NBER WORKING PAPER SERIES

WHAT ABOUT JAPAN?

Yi-Li Chien
Harold L. Cole
Hanno Lustig

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

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

We would like to thank Manuel Amador, Ben Hebert, Arvind Krishnamurthy, Peter DeMarzo, Bengt Holmstrom, Jonathan Payne and other participants of the Stanford Finance lunch, St. Louis Fed Brown-Bag seminar, Academia Sinica seminar, GRIPS seminar, and the SITE session on fiscal sustainability. 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.

What about Japan?
Yi-Li Chien, Harold L. Cole, and Hanno Lustig
NBER Working Paper No. 31850
November 2023
JEL No. E63,F30

ABSTRACT

As a result of the BoJ's large-scale asset purchases, the consolidated Japanese government borrows mostly at the floating rate from households and invests in longer-duration risky assets to earn an extra 3% of GDP. We quantify the impact of Japan's low-rate policies on its government and households. Because of the duration mismatch on the government balance sheet, the government's fiscal space expands when real rates decline, allowing the government to keep its promises to older Japanese 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 tax younger, poorer and less financially sophisticated households.

Yi-Li Chien
Research Division
Federal Reserve Bank of St. Louis
P.O. Box 442
St. Louis, MO 63166-0442
yilichien@gmail.com

Harold L. Cole
Economics Department
University of Pennsylvania
3718 Locust Walk
160 McNeil Building
Philadelphia, PA 19104
and NBER
colehl@sas.upenn.edu

Hanno Lustig
Stanford Graduate School of Business
655 Knight Way
Stanford, CA 94305
and NBER
hlustig@stanford.edu

1 Introduction

In many developed countries the population is currently aging and shrinking. As the rate of economic growth declines, these countries confront the prospect of sustained deficits. Japan has been at the leading edge of this development. Japan's central government runs large deficits mostly driven by a secular increase in social security spending as a result of Japan's aging population.

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). In spite of its low interest rates, Japan is not in the fiscal goldilocks region. Since 1997, the real return on Japanese government debt has exceeded the growth rate by 1.2%. The local and central government's debt has grown from 93% in 1997 to more than 241% of GDP (gross domestic product) in 2021.[1]

By consolidating the government with the Bank of Japan, we show that Japan's government has engineered a sizeable duration mismatch on its consolidated balance sheet. The government 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. As a result of the duration mismatch, the government's fiscal space expands significantly as real rates decline. All else equal, the Japanese government can increase spending as rates decline, but a typical Japanese household will have to cut spending, because it does not have enough duration in its portfolio. Conversely, when rates increase, the Japanese government's fiscal capacity is quickly eroded.

To manage this fiscal challenge, the public sector in Japan has deployed a levered investment technology that households and financial intermediaries cannot deploy. Through the public pension funds, the public sector takes on large quantities of unhedged duration risk and currency risk. The Japanese government implements a sizeable carry trade, and it earns high realized asset returns while its borrowing rates decline. Japan's government has realized an ex post excess return of about 2.13% per annum above its funding cost by going long in long-duration risky assets, financed with mostly short-duration funding in the form of bank reserves, T-bills and bonds. This investment strategy has allowed the government to earn more than 3% of GDP from its risky investments. As a result, the net debt, liabilities minus assets, of the entire public sector has only grown from 49% to 117% over the same period.

From an ex ante perspective, the government's investment strategy delivers excess returns above its funding costs only if the expected return on its debt does not fully reflect the riskiness of its investments. As the government invests in riskier assets, the required return on government debt should increase commensurately unless government surpluses absorb this extra risk by becoming safer (Jiang et al., 2019a, 2020). We find no evidence of this, as this would entail cutting

[1] The government debt includes T-bills, government bonds and loans

payouts to pensioners and/or raising taxes in bad times.[2] If the Japanese government is engaged in financial repression, then government debt may be overpriced. To quantify the effect of financial repression, we conservatively assume that government surpluses as a fraction of GDP are a-cyclical, and we infer a financial repression wedge of -1.96% for Japanese government debt, implying that the government debt return should be at least 1.96% higher. This wedge is ultimately a tax on depositors.

First, we discuss the interest rate risk exposure on the government balance sheet. The Japanese government has engineered a sizable duration mismatch on its consolidated balance sheet. Japan's government engages in risky maturity transformation on a large scale by borrowing at floating rates and investing in long-duration assets. At the end of 2021, the consolidated government, including the central and local governments, the FILF (fiscal investment and loan fund), the pension fund, and the BoJ (Bank of Japan), had liabilities of more than 3 times GDP. Almost 1/2 have no duration: 101% of GDP in reserves held at BoJ, another 23% of GDP in cash. Finally, there is another 144% in Bonds and T-bills. QE (quantitative easing) has added a floating-for fixed interest rate swap of 1 GDP to the government's balance sheet, further shortening the duration of the Japanese government's liabilities. On the other hand, the government's risky assets, totaling around 200% of GDP, have much higher duration. The Japanese government invests one-third of GDP in domestic equities, more than half of GDP in foreign securities including equities and another 14% in domestic bonds.

To be fully hedged against interest rates, the duration of its 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 long duration.[3]

Second, we analyze currency risk. The consolidated government sector in Japan is engaged in a global currency carry trade, borrowing at the short rate in Yen, a typical carry trade funding currency, and investing more than 50% of GDP in risky foreign assets, without hedging currency risk. The currency exposure adds to the duration risk, because the Yen depreciates in real terms when the Japanese long rate declines if long-run U.I.P holds. The financial sector in Japan cannot replicate this currency carry trade, because financial intermediaries need to hedge currency risk. The CIP (covered interest parity) deviations reduce the currency-hedged returns earned by Japanese investors abroad (Du et al., 2018a), effectively taxing currency-hedged capital outflows. The fi-

[2]There is a risk mismatch because the government is backing risk-free promises to bondholders and safe promises to pensioners with risky cash flows from its tax revenue and its increasingly risky investments.

[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.

nancial sector in Japan starts with a large Yen depositor base, which they seek to deploy abroad to earn higher returns. This creates demand for synthetic borrowing in dollars, which increases the synthetic dollar rate above the cash dollar rate (Borio et al., 2016). Between 2011 and 2023, the negative spread of CIP deviation is especially large, which can be viewed as direct evidence of financial repression due to the QE and YCC policies of BoJ.

If the main 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 explore the welfare consequences of the lower real rates for Japanese household, many of which have little duration in their holdings of financial assets. The Japanese government is set to benefit from lower real rates, but most households are not. The stand-in Japanese household's balance sheet does not have enough duration on its balance sheet.

As a result of quantitative easing, the consolidated Japanese government is borrowing from Japanese households at floating rates: Japanese households have invested around 2 GDP in short-duration bank deposits, but only 38% of GDP in equities and 98% of GDP in private pension and insurance products. On the liability side, the Japanese households have 63% of GDP in loans. Given the low duration of the stand-in Japanese household's wealth, the majority of younger households is 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 consumption 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 transfers wealth from the young, less financially sophisticated to the older, more financially sophisticated Japanese households.

The demographic transition in advanced economies (Auclert et al., 2021), in addition to the

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

slowdown (Eggertsson et al., 2016) and the increase in inequality (Mian et al., 2020), have 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're also a policy outcome favored by governments of countries in transition. Conversely, a rise in real rate would have serious fiscal repercussions.

2 Related Literature

When governments take measures to allow themselves to borrow at below-market rates, this is usually referred to as financial repression (see Reinhart et al., 2011; Chari et al., 2020). During the Great Financial Crisis, 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 Great Financial Crisis, central 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 best 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] We reinterpret the Bank of Japan's large scale asset purchases and yield curve control 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 post bank deposits and pension reserves as a cheap source of funding. We believe our paper is the first to formally measure this financial repression wedge. To do so, we rely on the approach to government debt valuation developed in Jiang et al. (2019a).

Our paper contributes to the literature on fiscal sustainability in low rate environments (see 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, Japan 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). The Japanese government is levering up, not unlike underfunded pension funds in the U.S who gamble for resurrection (see Myers, 2018; Giesecke et al., 2022; Giesecke and Rauh,

[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, moral suasion used to increase domestic bank holdings of government bonds (see Acharya and Steffen, 2015; De Marco and Macchiavelli, 2016; Ongena et al., 2019, for examples from Europe during the GFC). Chari et al. (2020) derive conditions under which forcing banks to hold government debt may be optimal, because it acts as a commitment device.

2022). In the long run, the Japanese low-rate approach is not sustainable. 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.

We make contact with the growing literature on 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 deviations as a tool of financial repression.

We argue that the Japanese government is engaged in a massive global currency carry trade by borrowing at below-market rates in 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).[6] However, since the GFC, 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 (2019a)'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 discuss the example events of financial repression in the past few decades. We then consolidate the balance sheet of Japanese central government with local government, central bank, government-owned banks (FILF) and social security. Section 4 describes the dynamics of the debt-to-output ratio of the Japanese government

[6]This finding is consistent with long-run U.I.P.

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 expand the fiscal capacity government greatly. Section 7 analyzes the household balance sheet. We measure interest rate risk exposure on households' balance sheet and analyze the welfare consequences of low rate policies for the Japanese households. Section 8 concludes our study.

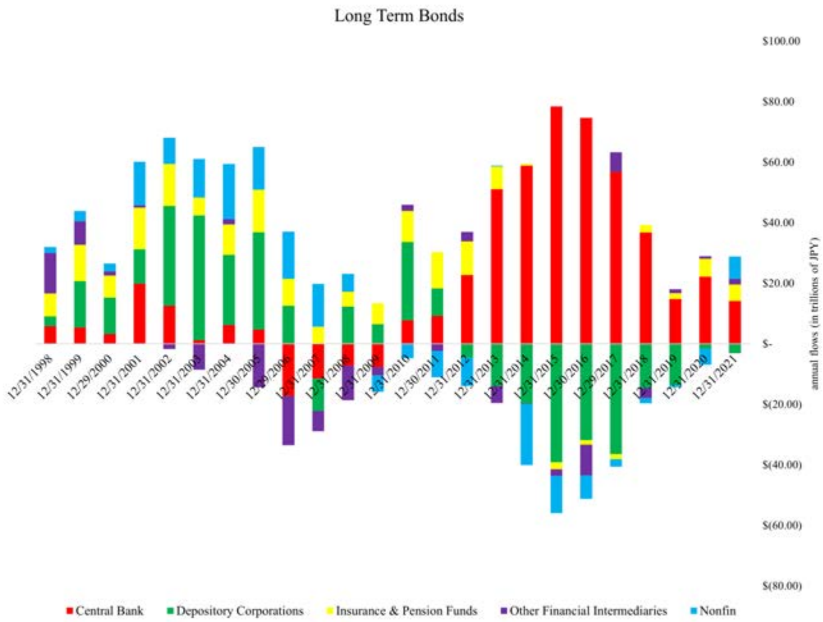
3 The Japanese Government's Carry Trade

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, US-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 Japan Post, the postal savings bank as well as the pension reserves were required to fully fund Japan's FILP, the Fiscal Investment and Loan Program, a large government-run lending program. Its loan portfolio exceeded 100% of GDP in 2001. During the 80s and 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 bank and the pension reserves. Instead, the FILP started to tap the bond market directly.

After the capital markets liberalization, the Japanese government effectively replaced the cheap funding it had obtained through the postal savings bank prior to the capital markets liberalization with bank reserves held at the Bank of Japan. Japan had been stuck in a low-growth regime since the mid-1990s. 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 and 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

Figure 1: Annual purchases of Japanese government Bonds (excluding T-bills)



Source: Japan's Flow of Funds.

assumption was that the banks would deploy these reserves in lending to firms and households.[7] Since 2012, the BoJ has stepped up its large-scale asset purchases as part of the Abenomics ambitious government spending program.

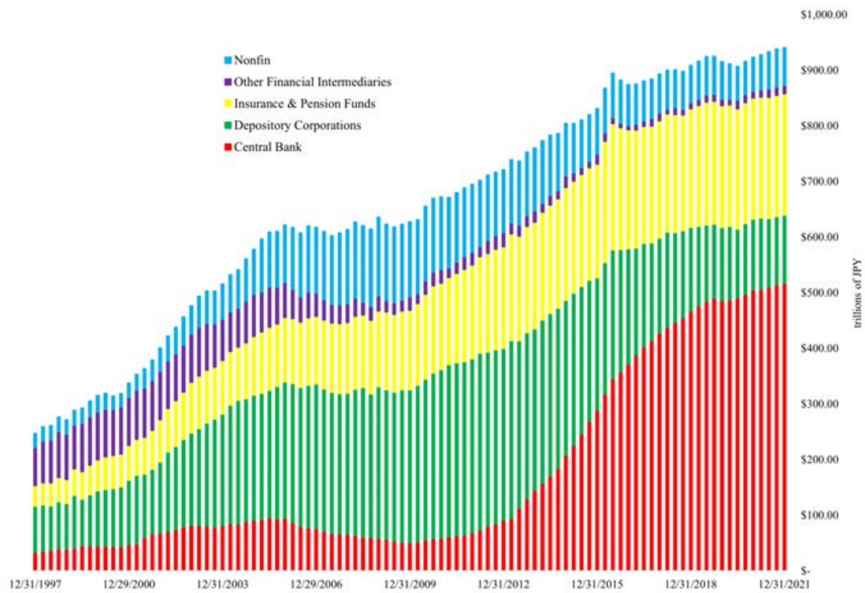
In 2016, the BoJ shifted to a policy of explicit yield curve control (YCC). The BoJ capped long-term yields explicitly. It set a target for the 10-year yield at zero percent. The BoJ was ready to purchase the necessary bonds to implement this cap, effectively putting a floor on the price of bonds.[8] 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 2021, the BoJ owned well over 500 trillion Yen in government bonds (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 FILF, and the general government which includes the central government, the local government and the public pension funds.

[7]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).

[8]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.

3.1 Consolidating the Government Balance Sheet

In 2021, the consolidated government invested 101 % of GDP in risky securities, while borrowing 311% of GDP. The consolidated government, shown in Table 1, takes a long position of 54% of GDP in foreign securities and 33% of GDP in domestic equities. To fund its operations the consolidated government issues T-bills and bonds (144% of GDP) as well as bank reserves (102% of GDP).

Table 2 shows the balance sheet of the BoJ, which has purchased about 1 GDP of bonds and issued reserves. The BoJ has entered into an interest rate swap, paying floating on bank reserves and receiving fixed on the bonds it has purchased. The underlying notional is 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 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. These risky long positions (including domestic bonds and equity as well as foreign securities), shown in the General Government balance sheet in Table 3 have grown from 24% of GDP in 1997 to 98% of GDP in 2021. In 2013, a government panel recommended a major realloca-

Table 1: Consolidated Government Balance Sheet

December 1997			
Assets		Liabilities	
Currency and Deposits	6.00%	Currency	10.77%
Domestic Loans	102.83%	Bank Reserves	0.73%
Other Domestic Securities	11.15%	Bonds & T-Bills	50.43%
Domestic Equities	13.85%	Loans	52.10%
Foreign Securities	6.75%	Deposits FILF	75.43%
Sum	140.57%	Sum	189.46%
		Net Debt	48.89%

December 2021			
Assets		Liabilities	
Currency and Deposits	19.28%	Currency	23.01%
Domestic Loans	73.37%	Bank Reserves	101.57%
Other Domestic Securities	14.00%	Bonds & T-Bills	143.94%
Domestic Equities	33.20%	Loans	38.06%
Foreign Securities	53.94%	Deposits FILF	4.61%
Sum	193.78%	Sum	311.19%
		Net Debt	117.41%

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

tion into risky assets for all of the government-run pension funds (Hoshi and Yasuda, 2015).[9] The government has increased its exposure to equities by 260%, and it has increased its exposure to foreign risky assets eightfold.

Figure 3 shows the quarterly evolution on the liability side of the consolidated balance sheet from 1997 to 2021. The evolution of government funding exactly reflects the phases of financial repression discussed in the beginning of this section. In 1997, around 75% of GDP in funding came from deposits with the FILP through the postal bank and the public pension reserves. As this source of funding gradually dried up in the wake of the 2001 reform, the Japanese government issued more Japanese government bonds and other fix income securities instead, but eventually, after 2012, 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 100% of GDP.

[9]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.

Table 2: BoJ Balance Sheet

December 1997			
Assets		**Liabilities**	
Currency and Deposits	0.00%	Currency	10.77%
Domestic Loans	4.16%	Bank Reserves	0.73%
Bonds & T-Bills	9.58%		
December 2021			
Assets		**Liabilities**	
Currency and Deposits	0.50%	Currency	23.01%
Domestic Loans	26.67%	Bank Reserves	101.57%
Bonds & T-Bills	97.94%		

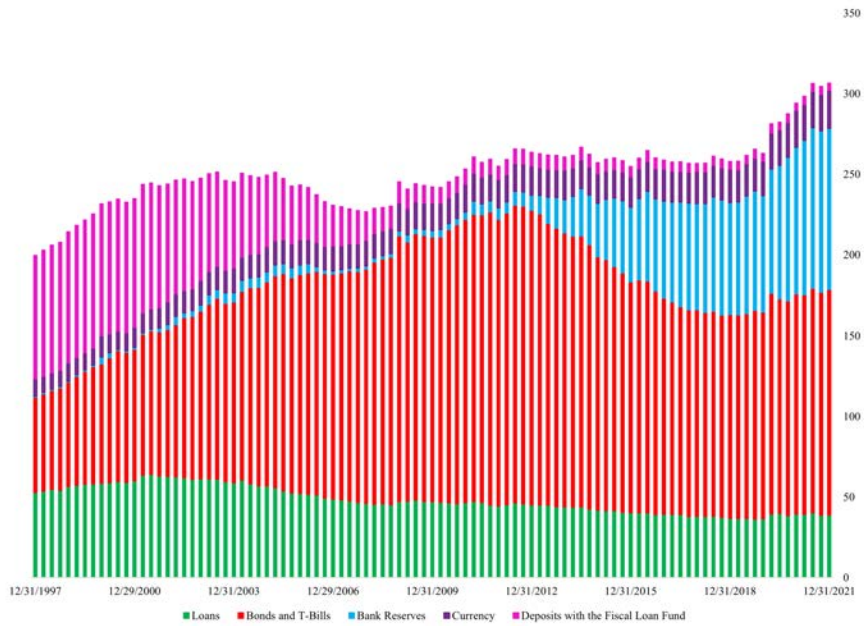
Unit: % of GDP. Source: Japan's Flow of Funds.

Table 3: General Government Balance Sheet

December 1997			
Assets		**Liabilities**	
Currency and Deposits	5.68%	Loans	25.22%
Domestic Loans	6.48%	Bonds & T-Bills	67.80%
Other Domestic Securities	5.70%		
Domestic Equities	11.65%		
Foreign Securities	6.75%		
December 2021			
Assets		**Liabilities**	
Currency and Deposits	17.24%	Loans	27.13%
Domestic Loans	3.40%	Bonds & T-Bills	213.77%
Other Domestic Securities	13.75%		
Domestic Equities	30.28%		
Foreign Securities	53.94%		

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

Figure 3: Liabilities of the Consolidated Japanese Government Balance Sheet



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

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 3.26% 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 static central government budget constraint,

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

where R_t denotes the gross return on the entire portfolio of marketable debt D_t. By iterating backwards, we obtain the following expression for the debt-to-output ratio. 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 $R_{t-j,t}$, past nominal growth $X_{t-j,t}$, as well as past primary deficit/output ratios $\frac{G_{t-j}-T_{t-j}}{Y_{t-j}}$:*

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

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

High deficits, high returns, and low nominal output growth in the past all contribute to a high debt-to-output ratio today.[10] We start by considering a deterministic environment. If the real growth rate of the economy, denoted by x, is higher than the bond returns, denoted by r, then the debt-to-output ratio will not explode even when the government runs permanent deficits. When the $r < x$, the government can roll over its debt in perpetuity and run steady-state deficits ($G > T$) with a constant debt/GDP ratio:

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

Recently, Blanchard (2019); 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 $r < x$, 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 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 $r < x$ region described by Blanchard (2019) and Mehrotra and Sergeyev (2021). Bond returns were low, but GDP growth was even lower. Table 4 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^n) and nominal GDP growth rates (x^n). Between 1997 and 2022, the average nominal growth rate and the average nominal inflation rate were close to zero. The average nominal return on Japanese bonds and T-bills is 1.32% per annum. The middle panel reports real returns. The real return on the portfolio of Japanese bonds and T-bills is 1.12% per annum, much higher than the real growth rate of -0.13% per annum. The bottom panel shows the gap between

[10] 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.

real returns real growth. Over the whole sample, this $r - x$ gap was 1.26%. The gap decreased from 2.30% in the 2000-2009 to 0.73% between 2010 and 2019, as real bond returns decreased while real growth increased.

Table 4: Bond Returns, Inflation and Growth

	x^n	π	r^n
1997-2022	0.07%	0.20%	1.32%
2000-2009	-0.63%	-0.22%	1.67%
2010-2019	0.96%	0.57%	1.69%
2020-2022	-0.14%	0.27%	-1.93%
	$x = x^n - \pi$		$r = r^n - \pi$
1997-2022	-0.13%		1.12%
2000-2009	-0.40%		1.90%
2010-2019	0.39%		1.11%
2020-2022	-0.41%		-2.20%
			$r - x$
1997-2022			1.26%
2000-2009			2.30%
2010-2019			0.73%
2020-2022			-1.79%

Source: Bond Returns are from BofA Ice Japan Government Bond Index Fund (excluding T-bills). Nominal GDP growth and CPI inflation from Cabinet Office of Japan. Top Panel reports nominal returns, inflation and nominal growth. Middle panel reports real return and real growth. The bottom panel reports the gap between real returns and real growth.

4.2 Consolidated Government Debt Dynamics Accounting

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

$$G_t - T_t + D_{t-1}R_t^D - A_{t-1}R_t^A = D_t - A_t \equiv ND_t \tag{3}$$

where R_t^A denotes the gross return on the portfolio of assets. 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 $R_{t-j,t}$, past nominal growth X_{t-j}, as well as past primary deficit/output ratios $\frac{G_{t-j}-T_{t-j}}{Y_{t-j}}$, as well as* *past cumulative excess returns between R_t^A and R_t:*

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

where $R_{0,t}^A = \prod_{k=1}^{t} R_k^A$. The net debt-to-output ratio depends on past cumulative government bond returns, past cumulative growth rates and past excess returns on the assets.

The above proportion then implies that even if the growth rate is lower than the rate of return, $r > x$, and the government is running deficits, the consolidated government's net debt may be 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/GDP ratio provided that the returns on its asset position r^A as well as asset position itself A are both large enough:

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

Table 5 reports the past returns on the Japanese government's consolidated balance sheet over our sample periods. The consolidated Japanese government earns an excess return of 2.13% per annum on its risky long position above the cost of its funding position. This average excess return has increased since 2000. The average return on the asset position of the consolidated balance sheet is 2.87%. The average return on the liability position is 0.74%. By taking on risks, the government earns a spread of 2.13% on its consolidated balance sheet.[11] The size of the balance sheet in 2021 is 194% of GDP in asset and 311% in liability. (see Table 1). As a result, the government earns an additional 3.26% ($= 1.94 \times 2.87\% - 3.11 \times 0.74\%$) of GDP on its risky asset position. The Japanese government therefore can generate positive steady-state fiscal capacity.

The government expenditure excluding interest payment and social security payment is around 15% of GDP in 2021. The net social security and welfare payment is around 8.5% of GDP. Total tax revenue is around 20% of GDP in 2019. Therefore, the average fiscal surplus required to fulfill government spending without increasing tax burden is around 3.5% of GDP. This simple accounting exercise indicates that the current financial leverage as well as tax policy chosen by the Japanese government is likely to balance its budget even in the long run. This could be a possible explanation that why there is no debt crisis nor inflation even if its debt-to-output ratio exceeds 200% of GDP.

Table 5 indicates that the spreads really started to increase during the period 2010 to 2019. This is the time when the BoJ resumed its large scale asset purchases in 2010 on a much larger scale, essentially crowding out private investors, as shown in Figure 1. This is also the time when the

[11] Please refer to Appendix A.1 for more details on the calculation of the consolidated balance sheet returns reported on Table 5

public pension funds started to reduce its government bond holdings and increase the foreign risky asset positions. Between 2000 and 2009, the spread was only 53 bps. It increased to 3.66% in the next decade, after the start of large scale asset purchases.

Table 5: Returns on Consolidated Balance Sheet

	Liabilities		Assets	
	Government	Consolidated	Consolidated	Difference
	(1)	(2)	(3)	(4)
1997-2022	1.32%	0.74%	2.87%	2.13%
2000-2009	1.67%	0.88%	1.41%	0.53%
2010-2019	1.69%	1.08%	4.74%	3.66%
2020-2022	-1.93%	-0.91%	1.07%	1.97%

See Appendix A.1 for details.

5 Financial Repression

To earn this 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. As the government takes on more risk, this risk should be reflected in the pricing of debt, unless the government renders the tax revenue safer or the transfer spending riskier.

Since 2010, the BoJ has been purchasing a significant fraction of the issuance of bonds. Since 2014, the BoJ has been buying more than the total issuance, completely crowding out private investors who have been net sellers. 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 levers up.

We find evidence that the risk is not priced into debt. The debt may be overpriced. Financial repression was common in advanced economies prior to the 1980s. The history of government debt financing is partly a history of financial repression.[12]

[12] 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); Acalin and Ball (2022), these measures played a key role in reducing the debt/GDP ratio after WW-II.

5.1 Mispricing of Government Bonds

To see this idea more clearly, we start by analyzing the case in which the debt is priced accurately. We use P_t^T to denote the cum-dividend price of the tax claim and P_t^G to denote the price of the spending claim. If the TVC (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: $P_t^T - P_t^G + A_t = D_t$. Moreover, governments cannot make risk disappear. The government debt portfolio's expected excess return is the expected return on a portfolio that goes long in the tax claim and short in the spending claim, and long in the risky assets A, given by (see Jiang et al., 2019b, for a full derivation):

$$\mathbb{E}_t\left[R_{t+1}^D - R_t^f\right] = \frac{P_t^T - T_t}{D_t}\mathbb{E}_t\left[R_{t+1}^T - R_t^f\right] - \frac{P_t^G - G_t}{D_t}\mathbb{E}_t\left[R_{t+1}^G - R_t^f\right] + \frac{A_t}{D_t}\mathbb{E}_t\left[R_{t+1}^A - R_t^f\right].$$

The risk of the tax, spending claims and the asset position have to be reflected in the riskiness of the government debt. Consider the simplest case in which spending and taxes have the same risk. Then the return on the government debt portfolio is given by a weighted average of the risk premium on a claim to surpluses and the risk premium on the risky portfolio:

$$\mathbb{E}_t\left[R_{t+1}^D - R_t^f\right] = (1 - \frac{A_t}{D_t})\mathbb{E}_t\left[R_{t+1}^S - R_t^f\right] + \frac{A_t}{D_t}\mathbb{E}_t\left[R_{t+1}^A - R_t^f\right]. \quad (4)$$

Denote the pricing kernel as: M_{t+1}. 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 sovereign wealth fund and the beta of the surpluses:

$$\beta_t^D = (1 - \frac{A_t}{D_t})\beta_t^S + \frac{A_t}{D_t}\beta_t^A. \quad (5)$$

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 (4), we can obtain an expression for the expected excess return on assets minus liabilities:

$$\mathbb{E}_t\left[R_{t+1}^A - R_{t+1}^D\right] = (1 - \frac{A_t}{D_t})\mathbb{E}_t\left[R_{t+1}^A - R_{t+1}^S\right]. \quad (6)$$

The Japanese government can only deliver a positive expected excess return on its investment strategy 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 2021 asset-to-debt ratio of the consolidated government is $0.62 = \frac{194\%}{311\%}$. The excess return of the consolidated balance sheet is 2.13% according to Table 5. Hence, the implied spread between the sovereign wealth fund and the surplus is

$$\mathbb{E}_t\left[R^A_{t+1} - R^S_{t+1}\right] = \mathbb{E}_t\left[R^A_{t+1} - R^D_{t+1}\right] \times \frac{1}{1-0.62} = \frac{2.13\%}{0.38} = 5.65\%.$$

A 5.65% implied excess return then suggests that, if the debt is priced correctly, then the implied risk premium on the surplus claim is -2.78% (= 2.87% − 5.65%). 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.

5.2 Quantifying Financial Repression

We then consider the possibility that the government debt is mispriced and hence the equation (4) might not holds.

Definition 1. *Given the assumption of constant surplus/output ratios, the financial repression 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:*

$$\omega_t = E_t\left[R^D_{t+1} - R^f_t\right] - \left((1 - \frac{A_t}{D_t})\beta^Y_t + \frac{A_t}{D_t}\beta^A_t\right)\frac{var_t\left(M_{t+1}, R^i_{t+1}\right)}{\mathbb{E}_t(M_{t+1})}. \tag{7}$$

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

The next step is to quantify the financial repression wedge defined in equation (7). First, consider the case that 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:

$$\beta^S_t \quad = \quad -\frac{\frac{A_t}{D_t}}{(1-\frac{A_t}{D_t})}\beta^A_t. \tag{8}$$

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.

$$\beta_t^D = (1 - \frac{A_t}{D_t})\beta_t^Y + \frac{A_t}{D_t}\beta_t^A. \tag{9}$$

Given that surpluses are actually pro-cyclical, this produces a lower bound on the financial repression wedge.

We then quantify the financial repression wedge in 2021 below. In 2022, the unlevered beta of equity in Japan is 0.45. The ratio of assets to debt in 2021 is 0.62 as mentioned earlier.

$$\beta_t^D = (1 - 0.62)0.45\beta_t^E + 0.62\beta_t^A. \tag{10}$$

The current expected excess return on equities in Japan is 5.1%[13] We then calculate the return beta of the asset portfolio in the consolidated balance sheet by the following equation:

$$\beta_t^A = \frac{\mathbb{E}_t\left[R_{t+1}^A - R_t^f\right]}{\mathbb{E}_t\left[R_{t+1}^E - R_t^f\right]} \times \beta_t^E \approx \frac{2.87\% - 0.1\%}{5.1\% - 0.1\%} \times \beta_t^E = 0.55\beta_t^E,$$

where the expected return for the asset portfolio is obtained directly from Table 5 and the risk free return is approximated by the average return of bank reserve in our sample period, which is 0.1%. We end up with an asset beta that is equal to 0.55 of the stock market or levered equity beta.

$$\beta_t^D = (1 - 0.62)0.45\beta_t^E + 0.62 \times 0.55\beta_t^E \approx 0.51\beta_t^E. \tag{11}$$

The implied expected excess return on the government's liabilities would then be equal to 2.6% (5.1% $\times$ 0.51). From Table 5, we then approximate the expected access return of the overall liability as 0.64% (0.74% $-$ 0.1%). Hence, the implied finance repression wedge is 1.96% if we assume that surpluses are expected to be a-cyclical in the future.

$$\omega_t = -2.6\% + 0.64\% = -1.96\%.$$

This back-of-the-envelope calculation suggests that Japanese earns returns that are much too low. In other words, Japanese debt is overpriced. In our view, the overpricing is a result of financial repression. Appendix A.2 uses the past returns to measure this financial repression wedge and find that the wedge is slightly larger at 2.24%. We believe that we are the first one to quantify this financial repression wedge. This wedge is ultimately a tax on depositors and financial intermediaries

[13] see AQR Capital Market Assumptions.

who hold bonds (e.g. insurance companies).

5.3 CIP Deviations as Evidence of Financial Repression

In order to circumvent financial repression at home, the Japanese financial sector could increase returns by investing abroad, but these financial institutions, unlike the government, would be expected or required to hedge their currency risk at least partially. If CIP holds, the hedging cost is exactly equal to the interest rate difference between domestic and foreign assets. The hedging requirement for currency risk imposed on the domestic financial institutions can then effectively reduce their hedged returns on foreign investments. As a result, these hedging requirements enable financial repression by trapping the assets of financial intermediaries in Japan (see, e.g., Setser, 2023).

To make this idea concrete, consider the CIP formula between USD and Japanese Yen. Let S_t denote Yen per dollar. The USD/Yen LIBOR 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:

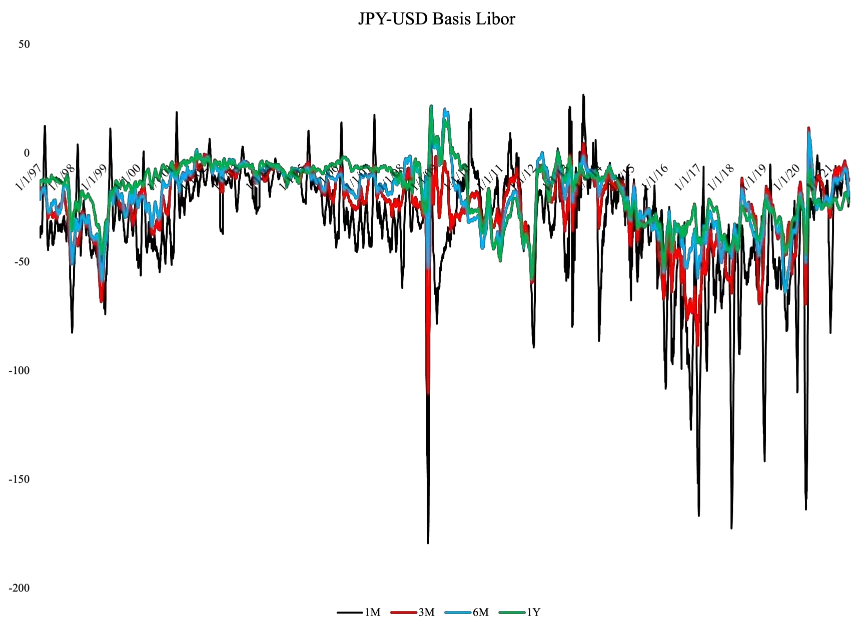
$$x_{t,t+n} = r^{\$,Libor}_{t,t+n} - (r^{Libor}_{t,t+n} - \rho_{t,t+n}),$$

where $\rho_{t,t+n} = (1/n)(f^n_t - s_t)$ denotes the n-period forward premium (in logs) obtained from the forward f^n_t and spot s_t exchange rates. Du et al. (2018b) document large deviations from Covered Interest Rate Parity in LIBOR markets during the crisis. These CIP deviations have not completely disappeared. 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 1M horizon, -31 bps. at the 3M, -28 bps at the 6M, -27 bps at the 12 M. 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 5Y horizon, -57 bps. at the 10Y, -43 bps. at the 20 Y, and -35. at the 30Y.

The large and consistent CIP deviations in the USD/Yen market provide strong evidence in supporting our view that the financial assets are effectively trapped in Japan. The large negative basis in the USD/Yen market, which are determined by the size of international capital flows, reduce the hedged returns on foreign investments even further for the Japanese private financial institutions.

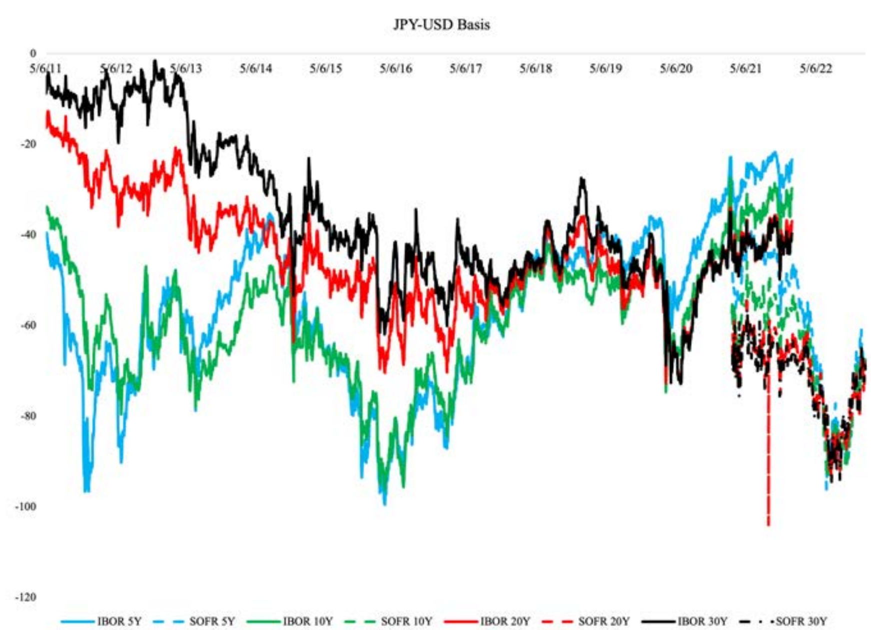
According to the flow of fund data, financial intermediaries in Japan have to intermediate about 3× GDP in bank deposits, insurance and pensions. However, they cannot replicate the government's strategy of foreign investments because of the hedging requirement. When they invest abroad, the Japanese banks have to hedge at least part of the currency risk. The banks have a large Yen depositor base of 2× GDP, and they seek dollar investments abroad to earn higher

Figure 4: LIBOR CIP Deviations



Source: Bloomberg and authors' calculation

Figure 5: LIBOR CIP Deviations –Longer Maturities



Source: Bloomberg and authors' calculation returns. To hedge the currency risk exposure, the banks will demand synthetic dollars, creating upward pressure on the synthetic USD LIBOR rate. This creates downward pressure on the basis. This is a general pattern documented by Du et al. (2018b) . Low interest rate currencies tend to have more negative bases against the USD, as investors seek higher returns abroad.

In addition, the BoJ's Quantitative and Qualitative Monetary Easing (QQE) announcements, starting in 2014, as well as its move to negative policy rates causes a widening of the USD/JPY basis (Borio et al., 2016). As the BoJ further depresses the term premium in Japan, this induces financial intermediaries to seek higher bond returns abroad, thus causing the CIP basis to widen. We view this as direct evidence of financial repression.

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 a 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.4 □

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

$$ND_t = \sum_{s=t}^{\infty} R^{t-s} (T_s - G_s), \tag{12}$$

which simply states that 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.

Equivalently, the effect of real rate declines on the government's spending possibilities set from the depends on the relative of its net financial assets and deficits:

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

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

When the duration of net assets exceeds the duration of the deficits, then a real rate expands fiscal capacity. The capital gain on its net assets exceeds the increase in the NPV of future deficits, and the government has extra fiscal capacity to increase G or reduce T in the future. Or, equivalently, when the duration of its net debt is smaller than the duration of future surpluses, then the resulting increase in the market value of debt is smaller than the increase in the NPV of its future surpluses, thus increasing the government's fiscal capacity. As we are about to show, this turns out to be the empirically relevant case for Japan. 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.[14] 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 1 year (0 years). For foreign securities, we used a weighted average of the duration of bonds and U.S. stocks (59 years). The weights are 50/50.

[14] 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.

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

According to the portfolio reported on Table 1, we can then calculate the duration of the consolidated balance sheet. In 2021, the duration of its risky asset position is around 23 years. The high duration is mostly due to the equity position. The duration of its liabilities is only 3.7 years. The net duration is the weighted average of asset and liability duration. The consolidated government has a negative net financial asset position of about 117% of GDP in 2021, the net result of a debt position of 311% of GDP and an asset position of 193% of GDP. As a result, the smaller asset position contributes more positive duration than the negative duration contributed by its larger debt. This means that the duration of the government's net asset position is positive and large (see Figure 10 in the Appendix). In 2021, the net duration is 29 years, up from 13 years in 2010. 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 29 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 projection of the Japanese Cabinet[15], the combined local and central government is projected to run primary deficits until 2032, the end of the projection range. The projected bond-to-GDP ratio in 2032 is 216%, which is roughly unchanged compared to the 214% bond-to-GDP ratio in 2021 (See table 3).

We assume that the economy is in the steady-state starting in 2032 and the net debt-to-GDP ratio remain unchanged at 117%. If the transversality condition holds, then the net debt position in 2032 is fully backed by surpluses. The government will need to run a steady-state surplus $\frac{S}{Y}$ of 2.11% of GDP:

$$\left(\frac{ND}{Y}\right)_{2032} = pd_Y \times \frac{S}{Y} = \frac{1}{r^Y - g} = \frac{1}{(0.3\% + 2\% - (0.5\%))} \times 2.11\%,$$

where pd_Y denotes the steady-state price/dividend ratio for a claim to GDP, g denotes the steady-state growth rate of the economy, r^Y denotes the discount rate for a claim to GDP.[16] We use a real long-term rate of 0.3% and a GDP risk premium of 2%. When we compute the duration of the entire projected surplus starting in 2022, we end up with a duration of 64 years for the surplus

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

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

claim:

$$D_{2021}^{T-G} \approxeq \frac{\sum_{t=0}^{\infty} R^{-t} t \times (T_{2021+t} - G_{2021+t})}{\sum_{t=0}^{\infty} R^{-t} (T_{2021+t} - G_{2021+t})} = 64.$$

If the government wanted to be fully hedged against interest rates, it would have had to issue zero coupon debt equal to the projected surplus for each maturity. In that case, its debt would have a duration of 64 years. Instead, the government borrows at a much shorter duration. As a result, the increase in the NPV 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 equation above, the PDV of future surpluses, increases by 64% in response to a permanent decrease in real rates of 100 bps. The right hand side decreases by 29%, 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 Japanese government expands significantly. In contrast, a permanent rate increase destroys fiscal capacity.

7 Interest Rate Risk Exposure on the Household Balance Sheet

Through financial repression, we have shown that it is possible for Japanese government to sustain its high debt with fiscal deficits even in the long run. In this section, we study the welfare consequence of the 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 80s (Hoshi and Kashyap (1999)). In 1997, the ratio of deposit-to-GDP was still quite elevated, at 129%. Even then, Japan was an outlier. U.S. households held only deposits worth 42% of GDP (Table 12). 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.

Table 6 compares the Japanese household balance sheet in 2021 to the one in 1997. In 2021, Japanese households held around 200% of GDP in deposits, compared to 40% of GDP in equities. About another 1 GDP are invested in insurance policies and pensions. Household demand deposits are up around 70% of GDP since 1997 despite the nominal deposit rate declining to zero during this period. In sum, 3X GDP of household wealth is intermediated through the banking and insurance sector. In contrast, as reported in Table 12, U.S. households only held currency and deposits, including money market mutual fund shares worth 70% of GDP. U.S households held 191% of GDP in equities, and 35% in debt (Treasuries, corporate bonds etc.).

In spite of the more than doubling of equity holdings as a fraction of GDP between 1997 and 2021, the duration of the Japanese stand-in household's net asset position has not increased significantly. It has hovered between 15 and 20 years. Figure 12 in the Appendix plots the duration of the household balance sheet. This stagnation of the stand-in household's duration is largely driven by the sizeable increase in the ratio of deposits to GDP which largely offsets the effect of the increase in household equity holdings.

Table 6: Japanese Household Balance Sheet

December 1997			
Assets		Liabilities	
Currency and Deposits	127.65%	Loans	64.90%
Other Securities	16.41%		
Equities	15.75%		
Insurance & Pension	63.15%		
December 2021			
Assets		Liabilities	
Currency and Deposits	197.74%	Loans	63.35%
Other Securities	4.64%		
Equities	38.32%		
Insurance & Pension	97.82%		

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

7.2 The Cross-section of Japanese Households

We then turn to the cross-section distribution of Japanese households. Our analysis utilizes the National Survey of Family Income, Consumption and Wealth data conducted in year 2019.[17] This survey data collects consumption, income and assets data for a sizeable number of households around 90,000.

First, for financial assets other than deposits, participation rates by Japanese households are low. Table 7 reports the participation rate for different financial assets for all households as well as across income quartiles. The average participation rate (for all households) of demand deposits and time deposits are 76.3% and 57.3%, respectively. Participation for other financial assets is

[17]The survey results are available at this web site.

more limited. For example, the overall participation rate for direct stock holdings is only 16%. The stock participation rate does increase in 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 stock, bond and open-end trust, 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 7: Asset Market Participation Rates (%) across Income Quartile

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**

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

Second, downsizing homes is not a popular option even among the senior retired Japanese households. Table 8 provides the supporting evidence. In general, the value of housing assets increases in 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 the aged and retired households.

Table 8: Estimated Value of Houses and Residential Land across Age and Income Groups

Income Decile	under 35	35 to 44	45 to 54	55 to 64	64 to 74	75 & above
1st	1,596	6,935	13,638	17,327	14,907	17,687
2nd	1,440	4,324	11,244	16,603	17,145	18,168
3rd	2,484	18,527	9,023	13,973	20,022	20,192
4th	2,818	8,088	17,627	14,611	21,781	21,437
5th	5,555	12,107	15,161	16,516	20,691	25,941
6th	6,139	11,322	17,518	22,256	23,042	28,916
7th	8,179	15,731	16,860	21,101	27,722	39,377
8th	9,035	18,877	19,252	23,404	27,906	40,358
9th	15,631	21,795	22,932	26,697	31,275	50,868
10th	15,858	38,896	34,350	38,960	50,069	71,938

Units: Thousand Yen. Source: National Survey of Family Income, Consumption and Wealth 2019 Report.

Third, the net worth of net financial assets remains large even for the aged households. Table 9 reports the net financial wealth conditional on income. Compared the level of financial asset to the housing value reported in Table 8, the size of their financial asset is not trivial. The average financial wealth to housing wealth ratio reaches 56% for the age group 74 and above. This empirical fact indicates that households have a strong precautionary saving motive for near end of life and/or strong bequest motives.

Table 9: Net Financial Asset for Aged Households across Income Groups

Income Decile	64 to 74	75 and above
1st	7,674	6,620
2nd	10,232	8,912
3rd	13,042	12,266
4th	18,647	15,186
5th	16,394	17,754
6th	17,169	19,165
7th	16,989	19,630
8th	19,489	26,129
9th	21,741	27,130
10th	30,968	31,811

Units: Thousand Yen. Source: National Survey of Family Income 2019 Report.

In the following three subsections, we use a sufficient statistics approach to assess the welfare effects based on recent work by Auclert (2019b); 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 household's 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 $\{c_s - y_s\}_{s=j}^{J}$:

$$\theta_j = \sum_{s=j}^{J} R^{s-j}(c_s - y_s), \tag{13}$$

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 present value of future excess consumption by the budget identity (13), 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 high duration of excess consumption, because they keep consuming when they are retired. Of course, this depends on the replacement ratio of the pensions provided by the Japanese governments. These 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-section of Households in the data. The income data we employed is the pre-tax income net of interests and dividends, which includes the social security taxes for young cohorts and the social security payment for the old cohorts.

Given the empirical observation that households do not downsize their house for consumption, we exclude housing related consumption, imputed rent, as well as housing related assets, mortgage and house, to compute the excess consumption and asset duration. Moreover, the end of life net financial asset is included in the end of life consumption in order to take the strong bequest and/or precautionary saving motives into consideration. In addition, we simply assume that the data observed as an outcome of a stationary economies. Namely, the consumption and income profiles observed in the data are the expected consumption and income profiles over life cycle.

According to the analysis in Subsection 6.2, the average durations of stocks and bonds are 76 and 7 years, respectively. On the other hand, the durations of demand and time deposits are short, 0 and 1 year, respectively. As a result, the determination of asset duration among households critically depends on participation in the security market. Therefore, for the welfare analysis, it is critical to classify the households according to their asset market participation. We consider three types of households described below. The first type of households only holds deposits but does not hold any securities. They are called non-participants. The second type holds all types of financial assets seen in the data. They are called participants. The third type of households does not hold any financial assets and hence are called hand-to-mouth households. Table 7 then directly implies that the percentage of hand-to-mouth households and participants are 10% and 23% of total households. The majority of households are non-participants, which account for 67% of the total population.

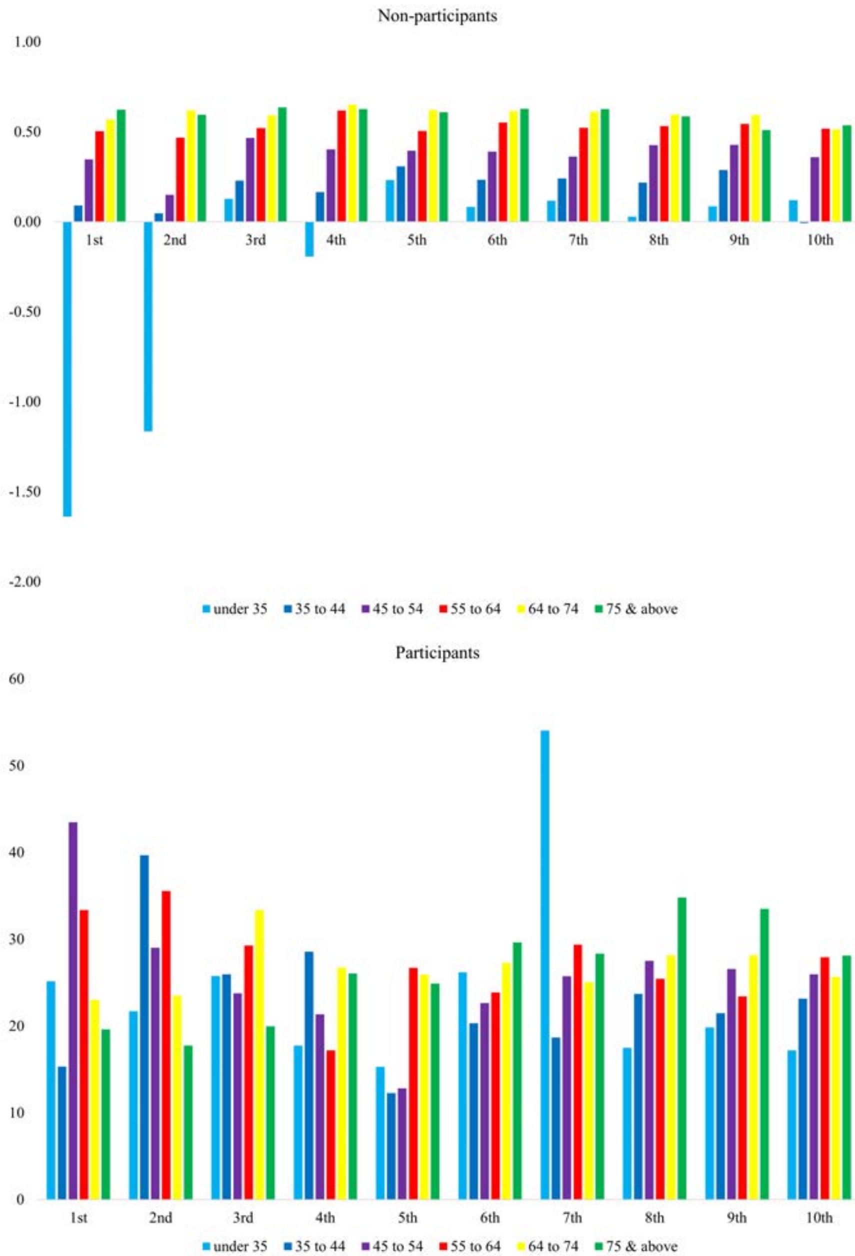
Figure 6 plots the asset duration for participants and non-participants across income and age groups. As we expected, participation in the security market is the key determination of asset duration among households. The asset durations of participants are at least one order of magnitude higher that of non-participants conditional on income and age. In addition, the asset duration of non-participants are low regardless of incomes and ages since their assets are either in demand deposits, which have zero duration, or in time deposits, which have one year duration. Our welfare analysis ignores hand-to-mouth households since both of their asset duration and excess consumption duration must be zero by construction. The interest rate change does not affect the welfare of hand-to-mouth households.

We then turn to the excess consumption duration. Figure 7 plots the excess consumption duration for participants and non-participants across income and age groups. The excess consumption durations of participants are higher than that of non-participants after controlling 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 compared the durations of asset and excess consumption among different type of households as shown in Figure 6 and 7, 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 the 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 to lower interest rate risk.

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

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

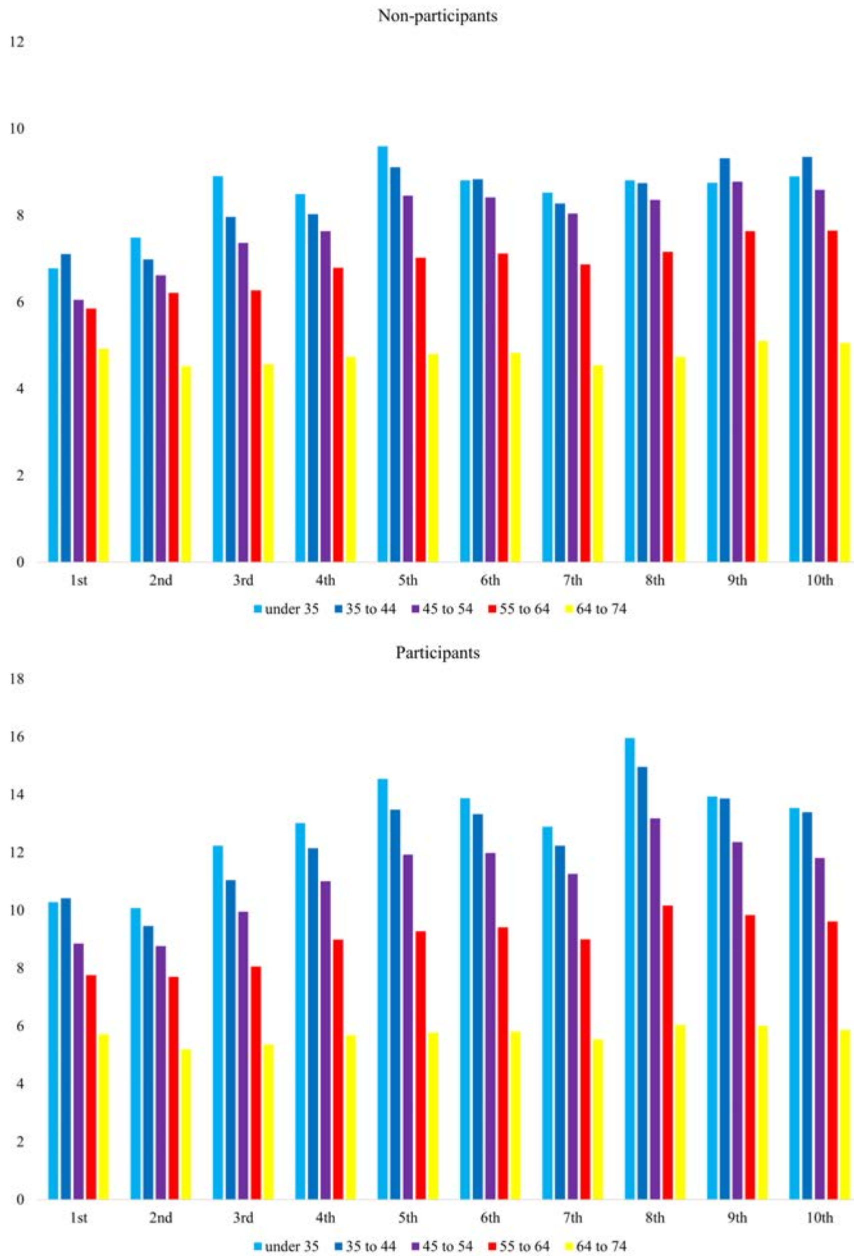
Figure 6: Household Asset Durations across Income and Age



measure of welfare gain for a household at age j:

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

Figure 7: Household Excess Consumption Durations across Income and Age



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 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):*

$$\textit{Welfare gain} \approx \left(D^{c-y} - D^{\theta}\right) \times \theta \times d \log R, \tag{14}$$

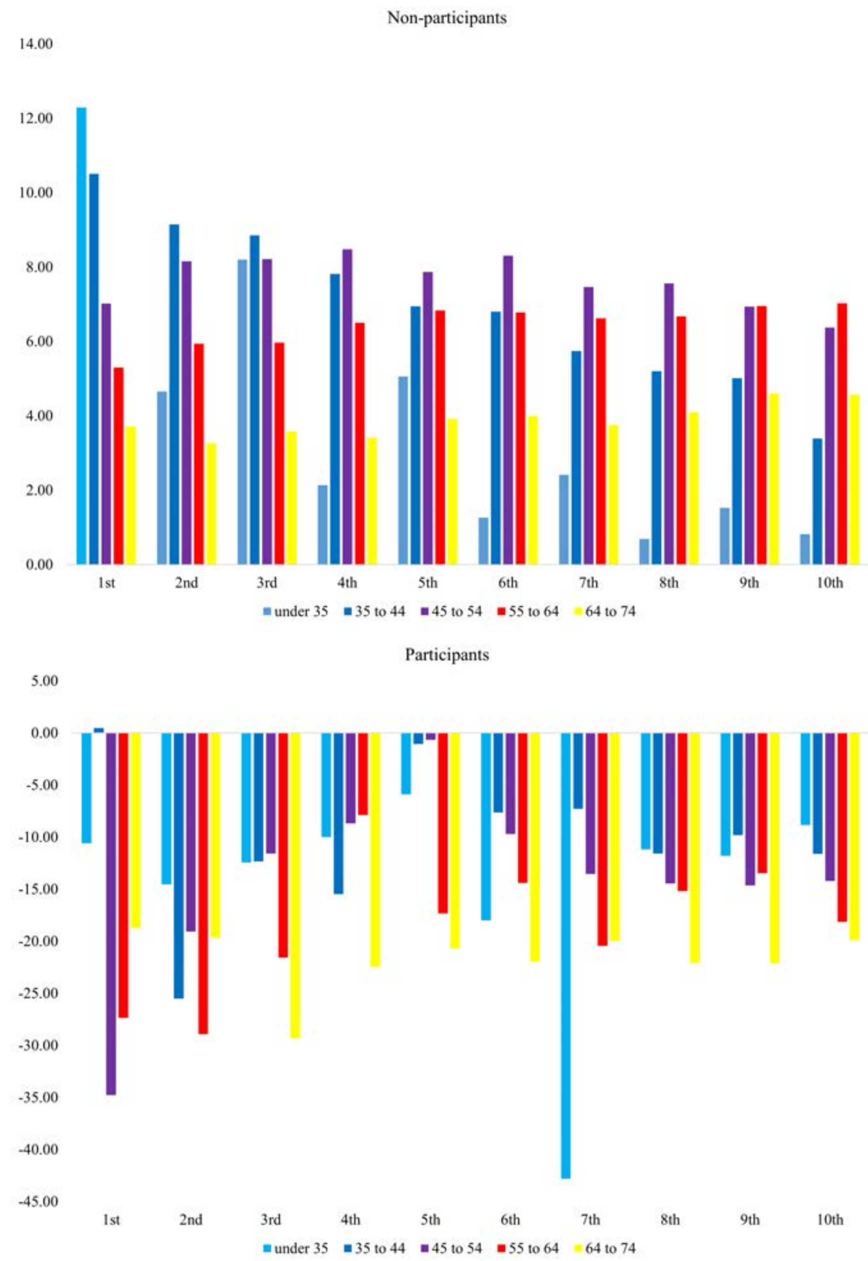
which depends on the net duration between excess consumption and net asset as well as the level of asset, θ.

Proof. Please refer to Appendix A.5 □

We are now ready to measure the welfare costs of financial repression. Consider a scenario where the interest rate decline permanently by 100 bps. By using Proposition 7.1 (or equation (14)), Figure 8 plots 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-participant, especially among younger households. For age groups between 35 to 64, the welfare cost of non-participants range 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 real rate is around or above 15% of their wealth even for the lower income households. For participants aged 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 be higher income and richer, tremendously. The welfare effects of financial repression are then regressive.

Figure 8: Welfare Cost of 1% Decline in R across Income and Age



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 mismatch on its balance sheet. As a result of this duration mismatch, the government has earned significant excess returns that help to explain why the Japanese government can sustain a high amount of debt, more than 200% of GDP, and run consistent fiscal deficits.

In order to do this, the government has to issue overpriced securities. We quantify the size of financial repression, which almost reaches 2%. In other words, without financial repression, the returns of government liability would be 2% higher.

Due to the large duration mismatch, its 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. Given that sophisticated households tend to be older and income richer and that 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 income rich and income poor as well as an intergenerational transfer from young to old.

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

In the long run, the Japanese low-rate approach is not sustainable. 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.

References

Acalin, Julien and Laurence Ball, "Did the U.S. Really Grow out its WWII Debt?," April 2022.

Acharya, Viral V. and Sascha Steffen, "The "greatest" carry trade ever? Understanding eurozone bank risks," *Journal of Financial Economics*, 2015, *115* (2), 215–236.

Aguiar, Mark, Manuel Amador, and Cristina Arellano, "Micro Risks and Pareto Improving Policies with Low Interest Rates," July 2021.

Andrews, Spencer, Ric Colacito, Mariano Max Massimiliano Croce, and Federico Gavazzoni, "Concealed carry," *Available at SSRN 3743205*, 2020.

Auclert, Adrien, "Monetary Policy and the Redistribution Channel," *American Economic Review*, June 2019, *109* (6), 2333–67.

_ , "Monetary Policy and the Redistribution Channel," *Am. Econ. Rev.*, June 2019, *109* (6), 2333–2367.

_ , Hannes Malmberg, Frédéric Martenet, and Matthew Rognlie, "Demographics, wealth, and global imbalances in the twenty-first century," Technical Report, National Bureau of Economic Research 2021.

Ball, Laurence M and N Gregory Mankiw, "Market power in neoclassical growth models," Technical Report, National Bureau of Economic Research 2021.

Bernanke, Ben S, *21st century monetary policy: the federal reserve from the great inflation to COVID-19*, Springer, August 2022.

Blanchard, Olivier, "Public debt and low interest rates," *American Economic Review*, 2019, *109* (4), 1197–1229.

Borio, Claudio E V, Robert N McCauley, Patrick McGuire, and Vladyslav Sushko, "Covered Interest Parity Lost: Understanding the Cross-Currency Basis," September 2016.

Chari, V. V., Alessandro Dovis, and Patrick J. Kehoe, "On the Optimality of Financial Repression," *Journal of Political Economy*, 2020, *128* (2), 710–739.

Doepke, Matthias and Martin Schneider, "Inflation and the Redistribution of Nominal Wealth," *Journal of Political Economy*, 2006, *114* (6), 1069–1097.

Du, Wenxin, Alexander Tepper, and Adrien Verdelhan, "Deviations from covered interest rate parity," *J. Finance*, June 2018, *73* (3), 915–957.

_ , _ , and _ , "Deviations from Covered Interest Rate Parity," *J. Finance*, June 2018, *73* (3), 915–957.

Eggertsson, Gauti B, Neil R Mehrotra, and Lawrence H Summers, "Secular stagnation in the open economy," *Am. Econ. Rev.*, May 2016, *106* (5), 503–507.

Fagereng, Andreas, Matthieu Gomez, Milien Gouin-Bonenfant, Martin Holm, Benjamin Moll, Gisle Natvik, Camille Landais, Ian Martin, Clara Martinez, and Daniel Reck, "Asset-Price Redistribution," https://benjaminmoll.com/wp-content/uploads/2022/07/APR.pdf 2022. Accessed: 2022-11-19.

Furman, Jason and Lawrence Summers, "A reconsideration of fiscal policy in the era of low interest rates," https://www.brookings.edu/wp-content/uploads/2020/11/furman-summers-fiscal-reconsideration-discussion-draft.pdf November 2020. Accessed: 2020-12-27.

Giesecke, Oliver and Joshua Rauh, "Trends in state and local pension funds," *Annual Review of Financial Economics*, 2022, *15.*

_ , Haaris Mateen, and Marcelo Jardim Sena, "Local government debt valuation," *Available at SSRN 4160225*, 2022.

Gourinchas, Pierre-Olivier and Hélène Rey, "International Financial Adjustment," *Journal of Political Economy*, 2007, *115* (4), 665–703.

Greenwald, Daniel, Matteo Leombroni, Hanno N Lustig, and Stijn Van Nieuwerburgh, "Financial and Total Wealth Inequality with Declining Interest Rates," July 2022.

Hall, George J and Thomas J Sargent, "Interest rate risk and other determinants of post-WWII US government debt/GDP dynamics," *American Economic Journal: Macroeconomics*, 2011, *3* (3), 192–214.

Hall, George J. and Thomas J. Sargent, "Three world wars: Fiscal–monetary consequences," *Proceedings of the National Academy of Sciences*, 2022, *119* (18), e2200349119.

Hébert, Benjamin M, "Externalities as arbitrage," Technical Report, National Bureau of Economic Research 2020.

Hoshi, Takeo and Anil Kashyap, "The Japanese Banking Crisis: Where Did It Come from and How Will It End?," *NBER Macroeconomics Annual*, 1999, *14*, 129–201.

_ and Ayako Yasuda, "Capital Market Regulation in Japan after the Global Financial Crisis," *The New International Financial System: Analyzing the Cumulative Impact of Regulatory Reform, World Scientific*, 2015, pp. 165–195.

Jiang, Zhengyang, Hanno Lustig, Stijn Van Nieuwerburgh, and Mindy Z. Xiaolan, "The U.S. Public Debt Valuation Puzzle," December 2019. SSRN Working Paper No. 3333517.

_ , _ , _ , and _ , "The U.S. Public Debt Valuation Puzzle," December 2019. NBER Working Paper 26583.

_ , _ , _ , and _ , "Manufacturing Risk-free Government Debt," September 2020. NBER Working Paper No. 27786.

_ , Hanno N Lustig, Stijn Van Nieuwerburgh, and Mindy Z Xiaolan, "Measuring U.S. Fiscal Capacity using Discounted Cash Flow Analysis," March 2022.

Jordà, Òscar, Katharina Knoll, Dmitry Kuvshinov, Moritz Schularick, and Alan M Taylor, "The rate of return on everything, 1870–2015," *The Quarterly Journal of Economics*, 2019, *134* (3), 1225–1298.

Lustig, Hanno, Andreas Stathopoulos, and Adrien Verdelhan, "The Term Structure of Currency Carry Trade Risk Premia," *American Economic Review*, December 2019, *109* (12), 4142–77.

Marco, Filippo De and Marco Macchiavelli, "The Political Origin of Home Bias: The Case of Europe," March 2016.

McKinnon, R I, "Money and capital in economic development (Washington, DC: Brookings Institution, 1973)," *McKinnonMoney and Capital in Economic*, 1973.

Mehrotra, Neil R. and Dmitriy Sergeyev, "Debt sustainability in a low interest rate world," *Journal of Monetary Economics*, 2021, *124.*

Mian, Atif, Ludwig Straub, and Amir Sufi, "A Goldilocks Theory of Fiscal Policy," 2021. NBER Working Paper No. 29351.

Mian, Atif R, Ludwig Straub, and Amir Sufi, "Indebted Demand," April 2020.

Myers, Sean, "Public Employee Pensions and Municipal Insolvency," https://rodneywhitecenter.wharton.upenn.edu/wp-content/uploads/2021/10/Myers-Public-Employee-Pensions-and-Municipal-Insolvency.pdf 2018. Accessed: 2022-11-29.

Ongena, Steven, Alexander Popov, and Neeltje Van Horen, "The Invisible Hand of the Government: Moral Suasion during the European Sovereign Debt Crisis," *American Economic Journal: Macroeconomics*, October 2019, *11* (4), 346–79.

Piazzesi, Monika and Martin Schneider, "Interest Rate Risk in Credit Markets," *American Economic Review*, May 2010, *100* (2), 579–84.

Reinhart, Carmen M and Kenneth S Rogoff, *This Time Is Different*, Princeton University Press, September 2009.

Reinhart, Carmen M., Jacob F. Kirkegaard, and M. Belen Sbrancia, "Finance and Development," https://www.imf.org/external/pubs/ft/fandd/2011/06/reinhart.htm June 2011. Accessed: 2022-11-25.

Sargent, Thomas J, George Hall, Martin Ellison, Andrew Scott, Harold James, Era Dabla-Norris, Mark De Broeck, Nicolas End, Marina Marinkov, and Vitor Gaspar, "Debt and Entanglements Between the Wars," https://www.imf.org/en/Publications/Books/Issues/2019/11/08/Debt-and-Entanglements-Between-the-Wars-48602 November 2019. Accessed: 2022-11-17.

Setser, Brad W, "The Disappearing Japanese Bid for Global Bonds," https://www.cfr.org/blog/disappearing-japanese-bid-global-bonds January 2023. Accessed: 2023-10-30.

A Appendix

A.1 Consolidated Balance Sheet Return Calculation

The consolidated balance sheet returns are calculated in quarterly frequency. The data range from the first quarter of 1998 to the last quarter of 2022. The composition of financial assets and liabilities is directly obtained from Japan's Flow of Funds. On the asset sides, asset data can be classified into the following major types of financial instruments: currency and deposits, loans, domestic equities, other domestic assets, foreign reserves and foreign securities. In the flow of funds data, there is no detail decomposition of foreign securities. However, we know that these foreign securities are exclusively held by social security funds. To further classify the foreign securities portfolio, we then turn to the quarterly reports of the GPIF (Government Pension Investment Fund), the major public pension fund in Japan. According to the GPIF report data, foreign securities can be decomposed into two subcategories: foreign equities and foreign bonds. The portfolio share of equity out of total foreign investment is fixed at 50% since 2020, and it varied between 50% and 64% before 2013 to 2020. We simply assumed the portfolio share before 2013 was the same as that in 2013, which is 56%.

The following return data are assigned to be the return on the categories of assets listed above: interest on reserves at BoJ for currency and deposits, return on BofA (Bank of America) Ice Japan government bond index for loans and other domestic assets, return on the BofA 10 Year US Treasury Index for foreign reserves, the return on MSCI Japan index for domestic equities, the return on the MSCI world index excluding Japan for foreign equities, and the return on 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 and FILF (Fiscal investment and Loan Fund) deposits. We use the following as their returns: zero for cash, T-bill return for T-bills, loans and FILF deposits, interest on reserves at BoJ for reserves, and the return on BoFA ICE Japan government bond index for government bonds.

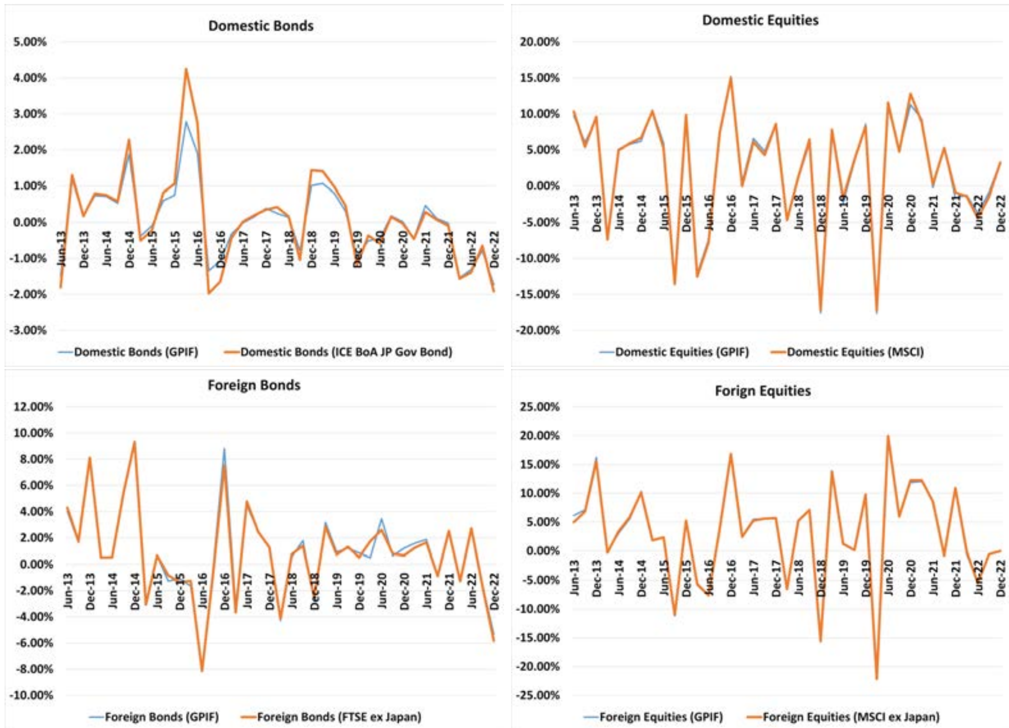
We also check the accuracy of our return choices by comparing them to GPIF asset returns, which are available in four major categories of assets: domestic bonds, domestic equities, foreign bonds and foreign equities. As indicated by Figure 9, our choices of returns matches the returns reported by the GPIF quite well.

In addition, Table 10 reports the nominal returns for domestic equity, domestic bond, foreign equity and foreign bond in Japanese Yen or in U.S. dollars. The top panels reports equity returns for the Japan and ROW (rest of the world) in USD and JPY, as well as the difference between them. Over the entire sample, there is a 5.4% spread in ROW vs. Japan returns expressed in JPY. This gap reflects an additional 1.2% due to the depreciation of the JPY against the USD. The bottom panels reports bond returns for Japan and the ROW in USD and JPY, as well as the difference them. Over the entire sample, there is a 2.8% spread ROW vs. Japanese bond returns expressed in JPY.

A.2 An Alternative Measure of Financial Repression

We provide an alternative measure of financial repression assuming the expected return of each asset in 2021 is its past average return during our sample period (1997 to 2022). Table 11 reports

Figure 9: Returns Comparison



the asset and liability positions of each type of financial instrument in 2021 as well as their returns in sample average.

The 2021 assets to debt ratio of the consolidated government is 0.62 = 194%/311% . Table 11 reports the weighted asset and liability returns are 3.53% and 0.72% 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. In 2021, the unlevered ratio is about 0.45. Then we can quantify the financial repression wedge in 2021 by the following equation below:

$$
\begin{aligned}
\omega_t^{Alt} &\approx \left(1-\frac{A_t}{D_t}\right)\mathbb{E}_t R_{t+1}^{Y}+\frac{A_t}{D_t}\mathbb{E}_t R_{t+1}^{A}-\mathbb{E}_t R_{t+1}^{D} \\
&= (1-0.62)\times 0.45\times 4.55\% + 0.62\times 3.52\% - 0.72\% \\
&= 2.24\%.
\end{aligned}
$$

This alternative financial repression calculation gives a slightly higher financial repression wedge compared to our benchmark case at 2.02%.

Table 10: Equity and Bond Returns

Country	JP	ROW	ROW	ROW-JP
Currency	JPY	USD	JPY	
	Nominal Equity Returns			
1997-2022	4.7%	8.9%	10.2%	5.4%
2000-2009	-2.4%	3.5%	3.3%	5.6%
2010-2019	10.0%	10.2%	12.5%	2.5%
2020-2022	9.0%	8.4%	17.0%	8.0%
	Nominal Bond Returns			
1997-2022	2.0%	3.9%	4.8%	2.8%
2000-2009	1.9%	8.2%	7.3%	5.5%
2010-2019	2.2%	2.5%	4.3%	2.1%
2020-2022	-1.0%	-4.9%	4.0%	5.0%

Table 11: 2021 Balance Sheet Portfolio and Past Returns

Asset Position	% of GDP in 2021	Average Past Return
Currency and Deposits	19%	0.1%
Domestic Loans	73%	1.74%
Domestic Bonds	14%	1.74%
Domestic Equities	33%	4.55%
Foreign Equities	12%	9.85%
Foreign Reserve	29%	6.59%
Foreign Bonds	12%	4.51%
Weighted Asset Return		**3.52**%
Liability Position	% of GDP in 2021	Average Past Return
Currency	23%	0%
Bank Reserves	102%	0.09%
T-Bills	23%	0.07%
Gov Bonds	121%	1.74%
Domestic Loans	38%	0.07%
Deposits FILF	5%	0.09%
Weighted Liability Return		**0.72**%

A.3 U.S. Household Balance Sheet

For the comparison to the Japanese household balance reported on Table 6, Table 12 reports the US household balance sheet by the end of 1997 and 2021.

Table 12: US Household Balance Sheet

December 1997			
Assets		Liabilities	
Currency and Deposits	41.96%	Loans	59.73%
Other Securities	130.86%		
Equities	91.47%		
Debt	34.87%		
December 2021			
Assets		Liabilities	
Currency and Deposits	71.64%	Loans	69.13%
Other Securities	155.83%		
Equities	191.83%		
Debt	34.99%		

Units: % of GDP. Source: Federal Reserve Board of Governors, Flow of Funds Table B.101e.

A.4 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.5 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

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

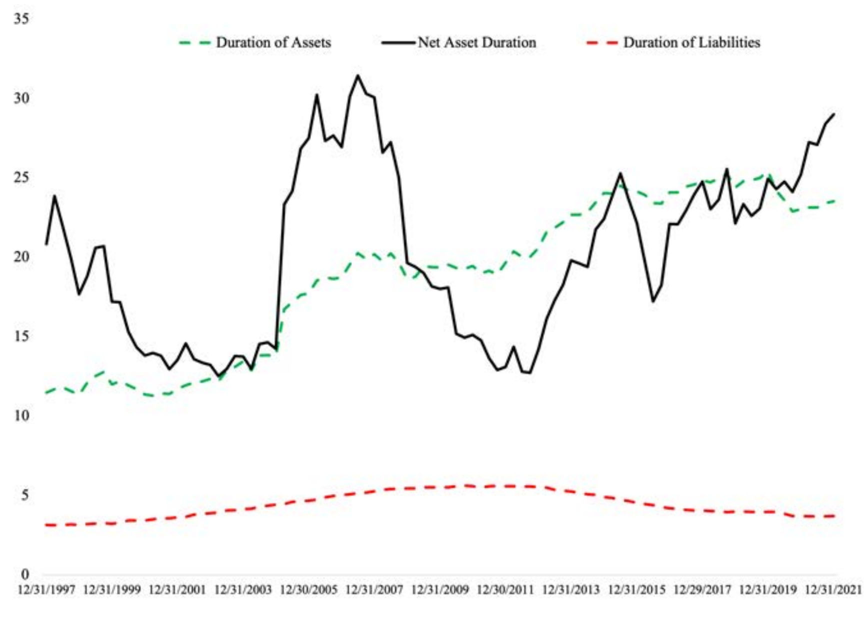
Then we have:

$$\frac{dV_j}{d\ln R} = u_{c,j}\left(D^{c-y} - D^{\theta}\right)\theta. \tag{15}$$

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

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

Figure 10: Duration of Japanese Government's Balance Sheet

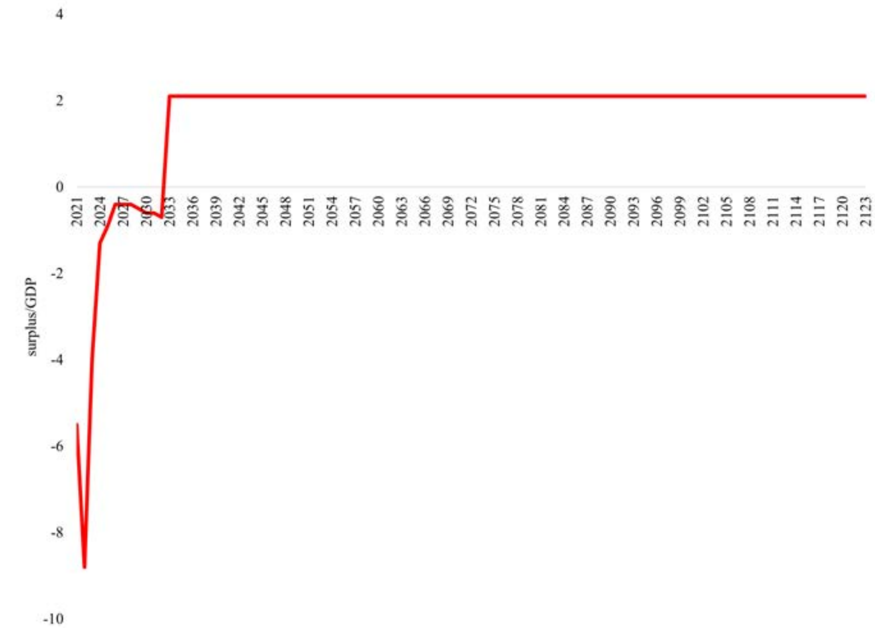


Source: Jorda-Schularick-Taylor Macro-history database, Japan flow of funds and authors' calculation.

where the last equality utilizes equation (15).

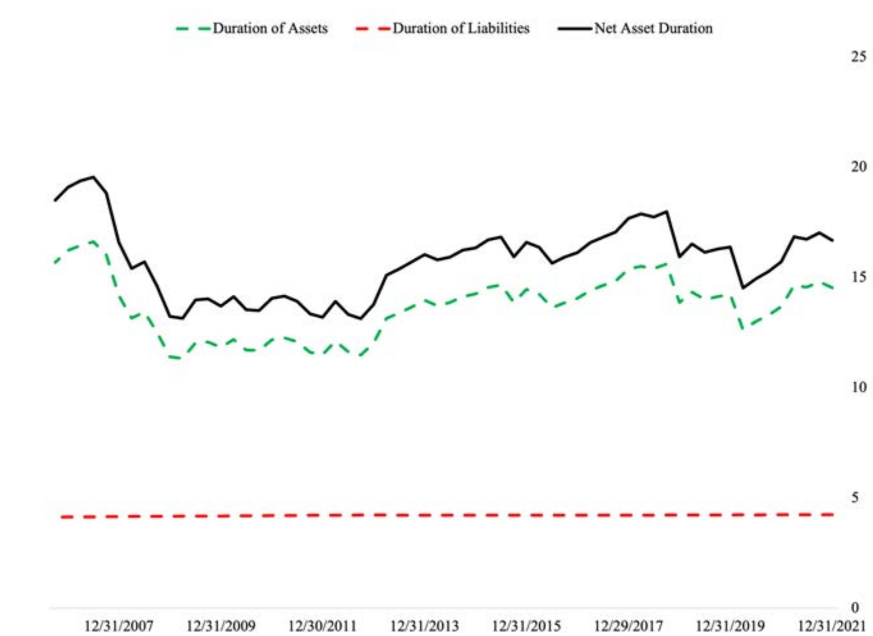
A.6 Additional Figures

Figure 11: Projected Surpluses



Note: Based on Japanese fiscal projections. The projected debt in 2032 is fully backed by a steady-state surplus.

Figure 12: Duration of Japanese Household's Balance Sheet



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