1) is the asset position of the government. This is obviously a shortcoming, at least in Japan's case, since the consolidated balance sheet of the Japanese government exhibits a large asset position. We then augment the government budget constraint by including the asset term, A_t, and defining net debt, ND_t, as the debt minus the asset position:

$$G_t - T_t + D_{t-1}R_t^D - A_{t-1}R_t^A = D_t - A_t \equiv ND_t$$

where R_t^A denotes the gross return on the portfolio of assets, A_{t-1}. Given this government budget constraint, Proposition 4.1 can be modified as the following:

Proposition 4.2. *The net debt-to-output ratio ND_t/Y_t can be stated as a function of cumulative past debt returns, past nominal growth X_{t-j}, primary deficit/output ratios $\frac{G_{t-j}-T_{t-j}}{Y_{t-j}}$, past asset position/output ratios*

[14] Multiple factors, including aging population, regulatory restriction and zombie lending, have been found to contribute to the zero growth of the Japanese economy. See, for example, Hayashi and Prescott (2002), Blomstrom et al., eds (2003), Hoshi and Kashyap (2004), Caballero et al. (2008), and, the literature within.

Table 2: BoJ Balance Sheet

% of GDP, Year End	1997	2012	2023
Assets			
Loans	4.2%	6.2%	17.1%
Bonds & T-Bills	9.6%	23.2%	98.0%
Domestic Equities	0.0%	0.7%	10.7%
Foreign Securities	0.7%	1.5%	1.9%
Other Assets	0.9%	1.7%	0.1%
Sum	**15.4%**	**33.4%**	**127.9%**
Liabilities			
Currency	10.8%	18.3%	21.7%
Bank Reserves	0.6%	9.5%	91.1%
Loans	3.0%	3.1%	0.7%
BoJ External Debt	0.0%	0.1%	7.5%
Sum	**14.4%**	**31.0%**	**120.9%**
Net Assets	**0.9%**	**2.4%**	**6.9%**

Unit: % of GDP. Source: Japan Flow of Funds and National Accounts of Japan.

Table 3: Bond Returns, Inflation and Growth

Periods	x^n	$r^{D,n}$	π
1997-2023	0.39%	1.66%	0.36%
2000-2009	-0.59%	1.70%	-0.26%
2010-2019	1.04%	1.89%	0.48%
2020-2023	2.13%	-0.47%	1.38%
Periods	$x = x^n - \pi$	$r^D = r^{D,n} - \pi$	$r^D - x$
1997-2023	0.03%	1.30%	1.27%
2000-2009	-0.33%	1.96%	2.29%
2010-2019	0.56%	1.41%	0.84%
2020-2023	0.75%	-1.85%	-2.60%

Source: Bond Returns are calculated as weighted average returns between bonds and T-bills. The return data of government bonds (excluding T-bills) is obtained from BofA Ice Japan Government Bond Index Fund. Nominal GDP growth and CPI inflation from Cabinet Office of Japan.

$\frac{A_{t-j}}{Y_{t-j}}$*, as well as past cumulative excess returns between* R_t^A *and* R_t^D*:*

$$\frac{ND_t}{Y_t} = \sum_{j=0}^{t} \left(\frac{G_{t-j} - T_{t-j}}{Y_{t-j}} \right) \frac{R^D_{t-j,t}}{X_{t-j,t}} - \sum_{j=0}^{t} \frac{A_{t-j}}{Y_{t-j}} \frac{R^A_{t-j,t} - R^D_{t-j,t}}{X_{t-j,t}} + \frac{R^D_{0,t}}{X_{0,t}} \frac{ND_{-1}}{Y_{-1}},$$

where $R^A_{t-j,t} = \prod_{k=1}^{j} R^A_{t-j+k}$*.*

Proof. Please refer to Appendix A.2 □

The above proportion implies that even if the growth rate is lower than the rate of return on debt, $r^D > x$, and the government is running deficits, the consolidated government's net debt may remain stable as a fraction of output. In other words, the government can roll over its debt in perpetuity and run steady-state deficits ($G > T$) with a constant debt-to-GDP ratio, provided that both the real returns on its asset position, r^A exceed the government's funding costs, r^D, and the asset position itself, A/Y, are sufficiently large. This can be seen by imposing the steady-state assumption in the government budget constraint:

$$\frac{r^A - r^D}{1+x} \frac{A}{Y} + \frac{x - r^D}{1+x} \frac{D}{Y} = \frac{G-T}{Y}.$$

Panel A of Table 4 reports the past rates of returns on the Japanese government's consolidated balance sheet over our sample periods. The details of return calculation are reported in Appendix A.3.[15] The consolidated Japanese government earns an excess return rate of 1.90% per annum on its risky long position above the cost of its funding position. The significant rate of return resulted from a 2.59% return rate in assets and 0.69% in liabilities.

There is a big difference between the periods before and after 2012. During the period before 2012, the average asset return is only 0.89%, which is lower than its funding costs. The consolidated balance sheet suffered a net loss of 0.63% of GDP per annum. In the decade after 2012, the consolidated government started to earn positive excess returns. The asset return increased rapidly while the return of liability declined. By taking on risks, the government earned a spread of 4.66% on its consolidated balance sheet. This spread combined with the size of the balance sheet yielded sizable returns. The Japanese public sector harvested an average excess return of more than 6% of GDP annually.

Since 1998, the general government has been running deficits. The average annual primary deficit is around 5.1% of GDP in the last 26 years. This translates to 133% of GDP in cumulative

[15] Appendix A.3 also compares our return calculation to that of using reconciliation returns. As discussed in the appendix, our measure of returns is quite conservative.

Table 4: Rates of Returns on Consolidated Balance Sheet

	Return Rate			Net Return
	(1)	(2)	(3)	(4)
Panel A: Estimates of Actual Returns				
Periods	Liabilities	Assets	Difference	% of GDP
1998-2023	0.69%	2.59%	1.90%	2.28%
1998-2012	0.92%	0.89%	−0.04%	−0.63%
2013-2023	0.38%	5.04%	4.66%	6.25%
Panel B: No-QE Counterfactual				
Periods	Liabilities	Assets	Difference	% of GDP
1998-2023	1.34%	2.59%	1.25%	0.66%
1998-2012	1.03%	0.89%	−0.14%	−0.87%
2013-2023	1.77%	5.04%	3.28%	2.75%
Panel C: Currency-Hedged Counterfactual				
Periods	Liabilities	Assets	Difference	% of GDP
1998-2023	0.69%	1.89%	1.20%	1.07%
1998-2012	0.92%	1.07%	0.15%	−0.44%
2013-2023	0.38%	3.05%	2.67%	3.11%
Panel D: Combined Counterfactual				
Periods	Liabilities	Assets	Difference	% of GDP
1998-2023	1.34%	1.89%	0.55%	−0.55%
1998-2012	1.03%	1.07%	0.04%	−0.67%
2013-2023	1.77%	3.05%	1.28%	−0.38%

For Panel A, see Appendix A.3 for details. Section 5.3 discuss the results reported in Panel B, C and D. Column (1) reports returns on the liabilities. Column (2) reports the returns on the assets. Column (3) reports the difference between (1) and (2). Column (4) reports the net return as % of GDP, weighted by the size of assets and liabilities.

deficits (see Table 13). However, the net liabilities of the consolidated government balance sheet only increased about 70% of GDP (see Table 1). Through a back-of-the-envelope calculation, an excess balance-sheet return can be inferred: 133% minus 70% and then divided by 26 years, which is around 2.42% of GDP. This estimate is a bit higher but not far from the 2.28% of GDP reported in Table 4.

Looking ahead, the expected return, conditional on the current portfolio, is unsurprisingly sizable. We can estimate the expected return on the 2023 portfolio using the average returns during our sample period. By the end of 2023, the balance sheet consists of assets equivalent to 181% of GDP, more than half of which are high-risk assets, including equities and foreign assets. This risky asset position yields a high expected return of 5.41% of GDP. In contrast, the larger liability position, amounting to 276% of GDP, carries a lower expected return of only 1.53% of GDP. As a result, the government anticipates a balance sheet return of 3.89% of GDP (See Table 12).

Fiscal consolidation over the past decade, including two consumption tax rate hikes in 2014 and 2019, has helped reduce the fiscal deficit. Excluding the exceptional year of 2020, when the government implemented a large COVID-related fiscal stimulus, the average primary deficit after 2015 dropped to only 3.2% of GDP—an average fiscal surplus sufficient to fund government spending without increasing the tax burden during normal times. This simple accounting exercise suggests that the current financial leverage and tax policy chosen by the Japanese government have the potential to balance the budget, even in the long run. This may explain why Japan has not experienced a debt crisis or inflation, until recently, despite its public debt-to-GDP ratio exceeding 200%.

5 Financial Repression

Panel A of Table 4 indicates that the return spreads really started to increase during the period after 2012. This is the time when the BoJ resumed its large-scale asset purchases in 2012 on a much larger scale, essentially crowding out private investors, as shown in Figure 1. This is also the time when the public pension funds started to reduce their government bond holdings and increase their foreign risky asset positions. In short, the significant increase of return-spread after 2012 clearly echoes the policy choices of the BoJ and public pension funds.

To earn the advantageous return-spread, the Japanese government has increasingly taken on aggregate risk in foreign and domestic equity and bond markets. In the absence of financial frictions, this risk should be reflected in the pricing of the government debt, unless the government's surpluses absorb the risk. In other words, as the government takes on more risk, unless the government renders the tax revenue safer or the transfer spending riskier, the price of debt should reflect its increasing risks.

Starting in 2010, the BoJ has been purchasing a significant fraction of the issuance of Japanese government bonds. Since 2014, the BoJ has been buying more than the total issuance, completely crowding out private investors who have been net sellers (see Figure 1 and Figure 2). Without these purchases lowering bond yields, it is not clear the Japanese government could earn these spreads, because the required return on debt would increase as the government leverages up.

We find evidence that the risk is not priced into the debt. The debt may be overpriced because of financial repression. Financial repression is not only prevalent in developing economies but also common in advanced economies at least prior to the 1980s. In fact, the history of government debt financing is partly a history of financial repression.[16]

5.1 Covered Interest Rate Parity Deviations as a Tool of Financial Repression

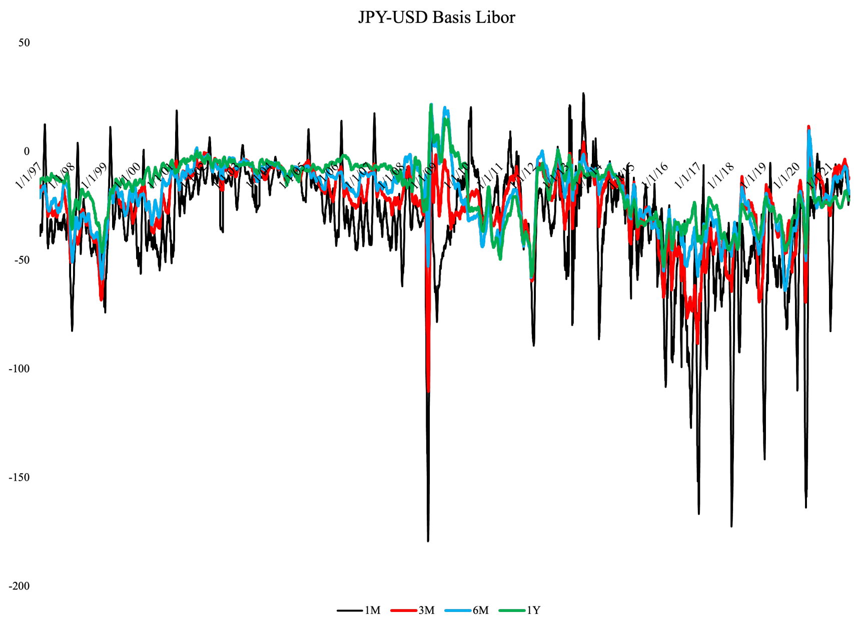
In order to circumvent financial repression at home, the Japanese financial sector could increase returns by investing abroad since Japan has no capital controls. However, these financial institutions, unlike the government, would be expected or required to hedge their currency risk at least partially.[17] If Covered Interest Rate Parity (CIP) holds, the hedging cost is exactly equal to the interest rate difference between domestic and foreign assets. In the case of Japan, the hedging cost is larger. As a result, these hedging requirements enable financial repression by trapping the assets of financial intermediaries in Japan (Setser, 2023).

To make this idea concrete, consider the CIP formula between USD and Japanese Yen. Let s_t^e denote the log of spot exchange rate Yen per dollar. The USD/Yen LIBOR basis is defined as cash LIBOR rate for borrowing in USD minus the synthetic USD LIBOR rate constructed from Yen

[16] There is a large literature documenting financial repression in emerging market economies (see McKinnon, 1973). U.S. financial history is replete with examples of financial repression. During the Civil War, the Union passed the National Bank Act in 1863, authorizing national banks to issue banknotes provided the notes were partly backed by U.S. Treasurys. During WW-I , the Federal Reserve helped the Treasury by buying short-term bonds. In addition, the Federal Reserve encouraged private investors to buy Liberty loans by borrowing from private banks. To do so, the Federal Reserve allowed banks to discount loans secured by Liberty loans at preferential discount rates. After WW-I, a number of European countries, most notably Italy and France, engaged in financial repression to keep interest rates low (see Sargent et al., 2019, for detailed discussions of the U.K., U.S. French and Italian experiences during the interbellum.). During and after WW-II, the Federal Reserve engaged in yield curve control by pegging short-term interest rates. This lasted until the Federal Reserve Treasury Accord in 1951. In addition, there were explicit ceilings on nominal interest rates in place (Regulation Q). According to Reinhart and Rogoff (2009) and Acalin and Ball (2022), these measures played a key role in reducing the debt/GDP ratio after WW-II.

[17] In Japan, the Financial Services Agency serves as the primary regulator for financial institutions, including oversight of their overseas investment activities. When financial institutions invest in foreign assets, they are expected to manage currency risk effectively, with their hedging strategies frequently monitored by regulators.

Figure 4: LIBOR CIP Deviations



Source: Bloomberg and authors' calculation. The Libor USD/Yen basis is defined as the difference between the cash LIBOR rate for borrowing in USD and the synthetic USD LIBOR rate constructed from Yen LIBOR rates and hedged back into USD: $x_{t,t+n} = r^{\$,Libor}_{t,t+n} - (r^{Libor}_{t,t+n} - \rho_{t,t+n})$, where $\rho_{t,t+n} = (1/n)(f^n_t - s^e_t)$ denotes the forward premium (in logs) obtained from the forward f^n_t and spot s^e_t exchange rates.

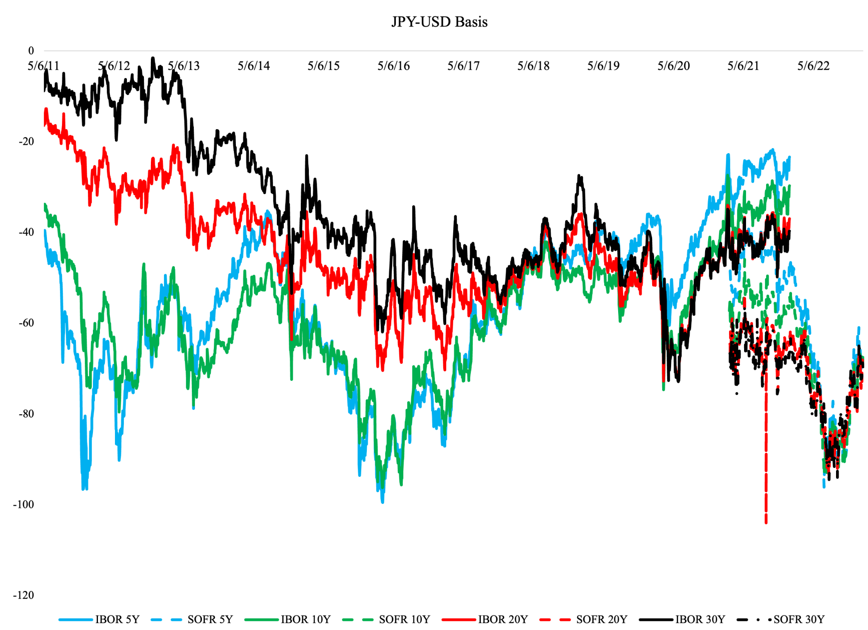
LIBOR rates and hedged back into USD:

$$x_{t,t+n} = r^{\$,Libor}_{t,t+n} - (r^{Libor}_{t,t+n} - \rho_{t,t+n}),$$

where $\rho_{t,t+n} = (1/n)(f^n_t - s^e_t)$ denotes the n-period forward premium (in logs) obtained from the forward f^n_t and spot s^e_t exchange rates. Du et al. (2018b) document large, negative deviations from CIP in LIBOR markets during the GFC. These CIP deviations have persisted. Figure 4 plots the LIBOR CIP deviations for maturities ranging from 1 month to 12 months. Between 2010-2019, the average basis was -41bps at the 1-month horizon, -31 bps. at the 3-month horizon, -28 bps at the 6-month horizon, and -27 bps at the 12-month horizon. Du et al. (2018b) document even larger CIP deviations at longer maturities of 5 years. Figure 5 computes the CIP deviations at maturities in excess of one year, computed from cross-currency swaps. Between 2011 and 2023, the average basis is -55 bps. at the 5-year horizon, -57 bps. at the 10-year horizon, -43 bps. at the 20-year horizon, and -35bps at the 30-year horizon.

The large and consistent CIP deviations in the USD/JPY market provide strong evidence to support our view that the financial assets are effectively trapped in Japan. The large negative basis in the USD/JPY market, which is determined by the size of international capital flows, reduces the

Figure 5: LIBOR CIP Deviations –Longer Maturities



Source: Bloomberg and authors' calculation. The Libor USD/Yen basis is defined as the difference between the cash LIBOR rate for borrowing in USD and the synthetic USD LIBOR (SOFR) rate constructed from Yen LIBOR (SOFR) rates and hedged back into USD: $x_{t,t+n} = r^{\$,Libor}_{t,t+n} - (r^{Libor}_{t,t+n} - \rho_{t,t+n})$, where $\rho_{t,t+n} = (1/n)(f^n_t - s^e_t)$ denotes the forward premium (in logs) obtained from the forward f^n_t and spot s^e_t exchange rates.

hedged returns on foreign investments even further for the Japanese private financial institutions.

According to flow of funds data, financial intermediaries in Japan are tasked with managing 278% of GDP in households' bank deposits, insurance, and pensions. However, they are unable to replicate the government's strategy of foreign investments due to hedging requirements. When Japanese banks and insurance companies invest abroad, they must hedge at least part of the currency risk, as their large depositor base is in yen. These financial institutions seek dollar investments to earn higher returns, but to hedge their currency exposure, they borrow synthetic dollars, which exerts upward pressure on the synthetic USD LIBOR rate and downward pressure on the basis. This general pattern, as documented by Du et al. (2018b), shows that low-interest-rate currencies tend to have more negative bases against the USD, as investors look for higher returns abroad. As the BoJ further depresses the term premium in Japan through its QE and YCC policies, financial intermediaries are incentivized to pursue higher bond yields abroad, thus widening the CIP basis. We interpret this as direct evidence of financial repression.

5.2 Mispricing of Government Liabilities

To see the idea more clearly, we start by analyzing the case in which the debt is priced accurately. Let G_t denote nominal government spending before interest expenses on the debt, T_t denote nominal government tax revenue, and $S_t = T_t - G_t$ denote the nominal primary surplus. We use P_t^S to denote the cum-dividend price of the surplus claim. If the transversality condition is satisfied, then the value of debt is fully backed by the present value of future surpluses and the value of the assets: $P_t^S + A_t = D_t$ (see Jiang et al., 2024). Moreover, governments cannot make risk disappear. The government debt's expected excess return is the weighted expected excess return on the surplus claim and risky assets A holding, given by (see Appendix A.4 for a full derivation)

$$\mathbb{E}_t\left[R_{t+1}^D - R_t^f\right] \approx (1 - \frac{A_t}{D_t})\mathbb{E}_t\left[R_{t+1}^S - R_t^f\right] + \frac{A_t}{D_t}\mathbb{E}_t\left[R_{t+1}^A - R_t^f\right], \tag{3}$$

which says that the risks of surplus claim and asset position have to be reflected in the riskiness of the government debt. Denote the pricing kernel as: M_{t+1} and define the return alpha as: $\alpha_t = \frac{var_t(M_{t+1})}{\mathbb{E}_t(M_{t+1})}$, and the return beta of an asset i as: $\beta_t^i = \frac{-cov_t\left(M_{t+1}, R_{t+1}^i\right)}{var_t(M_{t+1})}$. By the investor's Euler equation, $\beta_t^i \alpha_t$ determines the conditional risk premium of this asset:

$$\mathbb{E}_t\left[R_{t+1}^i - R_t^f\right] = \frac{-cov_t\left(M_{t+1}, R_{t+1}^i\right)}{var_t(M_{t+1})}\frac{var_t\left(M_{t+1}\right)}{\mathbb{E}_t(M_{t+1})} = \beta_t^i \alpha_t.$$

The beta of the debt is a weighted average of the beta of the asset holdings fund and the beta of the surpluses:

$$\beta_t^D \approx (1 - \frac{A_t}{D_t})\beta_t^S + \frac{A_t}{D_t}\beta_t^A. \tag{4}$$

As the consolidated government takes on more risk by leveraging up and by investing in riskier assets, the riskiness of its debt will increase proportionately, unless the government makes the surpluses correspondingly less risky.

In addition, by rearranging equation (3), we can obtain an expression for the expected excess return on assets minus liabilities:

$$\mathbb{E}_t\left[R_{t+1}^A - R_{t+1}^D\right] \approx (1 - \frac{A_t}{D_t})\mathbb{E}_t\left[R_{t+1}^A - R_{t+1}^S\right]. \tag{5}$$

The Japanese government can deliver a positive expected excess return on its investment strategy only if the return spread between the asset is riskier than the surplus. We can then calculate the return spread between the asset and the surplus. The 2023 asset-to-debt ratio of the consolidated government is $0.66 = \frac{181\%}{276\%}$. The excess return of the consolidated balance sheet is 1.9% according to Table 4. Hence, the implied spread between the sovereign wealth fund and the surplus is

$$\mathbb{E}_t\left[R^A_{t+1} - R^S_{t+1}\right] \approx \mathbb{E}_t\left[R^A_{t+1} - R^D_{t+1}\right] \times \frac{1}{1-0.66} = \frac{1.9\%}{0.34} = 5.55\%.$$

A 5.55% implied excess return then suggests that, if the debt is priced correctly, then the implied risk premium on the surplus claim is -2.96% (= 2.59% − 5.55%). The surpluses would have to be a hedge, i.e. counter-cyclical. But in reality, Japanese surpluses are strongly pro-cyclical. This is an indication that the government bonds might be mispriced as a result of financial repression. In other words, the government cannot just back risk-free promises to bondholders and safe promises to pensioners with risky cash flows from the tax revenue and the risky investments.

5.3 Quantifying Return Wedge

We then consider the possibility that the government debt is mispriced and hence equation (3) might not hold.

Definition 1. *Given the assumption of constant surplus/output ratios, the return wedge, ω_t, is defined as the difference between the expected return on government debts and the predicted return based on risk exposure in the balance sheet:*

$$\begin{aligned} \omega_t &= \mathbf{E}_t\left[R^D_{t+1} - R^f_t\right] - \left(1 - \frac{A_t}{D_t}\right)\mathbf{E}_t\left[R^S_{t+1} - R^f_t\right] - \frac{A_t}{D_t}\mathbf{E}_t\left[R^A_{t+1} - R^f_t\right] \\ &= \left[\beta^D_t - (1 - \frac{A_t}{D_t})\beta^S_t - \frac{A_t}{D_t}\beta^A_t\right]\alpha_t. \end{aligned} \tag{6}$$

Moreover, ω_t can also be seen as the Euler equation wedge or the pricing error.

The next step is to quantify the return wedge defined in equation (6). First, consider that the government debt portfolio has zero beta. Then all of the risk in the risky portfolio has to be offset by the insurance offered by the surpluses:

$$\beta^S_t = -\frac{\frac{A_t}{D_t}}{(1 - \frac{A_t}{D_t})}\beta^A_t. \tag{7}$$

Given that surpluses are co-integrated with output, this would require strongly counter-cyclical surpluses, which is again counterfactual. As the consolidated Japanese government takes on more leverage and more risk in its sovereign wealth fund, the beta of the surpluses has to decrease to completely insulate the government debt.

A more realistic approach is to consider the case in which both taxes and spending are constant fractions of output. Then the surpluses are as risky as a claim to output or, equivalently, unlevered equity:

$$\beta_t^D = (1 - \frac{A_t}{D_t})\beta_t^Y + \frac{A_t}{D_t}\beta_t^A, \tag{8}$$

where β_t^Y is the return beta of output claim. Given that surpluses are actually pro-cyclical, this produces a lower bound on the return wedge.

We then quantify the return wedge in 2023 below. In 2023, the unlevered beta of equity in Japan is 0.45. The 2023 ratio of assets to debt is 0.66 as mentioned earlier. Then we get

$$\beta_t^D = (1 - 0.66)0.45\beta_t^E + 0.66\beta_t^A. \tag{9}$$

In addition, the current expected excess return on equities in Japan is 5.1%[18] We then calculate the return beta of the asset portfolio in the consolidated balance sheet by the following equation:

$$\beta_t^A = \frac{\mathbb{E}_t\left[R_{t+1}^A - R_t^f\right]}{\mathbb{E}_t\left[R_{t+1}^E - R_t^f\right]} \times \beta_t^E \approx \frac{2.59\% - 0.1\%}{5.1\% - 0.1\%} \times \beta_t^E = 0.5\beta_t^E,$$

where the expected return for the asset portfolio is obtained directly from Table 4 and the risk-free return is approximated by the average return of bank reserves in our sample period, which is 0.1%. We end up with an asset beta that is equal to half of the stock market or levered equity beta. Then the implied return beta of the government's liabilities is almost half of equity beta:

$$\beta_t^D = (1 - 0.66)0.45\beta_t^E + 0.66 \times 0.5\beta_t^E \approx 0.48\beta_t^E. \tag{10}$$

The implied expected excess return on the government's liabilities would then be equal to 2.41% ($5\% \times 0.48$). Finally, from Table 4, we approximate the expected excess return of the overall liability as 0.59% ($0.69\% - 0.1\%$). Hence, the implied return wedge is 1.82% if we assume that surpluses are expected to be a-cyclical in the future.

$$\omega_t = -2.41\% + 0.59\% = -1.82\%.$$

[18]See 2024 AQR Capital Market Assumptions for Japan equity market.

This simple calculation suggests that the Japanese-government-bond holders earn returns that are much too low. In other words, Japanese debt is overpriced. Appendix A.5 uses the past returns to measure this return wedge and finds that the wedge is even higher at -2.23%.

Another symptom of low real rates is the depreciation of the Yen. If the real exchange rate stationary and markets are complete, long-run UIP holds for the real exchange rate and long-term real yields (Lustig et al., 2019): $\mathbb{E}_t \Delta s_{t\to t+k} \approx k(y_t^{\$,k} - y_t^{Yen,k})$. For long k, this implies that the % deviation of the real exchange rate from the long-run mean is determined by the long rate differential: $(s^* - s_t) \approx k(y_t^{\$,k} - y_t^{Yen,k})$. Note that the real exchange has to depreciate today as the long-run Japanese yield drops below the foreign yield. We can assume that the long-run real exchange rate s^* is constant. That implies that the percentage depreciation of the Yen is driven only by the change in the long yield differential: $\Delta(s_{t\to t+N}) \approx k\left((y^{\$,k}_{t\to t+N} - y^{Yen,k}_{t\to t+N}) - (y_t^{\$,k} - y_t^{Yen,k})\right)$ where we chose $k = N$. The Japanese real exchange rate has depreciated by 45% over 27 years between 1997 and 2023. That's an annual rate of 1.68% per annum. We can then infer the long-term real rate difference that would have been consistent with a stable real exchange rate. If the long-term real Japanese rate in 2023 was 168 bps higher relative to the foreign real rate than it is now, then the Japanese Yen would not have depreciated between 1997 and 2023. In other words, the wedge roughly accounts for the entire real depreciation of the Yen.

5.4 Sensitivity Analysis

The return wedge defined by equation (3) may arise from others factors beyond financial repression. For instance, research has noted that the U.S. government often borrows at very low rates, thus harvesting a convenience yield that is compensation for the safety and liquidity (Krishnamurthy and Vissing-Jorgensen, 2012). However, recent evidence suggests that Japanese government bonds do not enjoy convenience yields. Japan has borrowed at higher rates than the rest of the world when we compare dollar rates by hedging currency risk (Du et al., 2018c). In other words, Japanese government bonds are cheap compared to other sovereign bonds.

In Japan's case, in addition to financial repression, the low borrowing rate could be influenced by several factors such as low financial literacy in parts of the population, an underdeveloped financial retail market, and the lingering scarring effects of the stock and housing market crashes in the early 1990's. To shed a light on this issue, we study the sensitivity of the net returns in two counterfactual exercises.

5.4.1 Counterfactual Accounting Exercise 1: No QE and YCC

In the first counterfactual, we compute the Japanese government's cost of funding if the BoJ had not implemented its QE and YCC policies after 2012. To conduct this exercise, we need to understand how bond yields or returns would have behaved in the absence of the BoJ's QE policy. For this, we rely on two studies. First, Hansen and İmrohoroğlu (2023) use a general equilibrium model to assess the role of the BoJ's QE in Japan's fiscal sustainability. Their calibrated model includes several counterfactual analyses, and as shown in Figure 15 of their study, they estimate that JGBs interest rates between 2010 and 2019, without the BoJ's QE policy, would have ranged from 3% to 5%, compared to actual rates of 0% to 2%, resulting in an average interest rate difference of 3%. Second, Koeda and Kimura (2024) use maturity composition data of JGBs to structurally estimate a canonical preferred-habitat term structure model. Their findings suggest that the shortened duration of JGBs, driven by the BoJ's QE and YCC policy in the late 2010s, was crucial in lowering long-term bond yields. The compression of 10-year JGB yields in 2010 is estimated to be around 80 to 100 basis points.

We then conduct a counterfactual analysis based on two conservative assumptions. First, we assume that returns on JGBs after 2012 would have been 2% higher than the actual returns, at the middle of the two studies mentioned earlier. Second, we assume that the BoJ did not issue bank reserves to purchase any government debt. This second assumption effectively replaces bank reserves with JGBs on the consolidated balance sheet. We then recalculate the historical rate of return on the consolidated government balance sheet, with the results presented in Panel B of Table 4.

Since we assume no change in the realized returns on JGBs prior to 2012, the main impact occurs after 2012. The gains from the consolidated balance sheet after 2012 are reduced by 3.5% of GDP, dropping from 6.25% of GDP (as shown in Panel A of Table 4) to 2.75% of GDP. This accounting exercise only adjusts the returns on liabilities while keeping asset returns unchanged. As a result, the overall return on liabilities increases from 0.69% to 1.34%. The increase is one-to-one reflects on the reduction of return wedge, which is modified as

$$\omega_t^{NoQE} = -2.41\% + (1.34\% - 0.1\%) = -1.17\%.$$

In other words, the BoJ's QE policy contributed about 65 basis points to the Euler equation wedge, accounting for around 36% of the pricing error (65/182 basis points) over the entire sample period. This is quite significant since we only assume conservatively that the reduction of JGB yield occurred only after 2012 and not the entire sample.

However, if we assume QE reduced bond yields by 300 bps instead, then the net return after 2012 drops to only 1% of GDP, a reduction of more than 5% of GDP (see Table 17). The overall return liability further increases to 1.67% and the contribution of the BoJ's QE policy to the overall return wedge rises from 36% to more than half at 52%.

5.4.2 Counterfactual Accounting Exercise 2: Currency Hedged

The next counterfactual assumes that the Japanese government hedges its foreign asset position, putting it on equal footing with private financial institutions. We begin by expressing the return of an unhedged foreign investment for the Japanese government. Let $r^{FA,\$}_{t,t+n}$ represent the rate of return on the government's foreign assets denominated in foreign currency. The unhedged return in logs between time t and time $t+n$ can be written as the return in foreign currency plus the appreciation of the foreign currency against the Yen:

$$r^{unhedged}_{t,t+n} = r^{FA,\$}_{t,t+n} - \frac{1}{n}(s^e_{t+n} - s^e_t), \tag{11}$$

where s^e_t represents the Yen spot exchange rate at period t.

In the counterfactual scenario, it is assumed that the Japanese government fully hedges the currency risk of its entire foreign asset portfolio through the forward FX market. The return in logs on its foreign investments, after hedging, is expressed as the foreign currency return minus the forward discount

$$r^{hedged}_{t,t+n} = r^{FA,\$}_{t,t+n} - \frac{1}{n}(f^n_t - s^e_t), \tag{12}$$

where f^n_t is the n-period forward exchange rate at period t.

If CIP holds, then the hedged return in logs is the excess return in dollars plus the Japanese risk-free rate. However, given the negative CIP deviations, the hedged return will be lower than that. In our calculations, we use a three-month forward rate ($n = 3$ months) to match the quarterly frequency of our data. Our counterfactual is quite conservative because we assume that the negative basis does not widen even when the government hedges all of its risk exposure.[19]

The results, shown in Panel C of Table 4, reveal a significant reduction in returns due to the hedging requirement. The average asset return for the entire sample decreases by 70 basis points, from 2.59% to 1.89%. In terms of GDP, the average return drops from 2.28% to just 1.07%, representing a loss of over 1% of GDP annually. The decline is particularly pronounced after 2020,

[19]The recent study by Du and Huber (2024) highlights a strong link between CIP deviation and hedging demand. Their estimates suggest that a hedging demand equivalent to 20% of GDP could result in an 80-basis-point in 3-month CIP deviation. In our counterfactual analysis, the additional hedging demand from the government surpasses 56% of GDP.

when the Japanese yen appreciated significantly, boosting unhedged returns during that period.

We can then calculate its contribution to the return wedge. In this simple accounting exercise, the only thing affecting the return wedge is through the return beta of the asset portfolio, which is now modified into:

$$\beta_t^A = \frac{\mathbb{E}_t\left[R_{t+1}^A - R_t^f\right]}{\mathbb{E}_t\left[R_{t+1}^E - R_t^f\right]} \times \beta_t^E \approx \frac{1.89\% - 0.1\%}{5.1\% - 0.1\%} \times \beta_t^E = 0.36\beta_t^E,$$

which implies a decline of the return beta of the government's liabilities:

$$\beta_t^D = (1 - 0.66)0.45\beta_t^E + 0.66 \times 0.36\beta_t^E \approx 0.39\beta_t^E.$$

The return wedge then becomes

$$\omega_t^{hedged} = -5.0\% \times 0.39 + 0.69\% = -1.26\%,$$

which represents a 56 bps drop.

5.4.3 A Lower Bound

Furthermore, as indicated by Panel D of Table 4, in the absence of these two forms of financial repression, the government's balance sheet shifts from generating a substantial net return of 2.28% of GDP (See Panel A of Table 4) to a net loss at 0.55% of GDP. Over the past decade, the net return declines from 6.25% to -0.38% of GDP. Foreign currency risk and QE are key drivers of net returns.

Our combined counterfactuals imply that the BoJ's large-scale asset purchases and foreign currency risk can account for two-third, 66.5%, of the total return wedge ((65+56)/182). Without QE and with full hedging of foreign currency risk, the returns of government liability would be at least 1.21% (0.65%+0.56%) higher. These counterfactuals do not measure the full impact of financial repression because the underlying assumptions are quite conservative. We assumed that returns on other liabilities remain unaffected by the BoJ's large asset purchases. More critically, a higher path for real rates would have reduced the realized returns on high duration assets as well. As a result, these numbers provide a lower bound on the true impact.

6 Interest Rate Risk Exposure on the Government Balance Sheet

Does the rate reduction induced by the financial repression help the government to relax its budget constraint? If so, how much? These are the questions we intend to shed light on in this section.

6.1 Duration Mismatch and the Government's Fiscal Space

We first consider the implications of a permanent decline in interest rates on the fiscal space of the government. We begin by deriving the standard link between an asset's cash flow duration and its exposure to interest rates.

Proposition 6.1. *In period t, consider a sequence of cash flows $\{z_s\}_{s=t}^{\infty}$ and its valuation, $Z_t = \sum_{s=t}^{\infty} R^{s-t} z_s$. The revaluation of asset Z_t due to a change in R is given by:*

$$\frac{\partial \log Z_t}{\partial \log R} = \frac{\sum_{s=t}^{\infty} R^{s-t} z_s \times (s-t)}{Z_t} \equiv -D,$$

where D is the asset's duration.

Proof. Please refer to Appendix A.6 □

If we iterate forward on the flow government budget constraint, then we can obtain the following expression for its period-t net debt:

$$ND_t = \sum_{s=t}^{\infty} R^{t-s}(T_s - G_s), \tag{13}$$

which simply states that the government's net debt is equal to the present value of future primary surpluses, defined as tax revenue minus spending. With this identity in hand and together with Proposition 6.1, the effect of a decline in rates on the government's spending possibility set depends on the duration of its balance sheet as well as the duration of its future spending plans. This theoretical insight regarding the link between interest rates and the government's spending possibility set is stated below:

Corollary 1. *The effect of real rate declines on the government's spending possibilities set depends on the relative duration of its net debt and surpluses:*

(a) If $D^{ND} < D^{T-G}$ then the government's spending possibilities expand when the interest rate falls,

(b) if $D^{ND} > D^{T-G}$ the government's spending possibilities contract.

When the duration of the surplus exceeds the duration of net debt, then a real rate decline expands fiscal capacity. The capital gain on its net liabilities exceeds the increase in the net present value of future surplus, and the government has extra fiscal capacity to increase G or reduce T in the future. Alternatively, when the duration of its net debt is higher than the duration of future surpluses, then the resulting increase in the market value of debt is higher than the increase in the net present value of its future surpluses, thus reducing the government's fiscal capacity. As we are about to show, the duration mismatch turns out to be very significant on the budget constraint of the Japanese government. By contrast, to fully hedge against shocks to real rates, the government should set its balance sheet portfolio in a way such that the duration of net debt matches the duration of future surpluses.

6.2 Measuring Duration Mismatch on the Government Balance Sheet

Next, we measure the net duration of the government's net financial assets. We start on the asset side. We infer the duration of equities from the price/dividend ratio using the Gordon growth model.[20] We use the Jorda-Schularick-Taylor Macro-history database (Jordà et al., 2019) for the price/dividend ratio on Japanese stocks. The average duration for Japanese stocks over this period is 75.6 years. This high number reflects the high valuation ratios for Japanese stocks over this period. For bonds, we use the ICE-BofA Japan Government index's effective duration. The average duration over this period is 7.19 years. For all of the loans on the government's balance sheet, we used a duration of 3 years. The duration of deposits (cash and bank reserves) is zero. For foreign securities, we used a weighted average of the duration of U.S. stocks (59 years) and bonds. The weights are 50/50.

Long-lived assets denominated in foreign currency are exposed to the domestic real discount rate as a result of long-run UIP, which equalizes the long-run holding period returns on real bonds denominated in domestic and foreign currency.

According to the portfolio reported in Table 1, we can then calculate the duration of the consolidated balance sheet. In 2023, the duration of its risky asset position is around 24.1 years. The high duration is mostly due to the equity position. The duration of its liabilities is only 3.3 years. The net duration is the weighted average of asset and liability duration. The consolidated government has a negative net financial asset position of 94.3% of GDP in 2023, the net result of a debt position of 275.6% of GDP, and an asset position of 181.3% of GDP. As a result, the smaller asset position contributes more positive duration than the negative duration contributed by its larger debt. This

[20] In the Gordon growth model, duration is given by $D = \frac{1+r}{r-g} = pd \times (1+r)$ where r denotes the expected return and g denotes the expected growth rate.

means that the duration of the government's net asset position is positive and large (see Figure 9 in the Appendix). In 2023, the net asset duration is 36 years, significantly up from 7.5 years in 2012. The Japanese government has dramatically increased the duration of its net asset position in the past decade or so. Put differently, the Japanese government has a negative duration of 36 years for its net debt, because the value of its net debt actually decreases when rates decline, as a result of the long position in high-duration risky assets.

At the same time, its surpluses accrue in the distant future, because Japan is expected to run deficits for now. We follow the procedure developed by Jiang et al. (2022) to measure the duration of government surpluses using budget projections. In the baseline of economic and fiscal projection published by the Japanese Cabinet Office in 2024,[21] the combined local and central government is projected to run primary deficits until 2033, the end of the projection range.

To estimate the government surplus after 2033, we assume that the economy reaches a steady state starting in 2033. The net debt-to-GDP ratio is assumed unchanged at 94.3% since the Japanese Cabinet Office projects the bond-to-GDP ratio in 2033 to be 208%, which is roughly unchanged from the 200% bond-to-GDP ratio in 2023 (see Table 14). If the transversality condition holds, then the net debt position in 2033 must be fully backed by future surpluses, as shown by the following equation:

$$\left(\frac{ND}{Y}\right)_{2033} = pd_Y \times \frac{S}{Y} = \frac{1}{r^Y - x}\frac{S}{Y} = \frac{1}{(0.3\% + 2\% - 0.5\%)}\frac{S}{Y},$$

where pd_Y denotes the steady-state price/dividend ratio for a claim on GDP. The price/dividend ratio is calculated using the Gordon formula, $\frac{1}{r^Y - x}$, where x represents the steady-state growth rate of the economy and r^Y denotes the discount rate for a claim on GDP.[22] We assume a real long-term interest rate of 0.3% and a GDP risk premium of 2%. Given a steady-state net debt-to-GDP ratio of 94.3%, the government will need to maintain a steady-state surplus $\frac{S}{Y}$ of 1.7% of GDP to satisfy its budget constraint in the steady state as shown in the equation above.

We now have the entire projected surplus starting in 2023, which enable us to compute its duration by using the following formula. We end up with a duration of 52 years for the surplus claim:

$$D_{2023}^{T-G} \approx \frac{\sum_{t=0}^{\infty} R^{-t}(T_{2023+t} - G_{2023+t}) \times t}{\sum_{t=0}^{\infty} R^{-t}(T_{2023+t} - G_{2023+t})} = 52.$$

If the government wanted to be fully hedged against interest rates, it would have to issue zero coupon debt equal to the projected surplus for each maturity. In that case, its debt would have a duration of 52 years. Instead, the government borrows at a much shorter duration and invest

[21] The Japanese Cabinet's fiscal projections are available at this web site.

[22] The steady-state price/dividend ratio of a claim on GDP determines the fiscal capacity as a fraction of GDP per percentage point of the primary surplus (Jiang et al., 2022).

in long duration assets. As a result, the increase in the net present value of surpluses exceeds the increase in the market value of the net debt in response to a real interest rate decline:

$$\Delta\left(\mathbb{E}_0 \sum_{t=0}^{\infty} R^{-t}(T_t - G_t)\right) > \Delta ND_t.$$

More specifically, the left-hand side of the equation above, the net present value of future surpluses, increases by 52% in response to a permanent decrease in real rates of 100 bps. The right-hand side decreases by 36%, because the net debt has negative duration. Japan can increase government spending or reduce taxes while still satisfying its intertemporal budget constraint. So, when real rates decline, the fiscal space of the Japanese government expands significantly. In contrast, a permanent rate increase destroys fiscal capacity.

7 Interest Rate Risk Exposure of Households

Through financial repression and a risky investment strategy, we have shown that it is possible for the Japanese government to sustain its high debt with fiscal deficits even in the long run. In this section, we study the long term welfare consequences of financial repression on Japanese households.

7.1 Stand-in Japanese Household Balance Sheet

For the household sector in Japan, the deposit-to-GDP ratio has been historically high since the 1980s (Hoshi and Kashyap (1999)). In 1997, the deposit-to-GDP ratio was already quite elevated, at 128%. Even then, Japan was an outlier. U.S. households held only deposits worth 43% of GDP, as reported in Table 5. In 2023, Japanese households held around 189% of GDP in deposits, compared to 63% of GDP in equities. About another 90% of GDP is invested in insurance policies and pensions. Household demand deposits have increased by around 61% of GDP since 1997, despite the nominal deposit rate declining to zero during this period. The direct foreign asset holdings of households increased gradually over time, although the total amount is still relatively small, around 5.6% of GDP by the end of 2023. In sum, 261% of GDP in household wealth is intermediated through the banking and insurance sectors. In contrast, as reported in Table 5, U.S. households held only currency and deposits, including money market mutual fund shares, worth 62% of GDP. U.S. households held 197% of GDP in equities.

In spite of the tripling of equity holdings as a fraction of GDP between 1997 and 2023, the duration of the Japanese stand-in household's net asset position has only increased gradually from

14.8 years in 1997 to 21 years in 2023. Most of the time, it has hovered between 14 and 21 years.[23] This stagnation in the stand-in household's duration is largely driven by the sizable increase in the ratio of deposits to GDP, which largely offsets the effect of the increase in household equity holdings.

Table 5: Japan and United States Household Balance Sheet

	Japan		U.S.	
% of GDP, Year End	1997	2023	1997	2023
Assets				
Currency and Deposits	127.6%	188.9%	43.4%	61.8%
Debt Securities	11.7%	4.8%	20.0%	20.3%
Equities	20.4%	63.4%	128.2%	196.9%
Insurance & Pension	63.1%	90.2%	112.0%	117.3%
Other Assets	12.8%	11.9%	10.6%	9.7%
Sum	**253.7%**	**352.9%**	**314.1%**	**406.0%**
Liabilities				
Loans	64.8%	61.9%	63.2%	69.0%
Other Liabilities	10.5%	2.4%	0.2%	0.1%
Sum	**75.3%**	**64.4%**	**63.5%**	**69.1%**
Net Wealth	**160.4%**	**294.8%**	**250.6%**	**336.9%**

Unit: % of GDP. Source: Japan's Flow of Funds. Federal Reserve Board of Governors, Z.1 Financial Accounts of the United States, Table B.101.h.

7.2 The Cross-section of Japanese Households

We then turn to the cross-sectional distribution of Japanese households. Our analysis utilizes the National Survey of Family Income, Consumption and Wealth data conducted in 2019.[24] This survey collects consumption, income, and assets data for a sizable number of households, around 90,000.

First, for financial assets other than deposits, participation rates by Japanese households are low. Table 6 reports the participation rate for different financial assets for all households as well as across income quartiles. The average participation rate (for all households) for demand deposits and time deposits is 76.3% and 57.3%, respectively. Participation in other financial assets is more limited. For example, the overall participation rate for direct stock holdings is only 16%. The stock participation rate increases with income but peaks at 28% among the top-quartile-income households. The participation rates for trusts, investment vehicles akin to mutual funds, are even lower. The overall participation rate for securities, which include stocks, bonds, and open-end

[23] Figure 10 in the Appendix plots the duration of the household balance sheet.
[24] The survey results are available at this website.

trusts, reaches only 23%. This empirical fact indicates that a large fraction of Japanese households hold mostly short-duration assets, such as deposits, in their portfolios.

Table 6: Asset Market Participation Rates across Income Quintile

Income Quintile	1st	2nd	3rd	4th	5th	Avg
Financial Assets	80	88	91	94	97	**90**
Demand Deposits	65	74	76	81	86	**76**
Time Deposits	46	55	58	59	70	**57**
Securities (stocks, bonds and trust)	12	19	22	26	37	**23**
Stocks	7	12	15	18	28	**16**
Unit & Open-end Trust	6	10	10	13	18	**12**

Unit: Percentage of Households. Source: National Survey of Family Income, Consumption and Wealth 2019 Report: Table 4-20.

Second, downsizing homes is not a popular option even among senior retired Japanese households. Figure 6a provides supporting evidence. In general, the value of housing assets increases with age and income. More importantly, the value of housing owned does not decrease even after age 65, conditional on the income decile. This suggests that the idea of home downsizing to finance consumption is not prevalent even among aged and retired households.

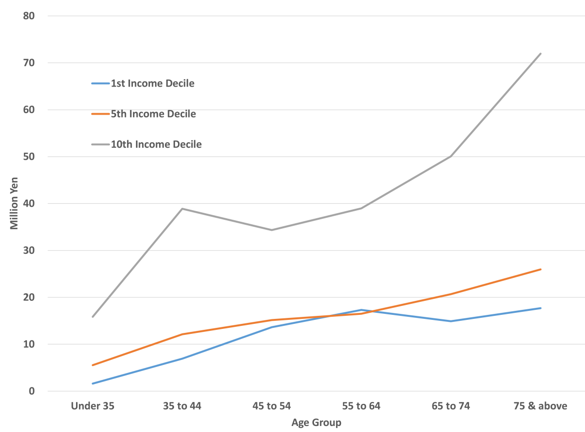
Third, the net worth of net financial assets remains large even for aged households. Figure 6b plots net financial wealth conditional on income. Compared with the level of financial assets to housing value reported in Figure 6a, the size of their financial assets is not trivial. The average financial wealth to housing wealth ratio reaches 56% for the age group 75 and above. This empirical fact indicates that households have a strong precautionary saving motive for the near end of life and/or strong bequest motives.

In the following three subsections, we use a sufficient statistics approach to assess the welfare effects based on recent work by Auclert (2019); Greenwald et al. (2022); Fagereng et al. (2022). This approach allows us to gauge the welfare effects of a decrease in real rates on the cross-section of Japanese households. The welfare effect depends on the duration of the household's wealth portfolio versus the duration of the household's excess consumption plan.

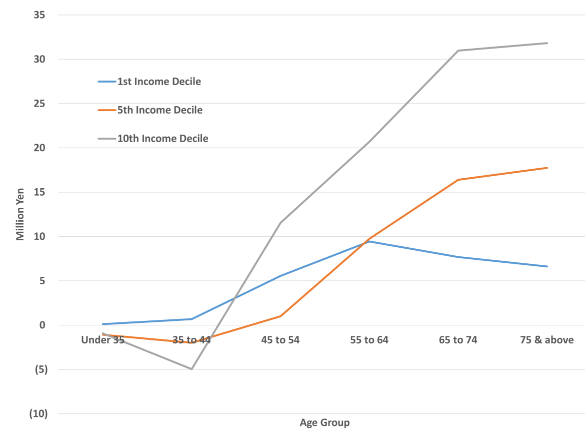
7.3 Duration Mismatch and Household Spending

We first consider the implications of a permanent decline in interest rates on households' consumption possibility set. Consider a household who lives from age 0 to age J and is given a stream of income denoted by $\{y_s\}_{s=0}^{J}$. By iterating forward on the flow household budget constraint, the net asset position of a household at age j, denoted by θ_j, can be expressed as the present value of future excess consumption, which is defined as the consumption minus income plan $\{c_s - y_s\}_{s=j}^{J}$:

Figure 6: Household Net Wealth



(a) Housing Asset



(b) Net Financial Asset

Source: National Survey of Family Income, Consumption and Wealth 2019 Report: Table 7-81.

$$\theta_j = \sum_{s=j}^{J} R^{s-j}(c_s - y_s), \tag{14}$$

which together with Proposition 6.1 implies that the effect of a decline in rates on the household's spending possibility set depends on the duration of its net asset holding as well as the duration of its future excess consumption plans. For notation, let D^θ to be the duration of the household's portfolio of financial assets, and let D^{c-y} be the duration of the household's excess consumption claim. We have the following corollary:

Corollary 2. *The effect of real rate declines on the household's consumption possibility set depends on the relative duration of its net wealth and excess consumption (Greenwald et al., 2022):*

(a) If $D^\theta > D^{c-y}$ then the household's consumption possibilities expand when the interest rate falls,

(b) if $D^\theta < D^{c-y}$ the household's consumption possibilities contract.

Whether changes in interest rates expand or contract a household's consumption possibilities depends on how that duration compares to the duration of that household's lifetime excess consumption. While financial wealth is always equal to the present value of future excess consumption by the budget identity (14), the two can be differentially exposed to the same interest rate shock, much like a bank with a maturity mismatch of assets and liabilities. As a result, even if a household gains financial wealth from a decline in rates, it can still see its consumption possibilities contract if the present value of its pre-shock excess consumption plan rises by more than its financial wealth. Intuitively, a decline in interest rates increases the cost of a given consumption plan. Thus, if the value of the household's human and financial wealth has not risen sufficiently at the same time, its former consumption plan may no longer be affordable.

The young will typically have a high duration of excess consumption, because their retirement consumption accrues in the further distant future. Of course, this depends on the replacement ratio of the pensions provided by the Japanese governments. These pensions are included in our definition of y.

7.4 Measuring Duration Mismatch in the Cross-section of Households

We then measure the duration mismatch in the cross-sectional data of households. The employed income data represents pre-tax income net of interest and dividends and is adjusted to include social security taxes for younger cohorts and social security payments for older cohorts.

Given the empirical observation that households do not downsize their housing for consumption purposes, we exclude housing-related consumption and imputed rent when computing the excess consumption duration. Similarly, for the asset duration calculation, housing-related assets, such as mortgages and house values, are excluded. Moreover, the end-of-life net financial assets are included in the end-of-life consumption to account for strong bequest and/or precautionary saving motives. Finally, we assume that the data observed represents outcomes from a stationary economy. Namely, the consumption and income profiles observed in the data are considered to be the expected consumption and income profiles over the life cycle.

According to the analysis in Subsection 6.2, the average durations of stocks and bonds are 76 years and 7 years, respectively. In contrast, the durations of demand and time deposits are relatively short, at 0 and 1 year, respectively. As a result, the determination of asset duration among households critically depends on their participation in the securities market. Therefore, for the welfare analysis, it is crucial to classify households according to their asset market participation. We consider three types of households, described below.

The first type of household does not hold any securities other than deposits. These are referred to as non-participants. The second type holds all types of financial assets observed in the data and is referred to as participants. The third type of household does not hold any financial assets and is hence referred to as hand-to-mouth households. Table 6 indicates that the percentages of hand-to-mouth households and participants are 10% and 23% of total households, respectively. The majority of households, 67%, are non-participants.

Table 7 reports the asset durations for participants and non-participants across age groups for the 1st, 5th, and 10th income deciles. Other income deciles exhibit similar patterns. As expected, participation in the securities market is the key determinant of asset duration among households. The asset durations of participants are at least an order of magnitude higher than those of non-participants, conditional on income and age. Additionally, the asset durations of non-participants remain low regardless of income and age, as their assets are predominantly held in demand deposits, which have zero duration, or in time deposits, which have a one-year duration.

Our welfare analysis excludes hand-to-mouth households since, by construction, both their asset duration and excess consumption duration are zero. Consequently, interest rate changes do not affect the welfare of hand-to-mouth households.

Table 7: Household Asset Duration across Income and Age

Non-Participants

	Age Group					
Income Decile	under 35	35 to 44	45 to 54	55 to 64	64 to 74	75& above
1st	-1.6	0.1	0.4	0.5	0.6	0.6
5th	0.2	0.3	0.4	0.5	0.6	0.6
10th	0.1	0.0	0.4	0.5	0.5	0.5

Participants

	Age Group					
Income Decile	under 35	35 to 44	45 to 54	55 to 64	64 to 74	75 & above
1st	25.2	15.3	43.5	33.4	23.0	19.6
5th	15.3	12.3	12.8	26.7	25.9	24.9
10th	17.2	23.2	26.0	27.9	25.7	28.1

Units: Years. Source: National Survey of Family Income, Consumption and Wealth 2019 Report and Authors' Calculation.

We then turn to the excess consumption duration. The results are reported in Table 8 for participants and non-participants across age groups and three income deciles. The excess consumption durations of participants are higher than that of non-participants after controlling for incomes and ages while the duration gap of excess consumption between these two type of households is much smaller than the gap of asset duration. As a result, the non-participants are exposed heavily to downside risks of interest rates and participants are the opposite. In short, by comparing the durations of asset and excess consumption among different types of households (as shown in Tables 7 and 8), we conclude that the non-participants, which are the majority of households, are exposed heavily to the downside risks of interest rates since their asset durations are far less than their excess consumption duration. Finally, the fraction of participants is increasing in income and age and hence our duration analysis implies that the younger and lower-income households have a larger exposure to the downside risks of interest rates. Instead, the higher-income and more senior households tend to have enough asset duration to hedge against lower interest rate risk.

7.5 The Welfare Impact of a 1% Decline in the Interest Rate

To further link the consumption possibility set with the welfare of households, we rely on the Euler equation derived from a household utility maximization problem. We then define a money-metric measure of welfare gain for a household at age j:

$$\textit{Welfare gain} = \sum_{s=j}^{J} \beta^{s-j} \frac{u_{c,s}}{u_{c,j}} dc_s$$

where β is the utility discount rate and $u_{c,s}$ denotes the marginal utility of consumption at period s. With the household Euler equation in hand, we can further state the welfare effect of changing the real rate:

Proposition 7.1. *In response to the change in rates, the welfare gain for a household can be approximated by the following equation (Greenwald et al., 2022; Fagereng et al., 2022):*

$$\textit{Welfare gain} \approx \left(D^{c-y} - D^{\theta}\right) \times \theta \times d\log R, \tag{15}$$

which depends on the net duration between excess consumption and net asset as well as the level of asset, θ.

Proof. Please refer to Appendix A.7 □

We are now ready to measure the welfare costs of financial repression. Consider a scenario where the interest rate declines permanently by 100 bps. By using Proposition 7.1, or equation (15), Table 9 shows the estimated welfare costs (as percentage of households' current wealth) for participants and non-participants across income and age groups. A decline of 100 bps in the real rate induces significant welfare losses for non-participants, especially among younger households. For age groups between 35 to 64, the welfare cost of non-participants ranges from 5% to more than 10% of their wealth except for the highest income decile.

The case of participants is quite different. These households have a considerable amount of duration in their portfolio. For almost all income and age groups, participants experience a large welfare gain (negative in cost) especially among senior households older than 55. Their welfare gain of 1% reduction in the real rate is above or well above 15% of their wealth even for the lower-income households. For participants younger than 55, the welfare gain is significantly reduced for middle-income groups. In short, the financial repression induces a high welfare cost to non-participants, who are the majority of households (67% of total households). At the same time, it also benefits participants, who tend to have much higher income and wealth, tremendously. The welfare effects of financial repression are then regressive.

Table 8: Household Excess Consumption Durations across Income and Age

Non-Participants

	Age Group					
Income Decile	under 35	35 to 44	45 to 54	55 to 64	64 to 74	75 & above
1st	7.0	7.3	6.2	6.0	5.0	0
5th	0.2	0.3	0.4	0.5	0.6	0
10th	0.1	0.0	0.4	0.5	0.5	0

Participants

	Age Group					
Income Decile	under 35	35 to 44	45 to 54	55 to 64	64 to 74	75 & above
1st	10.4	10.6	9.0	7.8	5.8	0
5th	14.3	13.3	11.8	9.2	5.7	0
10th	12.4	12.4	11.1	9.2	5.7	0

Source: National Survey of Family Income, Consumption and Wealth 2019 Report and Authors' Calculation.

Table 9: Welfare Cost of 1% Decline in R across Income and Age

Non-Participants

	Age Group					
Income Decile	under 35	35 to 44	45 to 54	55 to 64	64 to 74	75 & above
1st	8.7	7.3	5.9	5.5	4.4	-0.6
5th	9.1	8.5	7.8	6.4	4.1	-0.6
10th	7.2	7.9	6.9	6.3	4.1	-0.5

Participants

	Age Group					
Income Decile	under 35	35 to 44	45 to 54	55 to 64	64 to 74	75& above
1st	-14.8	-4.8	-34.8	-25.7	-17.4	-19.8
5th	-1.0	1.0	-1.1	-17.7	-20.3	-25.1
10th	-4.8	-10.8	-15.0	-18.9	-20.1	-28.3

Units: Years. Source: National Survey of Family Income, Consumption and Wealth 2019 Report and Authors' Calculation.

8 Conclusion

By consolidating the balance sheet of the Japanese government and the Bank of Japan, we document that the Japanese government has engineered a massive duration and currency mismatch on its balance sheet. By absorbing currency and interest rate risk, the government has earned significant excess returns on its risky investments that exceed 6% of GDP. This additional income helps to explain why the Japanese government can sustain a high amount of debt, more than 200% of GDP, and run consistent fiscal deficits. However, in order to do this, the government has to resort to low-rate polices and/or financial repression. When we consider a counterfactual scenario without quantitative easing and with full hedging of currency risk, these excess returns are gone.

Due to the large duration mismatch, Japanese government's fiscal capacity is greatly boosted by a lower real rates. On the household side, the duration mismatch is quite heterogeneous. The more financially sophisticated households who hold a significant amount of long-duration assets benefit from a lower interest rate, while the less financial sophisticated ones suffer a large welfare loss. Since sophisticated households tend to be older and income richer and the unsophisticated ones tend to be younger and income poorer, our welfare analysis indicates that a low-interest-rate policy induces a regressive distribution effect between high- and low-income households as well as an inter-generational transfer from young to old.

Japan is at the forefront of the demographic transition. In fact, an aging society, secular decline in growth, and high debt-to-GDP are common themes either already faced or about to happen among many countries. Our study cautions that low rate policies might expand the government's fiscal space at the expense of a large welfare loss.

The Japanese government has made risk-free promises to pensioners and to bondholders, but these promises are backed by risky tax revenue and risky investments. This risk mismatch is not apparent, because the bond portfolio, the promises to pensioners, have not been fully marked to market exactly because of financial repression.

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A Appendix

A.1 Proof of Proposition 4.1

Dividing the flow government budget constraint by Y_t leads to

$$\begin{aligned}\frac{D_t}{Y_t} &= \frac{G_t - T_t}{Y_t} + R_t^D \frac{D_{t-1}}{Y_{t-1}} \frac{Y_{t-1}}{Y_t} \\ &= \frac{G_t - T_t}{Y_t} + \frac{R_t^D}{X_t} \frac{D_{t-1}}{Y_{t-1}}\end{aligned}$$

Then keep iterating the above equation backward until period 0 gives the equation listed in Proposition 4.1.

A.2 Proof of Proposition 4.2

The flow government budget constraint can be written as

$$ND_t = G_t - T_t - A_{t-1}(R_t^A - R_t^D) + R_t^D ND_{t-1},$$

which divided by Y_t leads to

$$\begin{aligned}\frac{ND_t}{Y_t} &= \frac{G_t - T_t}{Y_t} - \frac{A_{t-1}}{Y_{t-1}} \frac{Y_{t-1}}{Y_t}(R_t^A - R_t^D) + R_t^D \frac{ND_{t-1}}{Y_{t-1}} \frac{Y_{t-1}}{Y_t} \\ &= \frac{G_t - T_t}{Y_t} - \frac{A_{t-1}}{Y_{t-1}} \frac{R_t^A - R_t^D}{X_t} + \frac{R_t^D}{X_t} \frac{ND_{t-1}}{Y_{t-1}}\end{aligned}$$

Then keep iterating the above equation backward until period 0 gives the equation listed in Proposition 4.2.

A.3 Consolidated Balance Sheet Return Calculation

A.3.1 Benchmark Calculation

The consolidated balance sheet returns are calculated at a quarterly frequency. The data range spans from the last quarter of 1997 to the last quarter of 2023. This choice of data range is motivated by the consistent and significant fiscal deficit of the Japanese general government starting in 1998. The composition of financial assets and liabilities is directly obtained from Japan's Flow of Funds.

On the asset side, data can be classified into the following major types of financial instruments: deposits, loans, and foreign securities. In the Flow of Funds data, we know part of the foreign security is held by public pension funds and the rest is mostly held by central government in the form of foreign reserves. To further classify the portfolio of foreign securities held by public pension funds, we refer to the quarterly reports of the GPIF (Government Pension Investment Fund), the major public pension fund in Japan. According to GPIF reports, foreign securities can be decomposed into two subcategories: foreign equities and foreign bonds. The portfolio share of equities out of total foreign investment has been fixed at 50% since 2020 and varied between 50% and 64% from 2013 to 2020. We assume that the portfolio share prior to 2013 was the same as that in 2013, which is 56%.

The following return data are assigned to the categories of assets listed above: interest on reserves at the BoJ for deposits, interest on bank reserves for loans made by FILP and the BoJ, the return on the BofA (Bank of America) ICE Japan Government Bond Index for loans (other than those made by FILP and the BoJ), the return on the BofA 10-Year US Treasury Index for foreign reserves, the return on the MSCI Japan Index for domestic equities, the return on the MSCI World Index (excluding Japan) for foreign equities, and the return on the FTSE World Government Bond Index (excluding Japan) for foreign bonds.

The liability side of the consolidated balance sheet includes the following major types of financial instruments: cash, T-bills, government bonds, bank reserves, loans, FILP deposits, and BoJ external debt. The following returns are used: zero for cash, T-bill returns for T-bills, loans, and FILP deposits, interest on reserves at the BoJ for reserves and BoJ external debt, and the return on the BofA ICE Japan Government Bond Index for government bonds.

The choice of returns significantly affects the estimate of the balance sheet return spread. We discuss this in greater detail below.

First, to the best of our knowledge, the portfolio data for Japan's foreign reserves are not publicly available. The return on foreign reserves is chosen based on two observations. First, data from the Treasury International Capital (TIC) System shows that most of Japan's holdings of US Treasury debt are long-term. For instance, in January 2023, Japan held approximately $1.1 trillion in US Treasury securities but only $72 billion in T-bills. Additionally, the average maturity of foreign official holdings of US long-term debt between 2015 and 2022 is around 8.5 years (see *Foreign Portfolio Holdings of U.S. Securities*, 2023, Page 24). Accordingly, we set the return on the 10-Year US Treasury Index as the return on foreign reserves.

Second, throughout our sample period, a significant portion of loans was issued by FILP, the BoJ, and the general government. The GDP share of these loans varies not only across different government entities but also over time. We discuss these separately below. Doi and Hoshi (2003) documented that the performance of FILP loans was poor and could result in significant losses prior to FILP's reform. Given the opacity of FILP's accounts, it is challenging to evaluate the actual return on its loans. Thus, we conservatively set its rate of return equal to the interest on reserves for all years. Similarly, the BoJ's recent annual income statements indicate that its loans earn an interest rate close to the interest rate on bank reserves, which is almost zero. Hence, we also set the return on BoJ loans to the reserve interest rate. Finally, we assume that all other loans earn a rate equivalent to that of Japanese government bonds.

Finally, investments made by public pension funds play an increasingly significant role in the portfolio of the consolidated balance sheet. In the next subsection, we compare our choice of returns for domestic bonds, domestic equities, foreign bonds, and foreign equities to those reported by the GPIF.

A.3.2 Compared to GPIF Returns

This subsection verifies the accuracy of our return choices by comparing them to GPIF asset returns, which are available for four major categories of assets: domestic bonds, domestic equities, foreign bonds, and foreign equities. As shown in Figure 7, our chosen returns align closely with those reported by the GPIF.

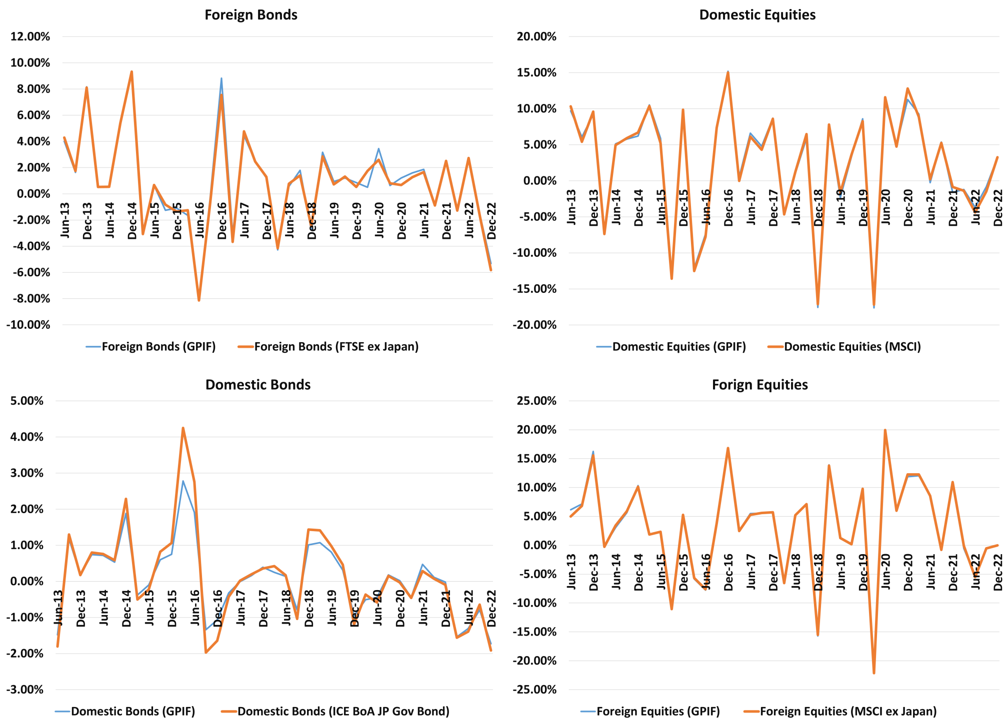
Additionally, Table 11 reports the nominal returns for domestic equities, domestic bonds, foreign equities, and foreign bonds in Japanese Yen (JPY). The top panel presents equity returns for Japan and the ROW (rest of the world) in JPY, as well as the differences between them. Over the entire sample, there is a 5.2% spread in equity returns between ROW and Japan.

The bottom panel reports bond returns for Japan and the ROW in JPY, as well as the differences between them. Over the entire sample, there is a 3.2% spread in returns between ROW and Japanese government bonds.

A.3.3 Compared to Reconciliation Returns

In addition, Japan's national account reports the flow, valuation, and stock, of financial assets and liabilities for central government, local government, and social security fund. The valuation or so-called reconciliation term is calculated in order to bring the balance sheet to its market value. Under this mark-to-market principle, the reconciliation is defined as the difference between the

Figure 7: Comparison to GPIF Returns



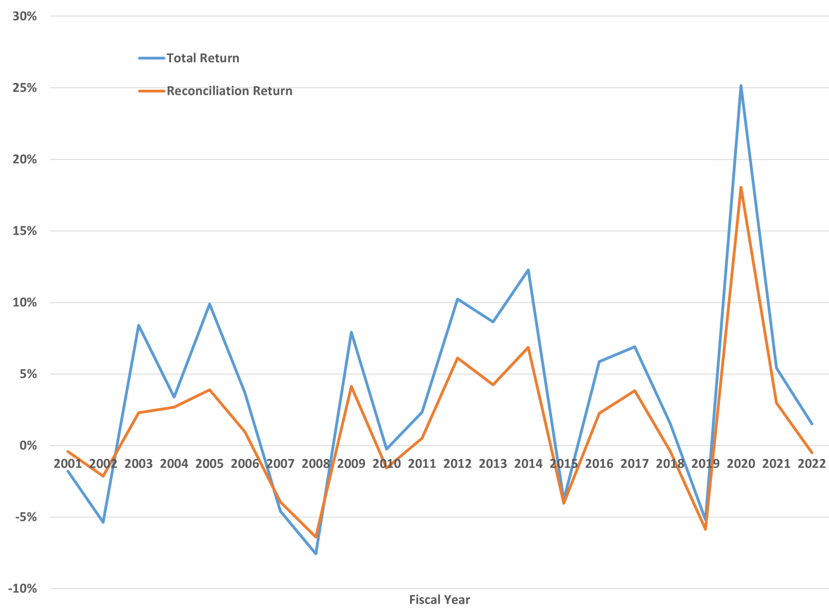
Source: Bloomberg, Annual Reports of GPIF and Authors' Calculation.

change of stock value subtracting out the financial transaction flow during the period.[25] Hence, the price return of assets and liabilities of the Japanese general government can be calculated from the reconciliation terms directly. However, by its definition, the reconciliation returns only include capital gains and losses and exclude coupon payments and dividend payments. Therefore, reconciliation return is not a complete measure of total return on the balance sheet and tends to be lower than total return. Table 10 reports the reconciliation returns for the general government using the Japan National Account data. The average excess reconciliation return between 1997 to 2022 is 1.71%, which is still quite significant even without including the dividends and coupon payments. We view this as additional evidence that the Japanese general government does earn a significant return spread on its balance sheet.

Finally, as an additional check, we can compare the reconciliation return of the social security funds and the total return reported from GPIF. The comparison is shown in Figure 8, which offers two observations. First, the total return and reconciliation co-move with each other closely reflecting capital gains and losses. Second, the total return tends to be higher than the reconciliation return since the latter misses dividend and coupon payments. The average return gap between

[25]For example, see chapter 2.3 of *Guide to Japan's Flow of Funds Accounts* (2023)

Figure 8: Comparison of Returns in Public Pension Funds



Source: Table 6.2 of Japan National Account Annual Reports, Annual Reports of GPIF and Authors' Calculation.

2001 and 2022 is 2.32%. This comparison provides direct evidence that the reconciliation return does miss the coupon and dividend payments by construction.

Table 10: Reconciliation Returns of General Government

	Assets	Liabilities	Difference
1997-2022	1.68%	-0.03%	1.71%
1997-2012	1.14%	0.02%	1.13%
2013-2022	2.19%	-0.38%	2.57%

Source: Table 6.2 of Japan National Account Annual Reports and Authors' Calculation.

A.4 Risk Premium Equivalence

The derivation of equation (3) is a straightforward extension from Jiang et al. (2024). Denote Q_t as the nominal dividends of government financial assets and denote M as pricing kernel. $P_t^S \equiv \mathbf{E}_t\left[\sum_{j=0}^{\infty} M_{t,t+j} S_{t+j}\right]$ to denote the price of surplus claim. The government also holds asset, $A_t = \mathbf{E}_t\left[\sum_{j=0}^{\infty} M_{t,t+j} Q_{t+j}\right]$. The present value of government budget constraint is at period $t+1$: $D_{t+1} = P_{t+1}^S + A_{t+1}$. Dividing the budget constraint equation by $D_t - S_t - Q_t$ gives

$$\frac{D_{t+1}}{D_t - S_t - Q_t} = \frac{P_{t+1}^S}{D_t - S_t - Q_t} + \frac{A_{t+1}}{D_t - S_t - Q_t}.$$

Then we have the following return equation:

$$\frac{D_{t+1}}{D_t - S_t - Q_t} = \frac{P_t^S - S_t}{D_t - S_t - Q_t} \frac{P_{t+1}^S}{P_t^S - S_t} + \frac{A_t - Q_t}{D_t - S_t - Q_t} \frac{A_{t+1}}{A_t - Q_t},$$

which can be rewritten as

$$\mathbf{E}_t \left[R_{t+1}^D \right] = \frac{P_t^S - S_t}{D_t - S_t - Q_t} \mathbf{E}_t \left[R_{t+1}^S \right] + \frac{A_t - Q_t}{D_t - S_t - D_t} \mathbf{E}_t \left[R_{t+1}^A \right],$$

where the returns are defined as: $R_{t+1}^D \equiv \frac{D_{t+1}}{D_t - S_t - Q_t}$, $R_{t+1}^S \equiv \frac{P_{t+1}^S}{P_t^S - S_t}$, and $R_{t+1}^A \equiv \frac{A_{t+1}}{A_t - Q_t}$. Using $D_t = P_t^S + A_t$, we then can rewrite the equation above as

$$\begin{aligned}
\mathbf{E}_t \left[R_{t+1}^D - R_t^f \right] &= \frac{P_t^S - S_t}{D_t - S_t - Q_t} \mathbf{E}_t \left[R_{t+1}^S - R_t^f \right] + \frac{A_t - Q_t}{D_t - S_t - Q_t} \mathbf{E}_t \left[R_{t+1}^A - R_t^f \right] \\
&= \left(1 - \frac{A_t - Q_t}{D_t - S_t - Q_t} \right) \mathbf{E}_t \left[R_{t+1}^S - R_t^f \right] + \frac{A_t - Q_t}{D_t - S_t - Q_t} \mathbf{E}_t \left[R_{t+1}^A - R_t^f \right] \\
&\approx \left(1 - \frac{A_t}{D_t} \right) \mathbf{E}_t \left[R_{t+1}^S - R_t^f \right] + \frac{A_t}{D_t} \mathbf{E}_t \left[R_{t+1}^A - R_t^f \right],
\end{aligned}$$

which is the equation (3).

A.5 An Alternative Measure of Return Wedge

We provide an alternative measure of return wedge assuming the expected return of each asset in 2023 is its past average return during our sample period (1997 to 2023). Table 12 reports the asset and liability positions of each type of financial instrument in 2023 as well as their returns in sample average.

The 2023 assets to debt ratio of the consolidated government is 0.66. Table 12 reports the weighted asset and liability returns are 3.17% and 0.63% respectively. By keeping the same assumption that return on the surplus claim is equal to the return of GDP claim, which can be approximated by the unlevered return of domestic equity claim. The 2023 unlevered ratio is about 0.45. Then we can quantify the return wedge in 2023 by the following equation below:

$$\begin{aligned}
\omega_t^{Alt} &\approx \mathbb{E}_t R_{t+1}^D - \left(1 - \frac{A_t}{D_t} \right) \mathbb{E}_t R_{t+1}^Y - \frac{A_t}{D_t} \mathbb{E}_t R_{t+1}^A \\
&= 0.64\% - (1 - 0.66) \times 0.45 \times 5.1\% - 0.66 \times 3.17\% \\
&= -2.23\%.
\end{aligned}$$

This alternative calculation gives an even larger return wedge compared to our main-text case at

Table 11: Equity and Bond Returns in Japanese Yen

Nominal Equity Returns

Country	JP	ROW	ROW-JP
1997-2023	5.4%	10.5%	5.2%
1997-2012	0.2%	7.1%	6.9%
2013-2023	12.9%	15.6%	2.7%

Nominal Bond Returns

Country	JP	ROW	ROW-JP
1997-2023	1.6%	4.9%	3.2%
1997-2012	2.4%	4.8%	2.5%
2013-2023	0.7%	4.9%	4.2%

Source: Bloomberg and Authors' Calculation. Note: ROW refers to the rest of the world, while ROW-JP represents the return differences between the rest of the world and Japan.

Table 12: 2023 Balance Sheet Portfolio and Average Past Returns

Assets	% of GDP in 2023	Average Past Return
Deposits	18.01%	0.08%
Loans	60.76%	0.05%
Equities	38.71%	5.37%
Foreign Reserve	31.97%	5.11%
Foreign Securities held by PPFs	24.63%	6.73%
Weighted Asset Return	**5.41**%	**3.17**%
Liabilities	% of GDP in 2023	Average Past Return
Currency	21.67%	0%
Bank Reserves	91.07%	0.08%
T-Bills	22.93%	0.05%
Gov Bonds	84.75%	1.69%
Loans	36.02%	0.05%
Deposits FILF	1.55%	0.08%
BoJ External Debt	7.48%	0.08%
Weighted Liability Return	**1.53**%	**0.64**%
Net Asset Return	**3.89**%	**2.53**%

Source: Japan Flow of Fund, Bloomberg and Authors' Calculation.

-1.82%.

A.6 Proof of Proposition 6.1

The proof is straightforward by taking derivative of $\ln Z_t$ on $\ln R$. First, rewrite $\ln Z_t$ as

$$\ln Z_t = \ln \left\{ \sum_{s=t}^{\infty} \exp\left((s-t) \times \ln R\right) z_s \right\},$$

and then take the partial derivative:

$$\begin{aligned} \frac{\partial \ln Z_t}{\partial \ln R} &= \left\{ \sum_{s=t}^{\infty} \exp\left((s-t) \times \ln R\right) z_s \right\}^{-1} \left\{ \sum_{s=t}^{\infty} (s-t) \exp\left((s-t) \times \ln R\right) z_t \right\} \\ &= -\frac{\sum_{s=t}^{\infty} R^{s-t} z_s \times (s-t)}{Z_t}, \end{aligned}$$

which is the definition of D.

A.7 Proof of Proposition 7.1

Consider a maximization problem of a household at age j with asset θ :

$$V_j = \max_{\{c_s\}_{s=j}^{J}} \sum_{s=j}^{J} \beta^{s-j} u(c_s)$$

subject to

$$\theta - \sum_{s=j}^{J} R^{-s} (c_s - y_s) \geq 0$$

The Lagrangian associated with the household problem is

$$\mathcal{L}_j = \sum_{s=j}^{J} \beta^{s-j} u(c_s) + \lambda \left(\theta - \sum_{s=j}^{J} R^{j-s} (c_s - y_s) \right),$$

and the first order condition with respect to c_s is

$$\beta^{s-j} u_{c,s} = \lambda R^{j-s} \text{ for all } s = j, .., J.$$

The Envelop condition together with the first order condition with respect to c_j imply that

$$\frac{dV_j}{d\ln R} = \frac{d\mathcal{L}_j}{d\ln R} = u_{c,j}\left(\frac{d\theta}{d\ln R} - \frac{d\left(\sum_{s=j}^{J} R^{-s}(c_s - y_s)\right)}{d\ln R}\right).$$

From Proposition 6.1 and binding budget constraint $\theta = \sum_{s=j}^{J} R^{-s}(c_s - y_s)$, we know that

$$\frac{d\theta}{d\ln R} = -D^{\theta}\theta$$

and that

$$\frac{d\left(\sum_{s=j}^{J} R^{-s}(c_s - y_s)\right)}{d\ln R} = -D^{c-y}\left(\sum_{s=0}^{J} R^{-s}(c_s - y_s)\right) = -D^{c-y}\theta.$$

Then we have:

$$\frac{dV_j}{d\ln R} = u_{c,j}\left(D^{c-y} - D^{\theta}\right)\theta. \tag{16}$$

Hence, the welfare gain of a change in interest rate can be approximated by

$$\begin{aligned}\text{Welfare Gain} &= \sum_{s=j}^{J} \beta^{s-j}\frac{u_{c,s}\mathrm{d}c_s}{u_{c,j}} \\ &= \frac{dV_j}{u_{c,j}} \simeq \left(D^{c-y} - D^{\theta}\right) \times \theta \times d\ln R,\end{aligned}$$

where the last equality utilizes equation (16).

A.8 Additional Table and Figures

Table 13: Fiscal Deficit of General Government

Periods	Primary Deficit	Total Deficit
1998-2023	5.1%	5.8%
1998-2012	5.9%	6.8%
2013-2023	4.1%	4.5%
1998-2023 Cumulative	**133.0%**	**151.1%**

Source: National Accounts of Japan Annual Report Supporting Table 6-2. The total deficit is defined as the total revenue minus the sum of total expense and net acquisition of non-financial assets. The primary deficit is the total deficit excluding property income and interest expense.

Table 14: Japan Central and Local Government Balance Sheet

% of GDP, year End	1997	2012	2023
Assets			
Deposits	4.7%	6.8%	16.2%
Loans	5.1%	5.7%	3.1%
Equities	7.7%	19.2%	19.9%
Foreign Securities	5.2%	20.9%	29.9%
Other Assets	2.1%	2.2%	4.4%
FILF Deposits	2.1%	3.2%	0.9%
Sum	**27.0%**	**58.1%**	**74.5%**
Liabilities			
Loans	22.0%	32.0%	25.5%
Bonds and T-Bills	67.0%	179.4%	200.3%
Other Liabilities	3.6%	5.5%	6.6%
Sum	**92.6%**	**216.9%**	**232.5%**
Net Liabilities	**65.7%**	**158.8%**	**158.0%**

Unit: % of GDP. Source: Japan Flow of Funds and National Accounts of Japan

Table 15: Japan Public Pension Fund Balance Sheet

% of GDP, year End	1997	2012	2023
Assets			
Deposits	1.0%	1.4%	2.5%
Bonds and T-Bills	2.4%	16.0%	10.0%
Equities	2.4%	4.4%	12.3%
Foreign Securities	1.3%	7.0%	24.6%
Other Assets	6.0%	8.7%	5.7%
FILF Deposits	26.9%	4.3%	3.1%
Sum	**39.9%**	**41.8%**	**58.2%**
Liabilities			
Loans and Other Liabilities	3.9%	3.6%	3.1%
Net Liabilities	**36.0%**	**38.3%**	**55.1%**

Unit: % of GDP. Source: Japan Flow of Funds and National Accounts of Japan

Table 16: Japan Public Finance Institution Balance Sheet

% of GDP, year End	1997	2012	2023
Assets			
Deposits	0.3%	0.6%	1.6%
Loans	92.2%	50.1%	40.3%
Bonds and T-Bills	13.3%	0.0%	0.0%
Other Assets	1.0%	0.5%	1.1%
Sum	**106.8%**	**51.2%**	**43.0%**
Liabilities			
Loans	26.9%	12.7%	9.5%
FILF Deposits	75.4%	8.7%	5.5%
Bonds and T-Bills	0.0%	22.1%	15.4%
Domestic Securities	0.0%	4.2%	6.0%
Equities	-0.5%	3.4%	4.2%
Other Liabilities	0.9%	0.4%	0.7%
Sum	**102.7%**	**51.5%**	**41.3%**
Net Assets	**4.1%**	**-0.3%**	**1.7%**

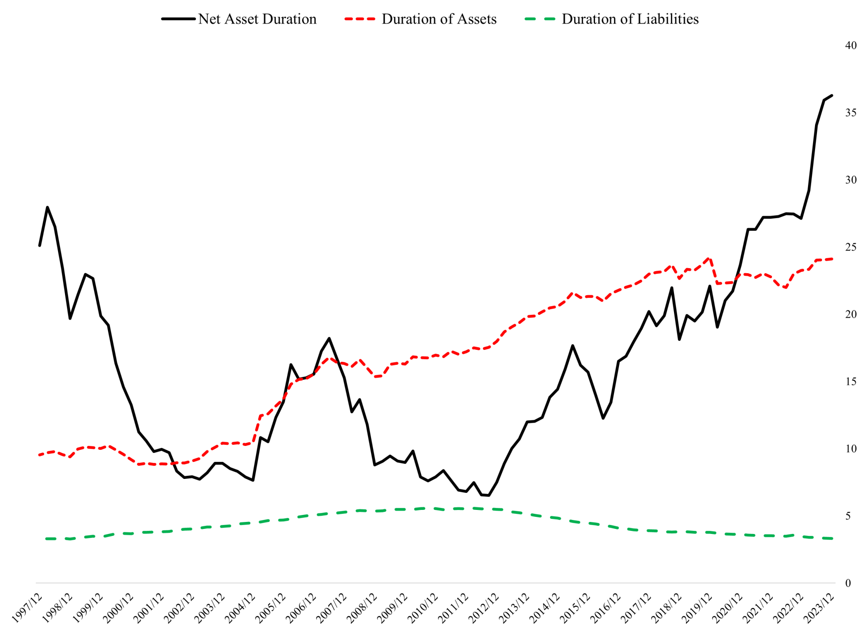
Unit: % of GDP. Source: Japan Flow of Funds and National Accounts of Japan

Table 17: Alternative No-QE Counterfactual (300 bps case)

	Return Rate			Net Return
	(1)	(2)	(3)	(4)
Periods	Liabilities	Assets	Difference	% of GDP
1998-2023	1.65%	2.59%	0.94%	-0.13%
1998-2012	1.07%	0.89%	-0.18%	-0.96%
2013-2023	2.44%	5.04%	2.60%	1.01%

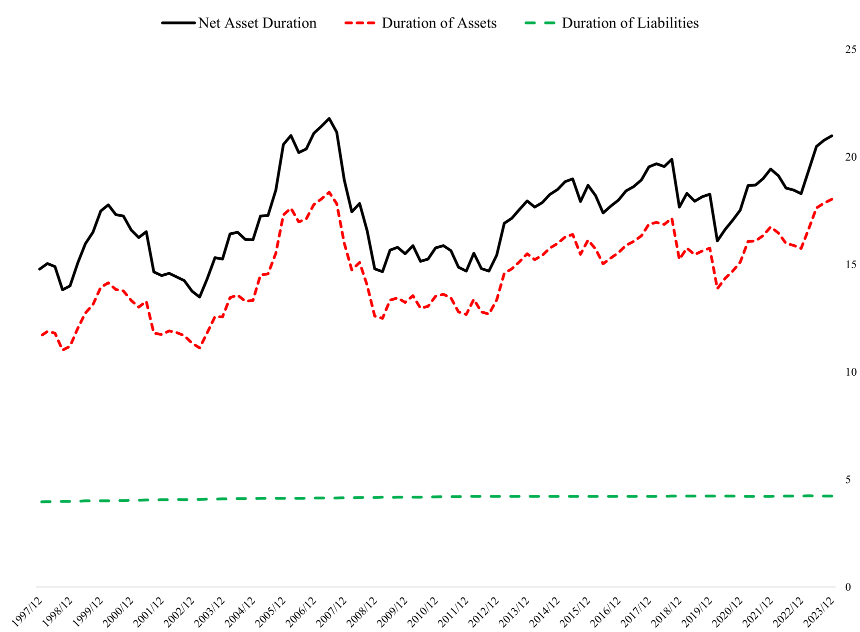
This table displays the return of the consolidated balance sheet under a counterfactual scenario where the JGB return increases by 300 basis points after 2012. Note: Column (1) reports returns on the liabilities. Column (2) reports the returns on the assets. Column (3) reports the difference between (1) and (2). Column (4) reports the net return as % of GDP, weighted by the size of assets and liabilities.

Figure 9: Duration of Japanese Government's Balance Sheet



Source: Jorda-Schularick-Taylor Macro-history database, Japan flow of funds and authors' calculation.

Figure 10: Duration of Japanese Household's Balance Sheet



Source: Jorda-Schularick-Taylor Macro-history database, Japan flow of funds and authors' calculation.