Reversal of the BoJ's Balance Sheet Policy and Liquidity Dependence

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Abstract

This study empirically examines liquidity dependence in the Japanese banking system. Acharya and Rajan (2024) and Acharya et al. (2024) pointed out the phenomenon of liquidity dependence, which was observed during the U.S. quantitative easing and tightening policies and is regarded as a possible factor in liquidity crises in September 2019 and March 2023 crises in the U.S. Since quantitative easing was introduced in March 2001, the Japanese economy has experienced a more than 20-year period of quantitative easing, longer than that encountered in the U.S. Our macro and micro analysis employs more than 20 years of macroeconomic and bank-level accounting data and reveals that the same liquidity dependence phenomenon is observed in the Japanese economy. The Japanese broad deposit insurance system is superior to that in the United States, so an incident like the Silicon Valley Bank bankruptcy is unlikely to occur in Japan. However, partly with the rise of digital banking, we suggest that the Japanese economy needs to prepare for the impending major quantitative tightening—the so-called exit from the long-term quantitative easing policy.

JEL: G01. G2. E5

Key words: Bank of Japan, quantitative easing, quantitative tightening, deposits,
financial stability, financial fragility, monetary policy

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1. Introduction

Developed market central banks that conduct quantitative easing have positioned the reduction in their balance sheets as merely adjustments with no policy intent. Therefore, they also state that the tightening effect of quantitative tightening (QT) is far weaker than the easing effect of QE. However, the history of central banks embarking on balance sheet reductions with such intentions shows that when they reduce their expanding balance sheets, the markets unwind portfolio rebalancing, causing bond prices to change. While this in itself is natural, several disruptive events occurred in the U.S. market and financial system as liquidity dried up. For example, after the Federal Reserve Board (Fed) started its QT in 2017, a repo rate spike occurred in September 2019. After the Fed restarted QT in 2022, Silicon-Valley Bank (SVB) and Signature Bank experienced massive outflows of non-insured deposits, reflecting their huge losses in security investments; both went bankrupt in March 2023.[3] Acharya et al. (2024) empirically showed that when the Fed expanded its balance sheet via quantitative easing, U.S. banks financed their reserve holdings with demandable deposits and issued credit lines to corporations. Since these bank-issued claims on liquidity did not shrink even when the Fed halted its balance-sheet expansion and began reducing its balance sheet, banks became highly vulnerable to liquidity turbulence. In the case of SVB, when the bank announced in March 2023 that it had incurred significant losses on its bond investments due to the sharp rise in interest rates and its recapitalization program, start-ups with deposits in the bank withdrew their deposits rapidly and at a large scale, driving it into bankruptcy in just a few days. The concentration of large deposits in demandable deposits backfired.

Acharya and Rajan (2024) and Acharya et al. (2024) called the phenomenon in which QE leaves the banking system with demandable claims that are not simply reversed by QT, "liquidity dependence" because it necessitates even greater central bank balance sheet support in the future.[4] While standard analyses focus on changes in the asset side of banks and examine how these affect the real economy through price changes, they do not consider changes in banks' liability side. The key to inspecting a financial system's fragility is to look specifically at the liability side, particularly changes in liquidity. Acharya and Rajan (2024) and Acharya et al. (2024) assumed that the asymmetric bank behavior between QE and QT is due to their confidence in retaining access to liquidity

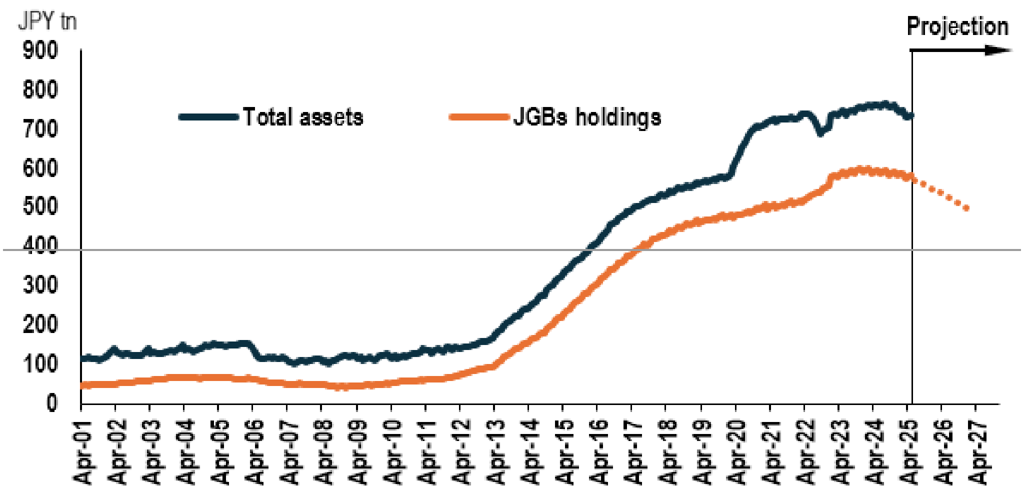
[3] Jiang et al. (2024) also examined monetary tightening and U.S. bank fragility in 2023. They provided a conceptual framework and an empirical methodology for analyzing all U.S. banks' exposure to rising interest rates and uninsured depositor runs, with implications for financial stability.

[4] While Acharya and Rajan (2024) theoretically examine this phenomenon, Acharya et al. (2024) do so empirically. The former do not emphasize the phrase "liquidity dependence" as much as the latter.

during QT if they substitute lost reserves with bonds that are eligible collateral for repo transactions.

In Japan, the Bank of Japan (BoJ) abolished its yield curve control (YCC) framework and negative interest rate policy in March 2024 after over 20 years of quantitative easing. The BoJ decided in July 2024 to begin reducing the amount of Japanese government bond (JGB) purchases from August 2024 from 5.7 trillion yen per month to 2.9 trillion yen per month in January–March 2026, thereby gradually reducing the size of its balance sheet. Then in June 2025 the BoJ further decided to reduce them in a more gradual way to 2.1 trillion yen per month in January-March 2027 (Figure 1). Since the Japanese economy has just completed the QQE and YCC framework, experiencing the longest period and largest size (in terms of the BoJ's balance sheet-to-GDP ratio) of quantitative easing, this asymmetric bank behavior would be worth addressing. In this study, we follow the U.S. Fed's terminology and refer to this phenomenon as a QT period. To examine the vulnerabilities of Japanese banks in the event of liquidity turbulence and how bank behavior impacts the effectiveness of monetary tightening during the QT period, we apply Acharya et al.'s (2024) method to analyze how the balance sheets of Japanese banks changed as the BoJ expanded and then shrunk its balance sheet.

Figure 1：Size of the BoJ's Balance Sheet



Note: The future size of JGB holdings is calculated based on the BoJ's plan to reduce its purchased amount of JGBs.

Source: BoJ, Macrobond

Specifically, when the demandable claims the BoJ supplies to banks become due as it moves from QE to QT, banks may experience liquidity stress. Therefore, we explore how the BoJ's balance sheet expansion affects banks' demandable deposits and demandable assets like credit lines. We also check whether banks move to reduce their liquid liabilities when the BoJ shifts from QE to QT when banks' increases in demandable deposits during the QE period were very large. Banks may engage in asymmetric behavior in which they do not decrease their liquid liabilities by reducing demand deposits or raising time deposits in the QT period. Moreover, long-term interest rates may rapidly increase during the QT period, resulting in losses on banks' bond investments. If demandable deposits are substantially increased during the QE period and banks behave asymmetrically between the QE and QT periods, deposits may be easily withdrawn when banks incur losses on bond investments, consequently increasing liquidity risk. In addition, a change in banks' asset/liability maturity transformation behavior could also affect monetary tightening's spillover effects.

In this study, since the BoJ first initiated QE in March 2001, we regard the period from April 2001 to February 2006 and from October 2010 to February 2024, just before the yield curve control (YCC) framework and negative interest rate policy were removed (March 2024), as the QE estimation period, considering the constraints of accessing reliable data. We do this because even though the BoJ converted from QQE to YCC in September 2016 (hereafter called "QQE with YCC"), it continued purchasing large amounts of JGBs; the period from QQE to YCC is often referred to as an unprecedented monetary easing. The period between the BoJ's operating target change from the outstanding amount of current account balances at the BoJ (hereafter called "reserves") to uncollateralized overnight call rate until its resumption of QE (March 2006 to September 2010) and the period after the BoJ terminated the quantitative and qualitative monetary easing (QQE) with YCC (March 2024) are identified as the QT estimation period. Except for SMEs (whose support operations ended in September 2022), following the BoJ's termination of its financial support operations in response to the COVID-19 pandemic at the end of March 2022, reserves have already begun to decline. Thus, we also include the period as the QT period as the alternative definition.

Using these periods, we examine how domestic banks increased or decreased demandable deposits, which are extremely liquid and can be withdrawn at any time, and time deposits, whose liquidity is fixed for a certain period of time. We make two key discoveries. First, the BoJ's QE created significant amounts of demandable deposits in Japan's banking system, although the behavior of time deposits is unclear. Second, when the BoJ moved from QE to QT, the time deposits have not increased, and the demandable deposits have not decreased in a statistically significant way. suggesting the banks' asymmetric behavior. At the least, banks didn't behave in a way that would eliminate the liquidity mismatch between assets and liabilities. Overall, the same phenomenon as that seen in the U.S. financial system is also observed in Japan's financial system. The BoJ is not trying to move QT forward too rapidly. In fact, while the Fed stopped bond purchases just three months after it started raising interest rates in March 2022 and allowed maturing bonds to expire at or below the cut-off rate, the BoJ has only reduced its JGB purchases amount and has not gone as far as to stop buying. In this sense, Japanese banks have plenty of liquidity. This raises the question: does this situation matter from the perspectives of financial system stability and monetary policy? The real problem does not occur in ordinary times but instead happens when there is a sudden need for large amounts of cash (Acharya et al. (2024) refer to this as a "dash for cash"). If liquidity is insufficient when this happens, Japanese banks not only will rush to secure reserves to avoid a bank run but will also concentrate the market's demand for funding. Consequently, interest rates will spike, and banks will be forced to conduct fire sales unless the BoJ can address them with appropriate market operations.

The rest of this paper proceeds as follows. Section 2 analyses aggregate time-series data by linking reserve amounts, types of deposits, and credit lines. Section 3 further analyses bank behavior using bank-level panel data. Section 4 discusses the potential financial vulnerability derived from asymmetric bank behavior. Section 5 concludes by describing the ratcheting-up of bank liquidity risk, the subsequent financial fragility, and certain monetary policy issues, offering some directions for future research.

2. Aggregate time-series analysis

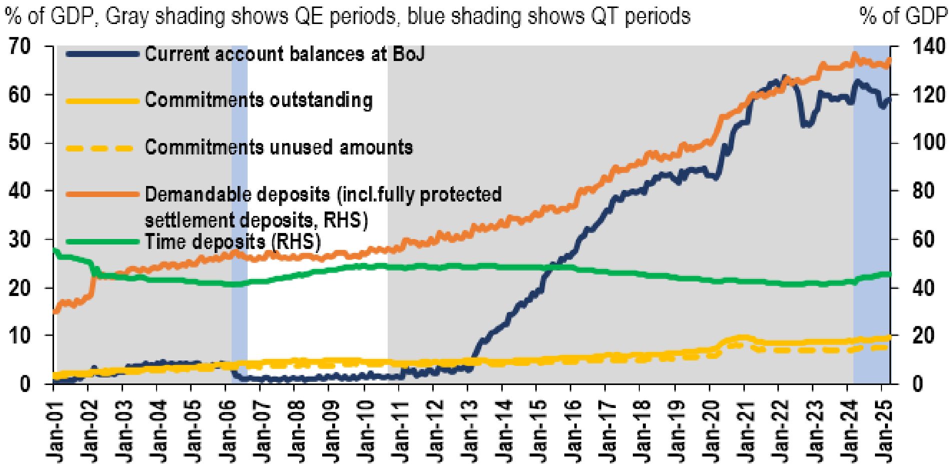
2.1.1. Bank reserves, deposits, and credit line

Before conducting the time-series analysis, we examine developments in domestic bank deposits and credit lines of Japanese banks during the QE period (Figure 2). Reserves increased throughout all QE periods; in particular, the pace of the increase accelerated when the BoJ launched QQE in 2013. Domestic banks' demandable deposits increased for almost the entire period, although their growth has accelerated since the BoJ implemented QQE. In contrast, time deposits appear to have continued to decline throughout the QE period, but the sensitivity to QE appears not to be large, leaving the following empirical analyses to conclude. During this period, there were two instances of fund shifts unrelated to QE. The first occurred in April 2002, when payoff was permitted for time deposits, resulting in a shift of funds from time deposits to demandable deposits. The second occurred in May 2020, when the government paid out large amounts of funds to the public at the beginning of the COVID-19 pandemic, which were transferred to demand deposits. Credit lines are smaller than those of U.S. banks. Since credit lines are hardly used by firms, the contract and unused amounts have moved in similar ways. In any case, they appear to have increased moderately during the QE period.

Looking at the QT period, reserves decreased slightly in 2006 and remained flat until QE resumed; demandable deposits actually declined slightly when reserves declined but seem to resume growth thereafter. Time deposits appear to have stabilized throughout this QT period. After the current QT started, demandable deposits appear not to decrease in response to the decline in reserves, and time deposits seem to stabilize, leaving the empirical analyses to conclude their behavior during the QT period. Behavior of credit lines seem to be more subtle, leaving the empirical analyses to conclude the characteristics.

Overall, demandable deposits generally increased during the QE period but appear not to have decreased much during the QT period. In addition, time deposits continued to decline during the QE period, but is unclear whether they conversely increased during the QT period. Especially, if we increase the period after the suspension of operations in response to the COVID-19 pandemic to the QT period, both behavior seem to be more subtle. Conducting an empirical analysis is necessary to rigorously determine whether deposits increased or decreased during the QT period. In the following, we first conduct the aggregate the time series analysis using macro data.

Figure 2: Current Account Balances at the BoJ, Deposits, and Credit Lines



Note: This figure covers domestically licensed banks. As current account balances at BoJ before 2005 do not include data for domestically licensed banks, those data are estimated using the shares of such banks in Jan. 2005. Source: BoJ, Cabinet Office

Specifically, following Acharya et al. (2024), we estimate the ordinary least square (OLS) regression using Eq. (1):

$$\Delta Y_t = \alpha \Delta X_t + \beta X_{t-12} + \gamma D1_t + \delta D2_t + \varepsilon_t \quad (1)$$

where $\Delta Y_t = Y_t - Y_{t-12}$ is the change in Ln(*Deposits*) or Ln(*Credit lines*) or change in *Deposits* or *Credit lines*, to control for seasonality. $\Delta X_t = X_t - X_{t-12}$ is the change in Ln(*Reserves*) or change in *Reserves*. *Deposits* are then split into *Demandable deposits* and *Time deposits*, and the same analysis is performed for each. Furthermore, to allow for a lagged impact of *Reserves* production, we include a 12-month lag in Ln(*Reserves*) or *Reserves*. $D1$is the dummy variable for permitting payoff for time deposits in April 2022 (this dummy is imposed from April 2022 to March 2023 here), and $D2$ is another dummy variable for the government's provision of large funds to the public in response to the COVID-19 pandemic in May 2020 (this dummy is imposed from May 2020 to April 2021). Newey-West's HAC estimator is applied to deal with variance heterogeneity and serial correlation.

The data used are domestic banks' reserves and monthly deposit and commitment lines data. The sample period is from January 2002, close to the initial period of QE to December 2024, after the removal of YCC framework and negative interest rate policy.

2.1.2. All periods

We estimate model (1) for all periods. Columns (1) to (4) of Table 1 show the correlation between the quarterly changes in the neutral logarithm of deposits/ demandable deposits/ time deposits, or credit lines (contract amount) and those of reserves. The results show that changes in reserves have a strong positive effect on changes in deposits and demandable deposits. On the other hand, changes in reserves and changes in time deposits are negatively correlated in some cases but not in others. Finally, changes in credit lines are negatively but weakly correlated with changes in reserves. Our point estimates indicate that a 10% increase in reserves is associated with a 0.15% increase in deposits and 0.4% increase in demandable deposits but is associated with a 0.2% decrease in time deposits. The correlations appear to be smaller than those Acharya et al. (2024) estimated for U.S. banks; the positive or negative signs of each deposit measure are the same; however, the sign of credit lines is not. Demandable and time deposits have opposite movements, as expected from Figure 1. This suggests that when the BoJ increased reserves, domestic banks not only increased deposits but also shifted from time to demandable deposits. That said, since the period of QT is very short compared to that of

QE, it is hard to judge whether there is asymmetric behavior of banks during the QT period based on this estimate.

Columns (5) to (8) are not log-transformed but instead use arithmetic changes in *Deposits* and their breakdown, as well as changes in c*redit lines*, as dependent variables. The results are generally similar to the log-transformed results, with changes in deposits responding to changes in reserves in the same direction by about its 28% share, and changes in demandable deposits respond in the same direction by 34% of the shift. In contrast, changes in time deposits responding to changes in reserves are in the opposite direction by about 8% share. Overall, as Acharya et al. (2024) measured, when the Fed increased the supply of reserves for U.S. banks, almost all of the increase was shifted to deposits. However, when the BoJ supplies reserves in Japan, about 30% flow into nonbanks as funds, which in turn flow back to the banks as demandable deposits. Since at least this portion has zero risk weight, domestic banks do not need to increase their capital or rebalance portfolios to meet liquidity regulations. We cannot determine from these macro data how much of demandable deposits is uninsured.

Table 1: Effects of reserves on aggregate deposits and credit lines (since the 2000s)

This table reports the results of OLS regressions of changes in deposits or credit lines on changes in reserves. The sample period is April 2001 to December 2024 for deposits, demandable deposits, and time deposits and January 2002 to February 2024 for credit lines. Demandable deposits consist of current, ordinary, savings, and notice deposits. Time deposits consist of time deposits and installment savings. t-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Newey-West's HAC estimator is applied.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ΔLn (Deposits)	ΔLn (Demandable deposits)	ΔLn (Time deposits)	ΔLn (Credit lines)	ΔDeposits	ΔDemandable deposits	ΔTime deposits	ΔCredit lines
ΔLn (Reserves)	0.0145***	0.0433***	-0.0171**	-0.0269**				
	(7.9183)	(4.5221)	(-2.1309)	(-1.8780)				
Ln $(\text{Reserves})_{t-12}$	0.0052***	0.0059**	-0.0043	-0.0033				
	(4.8497)	(2.1234)	(-1.3257)	(-0.5147)				
ΔReserves					0.2820***	0.3365***	-0.0753***	-0.0186
					(4.8036)	(4.8779)	(-2.6058)	(-1.4646)
Reserves_{t-12}					0.0595***	0.0583***	-0.0021	-0.0005
					(6.1615)	(4.8316)	(-0.2260)	(-0.2040)
Constant	-0.0428***	-0.0349	0.0542	0.0927	92981.4377***	90135.5976***	1754.1715	13710.1873***
	(-3.1521)	(-0.9633)	(1.2620)	(1.1113)	(9.4610)	(6.9459)	(0.0994)	(4.0864)
Dummy1	0.0141***	0.2111***	-0.1341***	0.1521***	83124.6509***	461360.9719***	-357685.4299***	12266.7469***
	(4.1664)	(15.4793)	(-11.5007)	(7.0041)	(3.9751)	(18.3172)	(-17.2678)	(4.0353)
Dummy2	0.0519***	0.0727***	0.0000	0.2413***	375318.3510***	373752.6771***	12099.8253	117937.7145***
	(16.2186)	(11.5293)	(0.0037)	(13.1577)	(13.5033)	(9.8926)	(0.5869)	(12.6856)
Number of Samples	285	285	285	276	285	285	285	276
Adj. R-sq	0.655	0.764	0.503	0.444	0.802	0.771	0.493	0.622
Type of regression	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS

2.1.3. QQE period

Although we describe the BoJ's QE using a single phrase, the scale of the reserves expansion differs significantly between the initial QE and QQE period that began in 2013. The effects on bank behavior may differ because of this scale difference Therefore, to see how the portfolios of domestic banks have changed, we examine only the QQE period, when the scale of the BoJ's QE increased significantly.

First, we conduct the same estimations as (1) through (8) in Table 1 from the start of the QQE in April 2013 to February 2024, just before the QQE with YCC was abolished in March 2024. The results in Table 2 show that, as in Table 1, reserves positively affect changes in deposits for both the logarithmic and arithmetic terms and positively affect changes in demandable deposits for only the arithmetic terms. Changes in time deposits are negatively correlated as in Table 1 only for the logarithmic terms, but the coefficients are statistically non-significant for both. The coefficients of changes in credit lines are negative and statistically significant for both, suggesting that banks appear not to take aggressive risks for earning profits in this area. The characteristics of QQE are such that domestic banks shifted more of the increase in reserves to demandable deposits than they did in QE, but shifting from time deposits to demandable deposits is unclear.

Table 2: Effects of reserves on aggregate deposits and credit lines (during QQE)

This table reports the results from OLS regressions of changes in deposits or credit lines on changes in reserves. The sample period is April 2013 to February 2024 for deposits, demandable deposits, time deposits, and credit lines. Demandable deposits consist of current, ordinary, savings, and notice deposits. Time deposits consist of time deposits and installment savings. t-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Newey-West's HAC estimator is applied.

	(1) ΔLn (Deposits)	(2) ΔLn (Demandable deposits)	(3) ΔLn (Time deposits)	(4) ΔLn (Credit lines)	(5) ΔDeposits	(6) ΔDemandable deposits	(7) ΔTime deposits	(8) ΔCredit lines
ΔLn (Reserves)	0.0312 **	0.0328	0.0184	-0.3989 ***				
	(2.3590)	(1.4618)	(1.0512)	(-4.6601)				
Ln (Reserves)$_{t-12}$	0.0103 **	0.0080	0.0018	-0.1580 ***				
	(2.1421)	(0.8699)	(0.2368)	(-4.1605)				
ΔReserves					0.2048 ***	0.2580 ***	-0.0342	-0.0531 ***
					(3.0681)	(4.1681)	(-1.2012)	(-2.6939)
Reserves$_{t-12}$					0.0488 ***	0.0616 ***	-0.0122	-0.0122 **
					(4.6716)	(5.3929)	(-2.1871)	(-2.1871)
Constant	-0.1176	-0.0590	-0.0446	2.3806 ***	144351.7666 ***	123910.5328 ***	-9757.5040	45547.5406 ***
	(-1.6254)	(-0.4317)	(-0.3936)	(4.2507)	(4.2983)	(3.9575)	(-0.5712)	(3.3239)
Dummy2	0.0486 ***	0.0682 ***	0.0029	0.2908 ***	385601.4703 ***	369267.9543 ***	18272.9089	129675.1079 ***
	(16.5142)	(11.2221)	(0.5885)	(14.4016)	(15.0579)	(11.5928)	(1.2370)	(12.6978)
Number of Samples	131	131	131	131	131	131	131	131
Adj. R-sq	0.597	0.399	0.086	0.760	0.724	0.698	0.022	0.756
Type of regression	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS

However, the unclearness of a negative correlation for time deposits may be due to the fact that QQE included a period when the supply of reserves was reduced. In fact, during the QQE period, when the COVID-19 pandemic occurred, the BoJ began strengthening monetary easing in March 2020. This included financial support operations, so that more liquidity was available to companies affected by COVID-19. These operations were terminated in March 2022 except for an extension of operations for SMEs until September 2022. Consequently, the amount of reserves supplied by the BoJ decreased beginning in March 2022. Thus, we treat the QQE period only up to February 2022, and conduct the similar estimation.

Table 3 shows that the positive responses of changes in deposits and demandable deposits to a 10% increase in reserves are even greater, with deposits and demandable deposits increasing by 0.37% and 0.47%, respectively. About 60% of the increase in reserves went to increase deposits or demandable deposits. Changes in time deposits in arithmetic terms are positively but weakly affected by changes in reserves. The coefficients of credit lines are again negative and statistically significant, suggesting the lack of banks' risk-taking behavior in this area, consistent with the results of the previous analysis. Thus, no major trends changed when defining the QQE period narrowly or broadly, with the exception of the size of the coefficients.

Table 3: Effects of reserves on aggregate deposits and credit lines (when the BoJ's amount of JGB holdings increased under QQE)

This table reports the results from OLS regressions of changes in deposits or credit lines on changes in reserves. The sample period is April 2013 to March 2022 for deposits, demandable deposits, time deposits, and credit lines. Demandable deposits consist of current, ordinary, savings, and notice deposits. Time deposits consist of time deposits and installment savings. t-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Newey-West's HAC estimator is applied.

	(1) ΔLn (Deposits)	(2) ΔLn (Demandable deposits)	(3) ΔLn (Time deposits)	(4) ΔLn (Credit lines)	(5) ΔDeposits	(6) ΔDemandable deposits	(7) ΔTime deposits	(8) ΔCredit lines
ΔLn (Reserves)	0.0368 **	0.0470 *	0.0068	-0.4115 ***				
	(2.5788)	(1.8461)	(0.4954)	(-4.1654)				
$Ln (Reserves)_{t-12}$	0.0133 **	0.0186	-0.0087	-0.1592 ***				
	(2.5112)	(1.7300) *	(-1.5648)	(-3.5163)				
ΔReserves					0.3758 ***	0.3309 ***	0.0428 **	-0.0798 ***
					(4.3644)	(3.3455)	(2.0334)	(-3.7905)
$Reserves_{t-12}$					0.0387 ***	0.0672 ***	-0.0234 ***	-0.0106
					(2.7413)	(4.1953)	(-5.2318)	(-1.5523)
Constant	-0.1607 **	-0.2082	0.1014	2.4042 ***	95217.9592 **	92916.3725 **	-20885.0850 *	53140.4379 ***
	(-2.0461)	(-1.3208)	(1.2346)	(3.6224)	(2.4871)	(2.2741)	(-1.8918)	(3.7892)
Dummy2	0.0468 ***	0.0591 ***	0.0131 ***	0.2870 ***	377610.4162 ***	352795.0860 ***	28960.2111 ***	130983.4021 ***
	(11.0402)	(7.0724)	(3.5687)	(11.3548)	(10.7433)	(9.0407)	(2.9358)	(9.5306)
Number of Samples	108	108	108	108	108	108	108	108
Adj. R-sq	0.591	0.387	0.536	0.764	0.783	0.710	0.487	0.783
Type of regression	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS

2.1.4. QT period

This study's main concern is whether bank behavior is asymmetric when the BoJ moves from QE to QT. In other words, if domestic banks rapidly increase demandable deposits during the QE period and then do not reduce them to the same extent during the QT period, liquidity risk may increase. From this perspective, we estimate bank behavior during the QT period using macro-time-series data (Table 4).

First, for the narrowly defined QT period from March 2006 to October 2010 and from March 2024 to December 2024, we estimate the same measurements as those in columns (1)–(8) of Table 3. The results show that the coefficient of changes in demandable deposits is positive as before, but no more statistically insignificant. In contrast, notably, the coefficients of changes in time deposits are positive and statistically significant, with time deposits decreasing 0.2% relative to a 10% decrease in reserves, or about 40% of the decrease in reserves. This suggests banks' asymmetric behavior and indicates the liquidity dependence during the QT period. Changes in credit lines are negative and statistically significant, with domestic banks increasing their credit lines when reserves decline. It likely indicates that firms' demands for credit line increases when the financial environment tightens during the QT period, or banks improve their risk-taking behavior.

Table 4: Effects of reserves on aggregate deposits and credit lines (from QT through the restart of QE)

This table reports the results from OLS regression of changes in deposits or credit lines on changes in reserves. The sample period is from March 2006 to September 2010 and from March 2024 to December 2024 for deposits, demandable deposits, time deposits, and credit lines. Demandable deposits consist of current, ordinary, savings, and notice deposits. Time deposits consist of time deposits and installment savings. t-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Newey-West's HAC estimator is applied.

	(1) ΔLn (Deposits)	(2) ΔLn (Demandable deposits)	(3) ΔLn (Time deposits)	(4) ΔLn (Credit lines)	(5) ΔDeposits	(6) ΔDemandable deposits	(7) ΔTime deposits	(8) ΔCredit lines
ΔLn (Reserves)	0.0124 ***	0.0063	0.0245 ***	-0.0667 **				
	(11.4468)	(1.0089)	(2.9324)	(-4.6845)				
Ln (Reserves)$_{t-12}$	0.0001	0.0020	0.0021	0.0065 *				
	(0.2637)	(1.2762)	(0.9618)	(1.8210)				
ΔReserves					0.5656 ***	0.1400	0.4085 **	-0.1168 ***
					(6.9382)	(0.9055)	(2.3658)	(-4.3146)
Reserves$_{t-12}$					0.0196 ***	0.0214 *	-0.0019	0.0090 ***
					(3.2160)	(1.8705)	(-0.1578)	(4.4770)
Constant	0.0203 ***	-0.0101	0.0158	-0.0514	119887.7670 ***	34097.5518 **	92013.1893 ***	4092.0265
	(3.1080)	(-0.5112)	(0.5960)	(-0.9677)	(25.4256)	(2.6401)	(7.9281)	(1.0957)
Number of Samples	65	65	65	65	65	65	65	65
Adj. R-sq	0.702	0.018	0.258	0.369	0.808	0.196	0.251	0.370
Type of regression	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS

Since the current QT period is relatively short, the sample size may not be large enough for the estimation to be stable. However, reserves have been decreasing since the end of the COVID-19 pandemic in the second half of the QQE period, when the BoJ terminated its financial support operations, leaving only operations for SMEs at the end of March 2022. We may therefore be able to consider this a QT period and estimate by combining this period with the first QT period (Table 5).

Using this combination, demandable deposits is again not statistically significant. Furthermore, the time deposit coefficients are positive and statistically significant at the 10% level for both the logarithmic and arithmetic terms as in Tabel 4, suggesting again their asymmetric behavior and liquidity dependence. Changes in credit lines respond to the decrease in reserves in a decreasing direction for the logarithmic term, as in the narrowly defined QT period.

Table 5: Effects of reserves on aggregate deposits and credit lines (from QT through the restart of QE and recent QE reduction)

This table reports the results from OLS regression of changes in deposits or credit lines on changes in reserves. The sample period is from March 2006 to September 2010 and from April 2022 to December 2024 for deposits, demandable deposits, time deposits, and credit lines. Demandable deposits consist of current, ordinary, savings, and notice deposits. Time deposits consist of time deposits and installment savings. t-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Newey-West's HAC estimator is applied.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ΔLn (Deposits)	ΔLn (Demandable deposits)	ΔLn (Time deposits)	ΔLn (Credit lines)	ΔDeposits	ΔDemandable deposits	ΔTime deposits	ΔCredit lines
ΔLn (Reserves)	0.0139 ***	0.0099	0.0179 **	-0.0721 ***				
	(11.7158)	(1.6026)	(2.1429)	(-5.0897)				
Ln $(Reserves)_{t-12}$	0.0023 ***	0.0065 ***	-0.0060 **	-0.0001				
	(3.8763)	(4.1952)	(-2.4466)	(-0.0295)				
ΔReserves					0.0551	-0.0086	0.1086 *	-0.0191
					(0.8302)	(-0.0969)	(1.7579)	(-1.2761)
$Reserves_{t-12}$					0.0599 ***	0.0680 ***	-0.0141 *	0.0008
					(8.7066)	(6.4791)	(-1.9081)	(0.4616)
Constant	-0.0037	-0.0607 ***	0.1056 ***	0.0226	102485.6970 ***	26128.0764 **	84789.7212 ***	7544.0530 **
	(-0.5210)	(-3.0466)	(3.5908)	(0.3938)	(9.4703)	(2.0520)	(6.4946)	(1.9896)
Number of Samples	88	88	88	88	88	88	88	88
Adj. R-sq	0.678	0.354	0.248	0.347	0.765	0.647	0.160	0.019
Type of regression	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS

Thus, bank behavior in response to the decline in reserves during the QT period suggests the liquidity dependence situation. However, this requires a more rigorous measurement using micro data and panel tests, as the OLS analysis of time series data is not conducive for inferences about the causal impact of reserves and may include other irrelevant factors. Therefore, we turn to panel tests with cross-sectional micro bank data in Section 3.

2.2. Price of liquidity

We have so far investigated the banks' behavior under the BoJ's balance sheet policy and its reversal by focusing on the volume of deposits and credit lines. Here we explore the price of the bank liquidity as the other side of the coin. The effective O/N call rate (EFCR) reflects how much liquidity suppliers can obtain in the call market, while the interest on excess reserves (IOER) serves as a benchmark for the price the BoJ aims to set in this market. The difference (EFCR-IOCR) represents the marginal value of the price of liquidity.

Following the reserve demand approach outlined in Lopez-Salido and Vissing-Jorgensen (2023) and revised by Acharya et al. (2022), we estimate an OLS regression based on the general specification described below:

$$EFCR_t - IOER_t = c + \alpha Ln(Reserves)_t + \beta Ln(Deposits)_t + \gamma Ln(Credit\ Line)_t + \varepsilon_t \quad (2)$$

The difference between EFCR and IOER represents the price of liquidity, which is not solely determined by reserve demand. Instead, it reflects banks' overall liquidity demand, where reserve demand must be adjusted for other liquidity needs, particularly demandable deposits or deposits (demandable and time deposits).

The results are reported in Table 6. In column (1), using reserve demand alone results in a positive relationship with EFCR-IOER, which is not economically meaningful. Column (2) shows an economically meaningful and statistically significant correlation between EFCR-IOER and deposit demand, and the relationship between EFCR-IOER and reserve demand returned to being meaningful, but was not statistically significant. This point is clarified in Column (3), where demandable deposits and time deposits are separated, and reserves return to a meaningful relationship and become statistically significant. Furthermore, looking at the breakdown of deposits, demandable deposits increase liquidity demand, resulting in a positive relationship that is statistically significant, while time deposits, which already have fixed liquidity, result in a negative relationship that is statistically significant.

Finally, in Column (4), we use credit lines. The relationship between EFCR-IOER and credit lines is positive and statistically significant because credit lines increase liquidity demand, but since credit lines have weak explanatory power, reserves show an inverse sign and are not statistically significant.

Table 6: Aggregate price of liquidity

This table reports the results from OLS regressions of difference between EFCR and IOER on reserves, deposits (demandable deposits and time deposits), and credit lines. The sample period is April 2001 to December 2024. Demandable deposits consist of current, ordinary, savings, and notice deposits. Time deposits consist of time deposits and installment savings. t-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Newey-West's HAC estimator is applied.

	(1)		(2)		(3)		(4)	
	EFCR-IOER		EFCR-IOER		EFCR-IOER		EFCR-IOER	
Ln (Reserves)	0.0071	**	-0.0050		-0.0051	***	0.0010	
	(2.4604)		(-0.7391)		(-0.8696)		(0.2173)	
Ln (Deposits)			0.0940	**				
			(1.9927)					
Ln (Demandable Deposits)					0.0380	***		
					(1.5096)			
Ln (Time Deposits)					-0.2568	***		
					(-3.5862)			
Ln (Credit Lines)							0.0335	*
							(1.9468)	
Constant	-0.0749	**	-1.3927	**	3.2837	***	-0.4094	**
	(-2.0215)		(-2.1103)		(3.0163)		(-2.4078)	
Number of Samples	285		285		285		285	
Adj. R-sq	0.067		0.108		0.245		0.094	
Type of Regression	OLS		OLS		OLS		OLS	

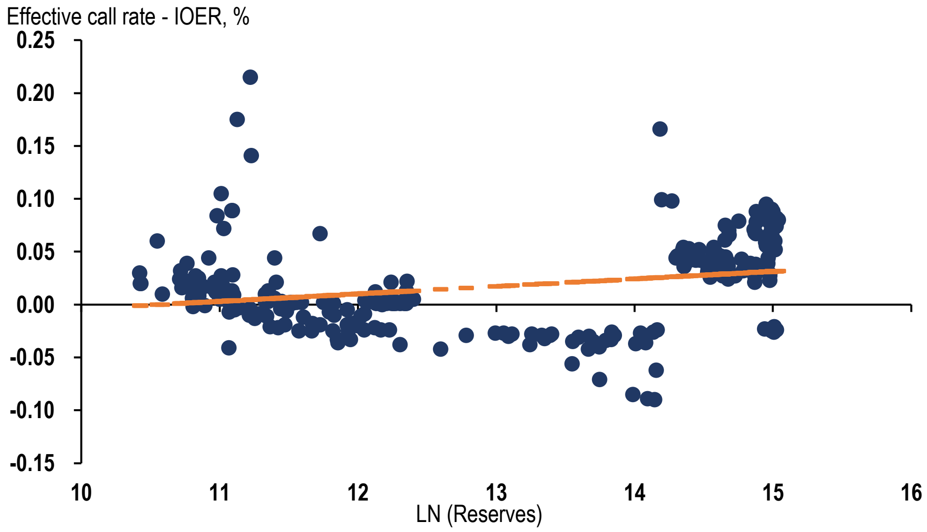
Next, following Lopez-Salido and Vissing-Jorgensen (2023) and Achary et al. (2022), we can transform the Eq. (2) as follows:

$$EFCR_t - IOER_t = \alpha \left[Ln(Reserves)_t + \frac{\beta}{\alpha} Ln(Deposits)_t \right] + \varepsilon_t \qquad (3)$$

where $Ln(Reserves)_t + \frac{\beta}{\alpha} Ln(Deposits)_t$ represents the deposit-adjusted reserves capturing banks' true liquidity demand. Deposits are decomposed into demandable deposits and time deposits. Credit lines were excluded because their explanatory power is too small and Japanese banks have not increased them even under QE.

Looking at the results, Figure 3 and 4 shows a scatter plot of EFCR-IOER on LN(Reserves), and that of EFCR-IOER on LN(Reserves), LN(Demandable Deposits), and LN(Time Deposits) in Table 6. If reserve demand alone represented the liquidity demand, we would expect to see a clear negative trend. However, as shown in Table 6, without adjusting for deposits, the price of liquidity in Figure 3 has a positive trend with the increase in reserves, revealing no economically meaningful relationship between the price of liquidity and reserves.

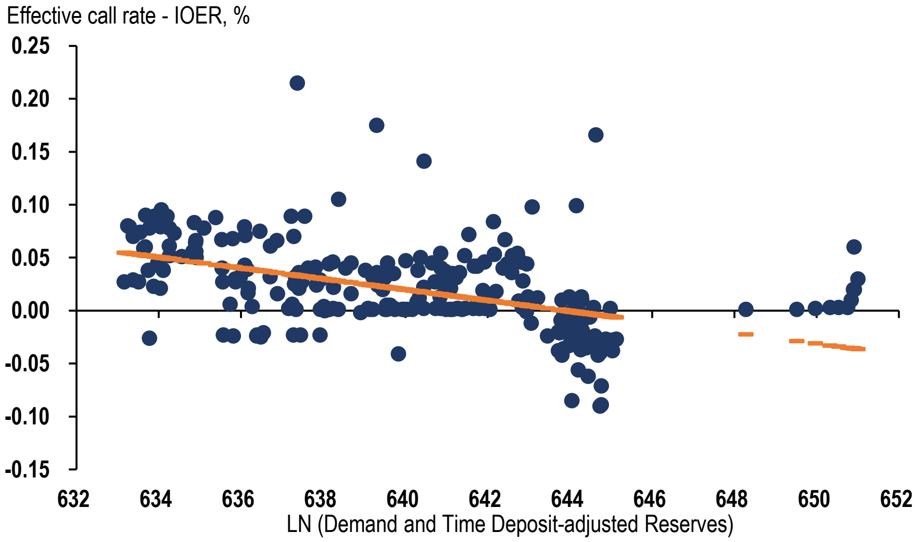
Figure 3：Aggregate price of liquidity (EFCR-IOER on LN<Reserves>)



Note: Sample period is April 2001 to December 2024. Source: BoJ, Macrobond

On the other hand, after adjusting reserves for bank deposits (demandable- and time-deposits), Figure 4 shows a significant negative correlation between the price of liquidity and adjusted reserves. This suggests that the price of liquidity thus serves as an indicator of banks' demand for liquidity (reserves). There are some outliers where EFCR-IOER exceeds 0.1%, corresponding with the period from 2007 to 2008, just before the Global Financial Crisis and before the huge injection of reserves. During that period, Japanese banks were concerned about the need for additional liquidity in anticipation of a crisis, fearing that companies might withdraw credit lines and households might even withdraw deposits to hold cash due to precautionary motives. The price of liquidity reflected these early signs of a crisis situation.

Figure 4：Aggregate price of liquidity (EFCR-IOER on LN<Demandable- and time-deposits adjusted reserves>)



Note: Sample period is April 2001 to December 2024. Source: BoJ, Macrobond

Considering both the analysis of banks’ deposit management (section 2.1) and liquidity pricing (section 2.2), our findings highlight the importance of understanding how banks manage liquidity during and beyond the BoJ’s balance sheet policy period.

3. BoJ reserves and bank deposits: bank-level analyses

In this section, we conduct a micro-econometric analysis using bank-level annual accounting data. A micro-analysis can consider confounding factors that cause biases that are difficult to remove in a macro-analysis. We cope with this difficulty by using two-stage least squares (2SLS) regressions.

The source of our bank accounting data is the Nikkei Economic Electronic Databank Systems' Financial QUEST (NEEDS FQ), and macroeconomic data are obtained from the BoJ. All data are as of the end of March of each year, which is the fiscal year end of all banks used in this empirical analysis. The bank-level accounting data we use is unconsolidated basis because NEEDS FQ contains very limited data on deposits and reserves on a consolidated basis.

Our estimation strategy largely based on Acharya et al. (2024) but it differs from theirs in several aspects. First, while Acharya et al. (2024) used quarterly data, this study employs annual data because there are only a small portion of the bank-level data available semi-annually in Japan, most of the variables used in our analysis are available annually. Second, our instrument variables in 2SLS slightly differ from theirs, which will be explained in detail later. We employ 2SLS analyses, instrumenting the change in bank-level reserves in the first stage to obtain the impact of an exogenous change in bank-level reserves on bank-level deposits to allay endogeneity concerns.

The first and second stage estimations are shown in Eqs. (4) and (5):

The first stage[5]

$$\Delta Ln(Reserves)_{it} = \alpha_1 z_{it} + \alpha_2 Ln(Reserves)_{it-1} + \gamma X_{it-1} + \epsilon_{it}, \tag{4}$$

The second stage

$$\Delta Ln(Deposits)_{it} = \beta_1 \Delta Ln(\widehat{Reserves})_{it} + \beta_2 Ln(Reserves)_{it-1} + \delta X_{it-1} + \tau_t + u_{it}, \tag{5}$$

where $\Delta Ln(Reserves)_{it}$ is the annual growth rate of bank *i*'s reserve holdings in year *t*. "Due from Banks" in bank balance sheets are used to measure $Reserves$. Ideally, we should and would like to use "Deposit Paid to BoJ," but these data have not been recorded since fiscal year 2013 (March 2014). Although it is unclear why it has not been recorded since 2013, the change coincided with the period during which Governor Kuroda's QQE led to a rapid increase in reserves at the BoJ. During the period of so-called

[5] Acharya et al. (2024) put two different instrument variables (z_{it}^{R1} and z_{it}^{R2}) together in the first stage estimation, where over-identified specifications might occur. So, we put one instrument variable in the first stage, Eq. (4).

unconventional monetary policy beginning in March 2001[6], "Due from Banks" primarily consists of "Deposit Paid to BoJ." Therefore, this treatment should not cause severe estimation biases.

$\Delta Ln(Deposits)_{it}$ is the annual growth rate of bank *i*'s deposits as liabilities in its balance sheet at year *t*. We use three different deposits as dependent variables: total deposits, demandable deposits (liquid deposits), and time deposits. Bank *i*'s total deposits are the sum of its current, ordinary, savings, notice, time, installment savings, and other deposits plus negotiable certificates of deposit. Demandable deposits are the sum of current, ordinary, savings, and notice deposits. Time deposits are the sum of time deposits and installment savings.

X_{it} represents bank controls lagged by one year, including bank size (measured as *Ln*(Total Assets)), profitability (Ordinary Revenue/Total Assets), and capitalization (Equity Capital /Total Assets). τ_t represents time fixed effects, and ϵ_{it} and u_{it} are the error terms.

z_{it} is a bank-level reserve instrument variables and we use the following two different variables as z_{it} which are shown in Eqs. (6) and (7):

$$z_{it}^{R1} = ln\left(\frac{Aggregate\ bank\ reserves_t}{Aggregate\ bank\ reserves_{t-1}}\right) \times \frac{Reserves_{i\ t-1}}{Aggregate\ bank\ reserves_{t-1}}, \quad (6)$$

$$z_{it}^{R2} = ln\left(\frac{Aggregate\ bank\ reserves_t}{Aggregate\ bank\ reserves_{t-1}}\right) \times \frac{Reserves_{i\ t-1}}{Asset_{i\ t-1}}, \quad (7)$$

where z_{it}^{R1} is computed as the product of two components, the most recent change in aggregate bank reserves and bank *i*'s previous-year share of aggregate bank reserves. The second instrument, z_{it}^{R2}, replaces bank *i*'s previous-year share of aggregate bank reserves with bank *i*'s previous-year dependence on reserves: bank *i*'s reserves to total asset ratio.

The first components of each variable are driven in large part by the BoJ's monetary policy stance, which can be considered as correlated with banks' reserves but not their deposits. The second component considers the difference among banks' propensity to use reserves, and it is what makes two instrument variables different. The idea for z_{it}^{R1} is based on Acharya et al. (2024). As they pointed out, we assume that a bank's lagged share in reserves captures some characteristics such as some banks being money-

[6] There are two different views regarding the start of unconventional monetary policy. One view is that it occurred in February 1999 (the start of the zero interest rate policy); the other is that it began in March 2001 (the start of the first quantitative easing policy). Significant increases in bank reserves begin with the latter.

center banks or primary dealers, and such banks are more susceptible to policy influence[7]. z_{it}^{R2} is our own modified variable. This variable captures the extent of the policy's impact more intuitively. We assume that banks that held larger reserves relative to their balance-sheet size in the previous year are more affected by the quantitative policy change. It is difficult to determine which variable is better as our instrumental variable, so we will make analyses by comparing the estimation results using each instrumental variable. It may be possible to use both variables as instrumental variables simultaneously. However, we use them separately due to concerns about overidentification problems.

The expected sign of α_1 is not unique. As Acharya et al. (2024) expected, α_1 will probably take a positive value because banks with a higher share or greater dependence are likely to increase their reserve in response to quantitative easing. However, if smaller banks, which are probably banks with lower share, decrease the reserve more during QT, α_1 can be negative.

Table 7 reports the variables' descriptive statistics. Our dataset comprises unbalanced panel data of 143 banks for 24 years, from March 2001 to March 2024. Approximately 2,800 observations are used in the empirical analysis.

We focus on the estimation results of β_1 in QE and QT periods to examine whether the fluctuations in bank deposits due to changes in reserves were asymmetric between QE and QT periods, implying that liquidity dependence would be observed in Japanese economy. When liquidity dependence occurs, the coefficients of demandable deposits are expected to be positive during QE periods but not during QT periods, while the coefficients of time deposits are expected to be negative during QE periods but not during QT periods.

The following subsections show the estimation results of different sample periods: All periods in 3.1., QQE periods in 3.2. and QT periods in 3.3. separately[8].

[7] Taking advantage of the characteristics of quarterly data, Acharya et al. (2024) use quarterly average lagged share in reserves. However, we used one-year lagged share in reserves by considering the characteristics of annual data.

[8] Although the macro analyses in the Section 2 and the micro analyses in this section are respectively monthly and yearly, the sample periods, fiscal years, for Tables 8, 9, 10, 11 and 12 in this section match those of Tables 1, 2, 3, 4, and 5 in Section 2, respectively.

Table 7: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Dependent Variables					
$\Delta Ln(Total\ Deposits)_{it}$	2,795	0.026	0.075	-0.890	1.339
$\Delta Ln(Demandable\ Deposits)_{it}$	2,795	0.063	0.104	-1.122	1.837
$\Delta Ln(Time\ Deposits)_{it}$	2,795	-0.007	0.091	-1.006	1.028
Explanatory & Instrument Variables					
z_{it}^{R1}	2,795	0.863	10.644	-22.366	396.413
z_{it}^{R2}	2,795	1.265	2.675	-8.666	29.876
$\Delta Ln(Reserves)_{it}$	2,795	0.101	0.775	-4.585	4.133
$Ln(Reserves)_{it}$	2,795	11.496	2.046	5.852	18.315
$Ln(Total\ Asset)_{it}$	2,795	14.849	1.255	12.083	19.518
ROA_{it}	2,795	0.020	0.006	0.007	0.064
$Equity\ to\ Asset_{it}$	2,795	0.049	0.021	-0.491	0.127

3.1. All periods

Table 8 shows the estimation results of the second stage of 2SLS using our full sample of 24 years from March 2001 to March 2024. It shows that, throughout the sample period, changes in reserves had little significant effects on changes in any bank deposits. Surprisingly, coefficients are negative but not significant. Also, the sample years in this table match that of Table 1, where we report the OLS regression results using macroeconomic data. However, these results are not consistent with those of Table 1.

These results may imply two interpretations: First, the fluctuations in bank deposits due to changes in reserves were asymmetric between QE and QT periods, and these asymmetric effects may be offsetting each other. The second possibility is that, after the effects of QE and QT are controlled in the first stages, changes in reserves may not affect those of banks' deposits. Which of the two possibilities is the more plausible interpretation can be discussed based on the results of the subsequent subsample analysis.

Table 8: Results of Second Stage (2SLS): Mar. 2001- Mar. 2024

This table reports the results of the second stage from the 2SLS regression of changes in deposits (: total, demandable, and time deposits) on changes in reserves as well as $z_{it}{}'$s coefficients and F-statistics of the first stage. The sample period is for 24 years of end-of-fiscal year: March 2001 to March 2024. Demandable deposits consist of current, ordinary, savings, and notice deposits. Time deposits consist of time deposits and installment savings. z-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Clustered robust standard errors are used in regression analysis to account for potential correlations within banks of observations.

Instr Variable	$\Delta Ln(Total\ Deposits)_{it}$ Z_{it}^{R1}	Z_{it}^{R2}	$\Delta Ln(Demandable\ Deposits)_{it}$ Z_{it}^{R1}	Z_{it}^{R2}	$\Delta Ln(Time\ Deposits)_{it}$ Z_{it}^{R1}	Z_{it}^{R2}
$Instr\ \Delta Ln(Reserves)_{it}$	-0.232	-0.039	-0.341 *	-0.138	-0.123	-0.006
	(-1.27)	(-0.96)	(-1.78)	(-1.39)	(-0.56)	(-0.15)
$Ln(Reserves)_{it-1}$	-0.110	-0.015	-0.165 *	-0.065	-0.057	0.000
	(-1.22)	(-0.75)	(-1.73)	(-1.31)	(-0.53)	(0.01)
$Ln(Total\ Asset)_{it-1}$	0.009	-0.096 ***	0.072	-0.038	-0.039	-0.103 ***
	(0.08)	(-2.63)	(0.56)	(-0.56)	(-0.31)	(-2.84)
ROA_{it-1}	1.256	0.320	1.596	0.614	1.330	0.764
	(0.65)	(0.29)	(0.58)	(0.26)	(0.69)	(0.58)
$Equity\ to\ Asset_{it-1}$	0.501	0.458	-0.329	-0.374	0.744	0.718 **
	(0.65)	(1.48)	(-0.30)	(-0.62)	(1.36)	(2.10)
$Constant$	0.930	1.549 ***	0.647	1.296 **	1.072	1.446 ***
	(1.02)	(3.66)	(0.60)	(2.10)	(1.18)	(3.23)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs	2795	2795	2795	2795	2795	2795
Number of banks	143	143	143	143	143	143
First Stage						
Z_{it}	-0.003 ***	-0.039 ***	-0.003 ***	-0.039 ***	-0.003 ***	-0.039 ***
F-Stat	40.45 ***	42.67 ***	40.45 ***	42.67 ***	40.45 ***	42.67 ***

3.2. QQE periods

Table 9 presents the estimation results of the second stage of 2SLS using the QQE period beginning in April 2013, from the end of March 2014 to March 2024. We find that reserves have less significant effects on deposits. Interestingly, however, unlike the analysis for the entire period in the previous subsection, the coefficients change to be positive, but significant only in the second column.

As discussed in subsection 2.1.2., when the COVID-19 pandemic occurred in 2020, during the QQE period, the BoJ began strengthening monetary easing in March 2020. The actions included financial support operations, so that more liquidity was available to companies affected by the COVID-19 pandemic. These were terminated in March 2022; consequently, the amount of reserves supplied by the BoJ decreased following March 2022. Thus, we conduct estimations to measure how Japanese banks shifted their portfolios during the QQE period, treating the period only up to February 2022 as the QQE' period.

Table 9: Results of Second Stage (2SLS): QQE (Mar. 2014–Mar. 2024)

This table reports the results of the second stage from the 2SLS regression of changes in deposits (: total, demandable, and time deposits) on changes in reserves as well as $z_{it}{}'$s coefficients and F-statistics of the first stage. The sample period is for QQE periods: 11 years of March 2014 to March 2024. Demandable deposits consist of current, ordinary, savings, and notice deposits. Time deposits consist of time deposits and installment savings. z-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Clustered robust standard errors are used in regression analysis to account for potential correlations within banks of observations.

	$\Delta Ln(Total\ Deposits)_{it}$		$\Delta Ln(Demandable\ Deposits)_{it}$		$\Delta Ln(Time\ Deposits)_{it}$	
Instr Variable	z_{it}^{R1}	z_{it}^{R2}	z_{it}^{R1}	z_{it}^{R2}	z_{it}^{R1}	z_{it}^{R2}
$Instr\ \Delta Ln(Reserves)_{it}$	0.338	0.137 *	0.500	0.150	0.190	0.109
	(1.18)	(1.81)	(1.23)	(1.53)	(0.90)	(1.47)
$Ln(Reserves)_{it-1}$	0.218	0.087 *	0.323	0.094	0.120	0.067
	(1.15)	(1.70)	(1.20)	(1.41)	(0.86)	(1.37)
$Ln(Total\ Asset)_{it-1}$	-0.410 *	-0.267 ***	-0.539	-0.290 **	-0.291 *	-0.234 ***
	(-1.60)	(-2.57)	(-1.49)	(-2.00)	(-1.53)	(-2.65)
ROA_{it-1}	-3.085	-3.436	-4.824	-5.436	-0.800	-0.941
	(-0.96)	(-1.36)	(-0.88)	(-1.31)	(-0.32)	(-0.40)
$Equity\ to\ Asset_{it-1}$	-0.378	-0.596	-0.509	-0.889	-0.924	-1.012 *
	(-0.30)	(-0.96)	(-0.26)	(-0.94)	(-1.14)	(-1.82)
$Constant$	3.608 **	3.067 ***	4.330 *	3.387 **	2.969 **	2.751 ***
	(2.19)	(2.77)	(1.88)	(2.16)	(2.34)	(3.02)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs	1213	1213	1213	1213	1213	1213
Number of banks	117	117	117	117	117	117
First Stage						
z_{it}	0.028 ***	0.030 ***	0.028 ***	0.030 ***	0.028 ***	0.030 ***
F-Stat	56.92 ***	58.17 ***	56.92 ***	58.17 ***	56.92 ***	58.17 ***

Table 10 presents the estimation results of the second stage of 2SLS using the QQE' period from March 2014 to March 2021. All the estimation results which use $\boldsymbol{z_{it}^{R2}}$ as instruments are significantly positive, implying that the change in deposits is positively and significantly affected by changes in reserves. Also, unlike the result of all periods (Table 8), coefficient values on $\boldsymbol{z_{it}^{R2}}$ in the first stage increase, indicating that the increase in reserves during the QQE' period increased individual banks' reserves in the BoJ.

The results for this "pure" QQE period, excluding the post-COVID-19 period of declining reserves from the sample, show that QQE increased both demandable deposits and time deposits. The result for demandable deposits is consistent with that of the macro-econometric analysis in Table 3, suggesting that when the BoJ increased reserves, Japanese banks increased demandable deposits. In other words, the Japanese economy also experienced a maturity-shortening of deposits at the bank level during QE periods[9].

Also, we need to note that, from the viewpoint of banks' rationally matching asset liquidity with their liability liquidity, banks may not have been rational: banks increased their time deposits even though it should have reduced them.

Table 10: Results of Second Stage (2SLS): QQE' (Mar. 2014-Mar. 2022)

This table reports the results of the second stage from the 2SLS regression of changes in deposits (: total, demandable, and time deposits) on changes in reserves as well as $z_{it}{}'$s coefficients and F-statistics of the first stage. The sample period is during the " QQE' " period: 8 years of March 2014 to March 2022. Demandable deposits consist of current, ordinary, savings, and notice deposits. Time deposits consist of time deposits and installment savings. z-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Clustered robust standard errors are used in regression analysis to account for potential correlations within banks of observations.

	$\Delta Ln(Total\ Deposits)_{it}$		$\Delta Ln(Demandable\ Deposits)_{it}$		$\Delta Ln(Time\ Deposits)_{it}$	
Instr Variable	Z_{it}^{R1}	Z_{it}^{R2}	Z_{it}^{R1}	Z_{it}^{R2}	Z_{it}^{R1}	Z_{it}^{R2}
$Instr\ \Delta Ln(Reserves)_{it}$	0.361	0.121 **	0.569	0.136 *	0.241	0.110 *
	(1.11)	(2.15)	(1.23)	(1.81)	(0.94)	(1.88)
$Ln(Reserves)_{it-1}$	0.264	0.086 **	0.415	0.093	0.176	0.078 *
	(1.08)	(2.01)	(1.19)	(1.61)	(0.91)	(1.81)
$Ln(Total\ Asset)_{it-1}$	-0.616	-0.423 **	-0.815	-0.468 *	-0.505 *	-0.400 ***
	(-1.65)	(-2.37)	(-1.55)	(-1.77)	(-1.73)	(-2.92)
ROA_{it-1}	-6.086	-9.434 **	-3.572	-9.611	-6.662	-8.497 **
	(-1.05)	(-2.20)	(-0.36)	(-1.34)	(-1.46)	(-2.40)
$Equity\ to\ Asset_{it-1}$	-3.088	-1.887 **	-5.062	-2.896 *	-2.314	-1.656 **
	(-1.29)	(-2.08)	(-1.29)	(-1.78)	(-1.31)	(-2.05)
Constant	6.331 **	5.584 **	7.583 *	6.235 *	5.677 **	5.267 ***
	(2.10)	(2.25)	(1.79)	(1.72)	(2.43)	(2.82)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs	907	907	907	907	907	907
Number of banks	117	117	117	117	117	117
First Stage						
Z_{it}	0.023 ***	0.042 ***	0.023 ***	0.042 ***	0.023 ***	0.042 ***
F-Stat	49.00 ***	49.03 ***	49.00 ***	49.03 ***	49.00 ***	49.03 ***

3.3. QT periods

Table 11 reports the results of estimating the second stage of 2SLS using the QT period from March 2006 to March 2010. In contrast to the results in QQE, while the change in time deposits is positively and significantly affected by changes in reserves, it is not significant for demandable deposits. Also, the coefficients in the third and fourth columns

[9] This result is consistent with Charoenwong et al. (2021), which examines the effects of BoJ' QE and found that the QE policy increased cash and short-term securities in the assets of non-financial listed firms (: in the liability of financial institutions).

are very small (0.006) and negative (-0.132). This suggests that the maturity-shortening shown in subsection 3.2. does not reverse when the central bank stops injecting or reduces aggregate reserves. The result for time deposits is consistent with that of the macro-economic analysis in Table 4. This suggests that when the BoJ decreased reserves, Japanese banks decreased time deposits. In sum, banks did not behave in a way that would eliminate the liquidity mismatch between assets and liabilities that they faced during QT periods.

Table 11: Results of Second Stage (2SLS): QT (Mar. 2006-Mar. 2010)

This table reports the results of the second stage from the 2SLS regression of changes in deposits (: total, demandable, and time deposits) on changes in reserves as well as $z_{it}{}'$s coefficients and F-statistics of the first stage. The sample period is during the QT period: 5 years of March 2006 to March 2010. Demandable deposits consist of current, ordinary, savings, and notice deposits. Time deposits consist of time deposits and installment savings. z-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Clustered robust standard errors are used in regression analysis to account for potential correlations within banks of observations.

	$\Delta Ln(Total\ Deposits)_{it}$		$\Delta Ln(Demandable\ Deposits)_{it}$		$\Delta Ln(Time\ Deposits)_{it}$	
Instr Variable	z_{it}^{R1}	z_{it}^{R2}	z_{it}^{R1}	z_{it}^{R2}	z_{it}^{R1}	z_{it}^{R2}
$Instr\ \Delta Ln(Reserves)_{it}$	0.066 **	0.081	0.006	-0.132	0.115 ***	0.227
	(2.23)	(0.42)	(0.11)	(-0.46)	(2.76)	(0.53)
$Ln(Reserves)_{it-1}$	0.060 **	0.072	0.013	-0.101	0.096 **	0.188
	(2.11)	(0.43)	(0.28)	(-0.42)	(2.51)	(0.52)
$Ln(Total\ Asset)_{it-1}$	-0.458 ***	-0.463 ***	-0.477 ***	-0.429 *	-0.452 ***	-0.492 **
	(-3.68)	(-3.32)	(-3.05)	(-1.79)	(-4.08)	(-2.23)
ROA_{it-1}	-3.198	-3.892	0.221	6.868	-5.812 *	-11.156
	(-1.53)	(-0.41)	(0.06)	(0.47)	(-1.77)	(-0.52)
$Equity\ to\ Asset_{it-1}$	0.190	0.049	-0.228	1.118	0.180	-0.903
	(0.24)	(0.02)	(-0.26)	(0.38)	(0.17)	(-0.22)
Constant	6.138 ***	6.109 ***	6.912 ***	7.186 ***	5.705 ***	5.485 **
	(3.51)	(3.36)	(3.45)	(2.82)	(3.46)	(2.39)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs	593	593	593	593	593	593
Number of banks	122	122	122	122	122	122
First Stage						
z_{it}	-0.013 ***	-0.016	-0.013 ***	-0.016	-0.013 ***	-0.016
F-Stat	43.81 ***	43.68 ***	43.81 ***	43.68 ***	43.81 ***	43.68 ***

When we include March 2023–2024 in the QT' sample period, the estimation results become clearer. Table 12 shows the second stage results of the 2SLS estimation using the QT' period: March 2006 to March 2010 and March 2023 to March 2024.

The effect of reserves on time deposits is significantly positive, which suggests that the shrinking of reserves during the QT' period decreased time deposits. On the other hand, the decrease of reserves has no significant effects on demandable deposits, and both coefficients in the third and fourth column are negative. These results are in line with Table 5.

Seeing the negative and positive coefficients of demandable and time deposits in Table 12, we might infer that the decrease in time deposits caused the decrease in total deposits. If this inference is correct, it implies that the Japanese economy experienced liquidity dependence during the QT' period, thus increasing the liquidity mismatch between the asset and liability sides in the Japanese banking sector. In other words, although liquidity in the asset side was decreased by the QT policy, liquidity in the liability side increased.

Table 12: Results of Second Stage (2SLS): QT' (Mar. 2006-Mar. 2010 & Mar. 2023-Mar. 2024)

This table reports the results of the second stage from the 2SLS regression of changes in deposits (: total, demandable, and time deposits) on changes in reserves as well as $z_{it}{}'$s coefficients and F-statistics of the first stage. The sample period is during the "QT' " period: 7 years from March 2006 to March 2010, and from March 2023 to March 2024. Demandable deposits consist of current, ordinary, savings, and notice deposits. Time deposits consist of time deposits and installment savings. z-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Clustered robust standard errors are used in regression analysis to account for potential correlations within banks of observations.

	$\Delta Ln(Total\ Deposits)_{it}$		$\Delta Ln(Demandable\ Deposits)_{it}$		$\Delta Ln(Time\ Deposits)_{it}$	
Instr Variable	z_{it}^{R1}	z_{it}^{R2}	z_{it}^{R1}	z_{it}^{R2}	z_{it}^{R1}	z_{it}^{R2}
$Instr\ \Delta Ln(Reserves)_{it}$	0.072 ***	0.057	-0.002	-0.065	0.136 ***	0.121
	(3.17)	(0.69)	(-0.03)	(-0.63)	(3.33)	(0.82)
$Ln(Reserves)_{it-1}$	0.044 ***	0.036	0.004	-0.031	0.076 ***	0.067
	(2.82)	(0.72)	(0.15)	(-0.53)	(2.97)	(0.78)
$Ln(Total\ Asset)_{it-1}$	-0.135 **	-0.120	-0.109	-0.047	-0.170 **	-0.156
	(-2.22)	(-1.16)	(-1.18)	(-0.37)	(-2.42)	(-0.95)
ROA_{it-1}	-2.058	-1.729	-1.066	0.311	-2.625	-2.302
	(-1.27)	(-0.73)	(-0.46)	(0.10)	(-1.02)	(-0.55)
$Equity\ to\ Asset_{it-1}$	0.246	0.298	-0.066	0.154	0.079	0.131
	(0.44)	(0.47)	(-0.12)	(0.22)	(0.10)	(0.15)
$Constant$	1.567 **	1.428	1.641 *	1.060	1.737 **	1.601
	(1.97)	(1.27)	(1.43)	(0.76)	(1.97)	(0.97)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs	794	794	794	794	794	794
Number of banks	125	125	125	125	125	125
First Stage						
z_{it}	-0.013 ***	-0.029	-0.013 ***	-0.029	-0.013 ***	-0.029
F-Stat	25.97 ***	25.96 ***	25.97 ***	25.96 ***	25.97 ***	25.96 ***

Overall, the results in this section suggest that, as in the U.S. economy, the Japanese economy experienced liquidity dependence. Maturity-shortening of deposits at the bank level occurred during QE periods; however, this does not reverse during QT periods. A micro-analysis that considers confounding factors, which are difficult to remove in a macro-analysis, reveals the existence of the liquidity dependence phenomenon in Japan.

We can infer that the asymmetric behavior of banks between QE and QT periods is the underlying reason why no significant results can be obtained in the analysis using the full sample. In addition, z_{it}^{R2} seems to be an appropriate instrument in the QE period, but is not in the QT period. z_{it}^{R1} is vice versa. This suggests that the impact of changes in reserve balances due to monetary policy on fluctuations in each bank's reserve balance may also differ (be asymmetric) between QE and QT periods.

4. Financial fragility derived from banks' asymmetric behavior

Why do banks have asymmetric behavior in their deposit structure during QE and QT? Since short-term interest rates were almost zero during QE, both households and firms had a high incentive to deposit demandable deposits, which offer the same interest rate as time deposits but better liquidity, so that reserves were forced to be financed by demandable deposits. However, since an increase in reserve deposits on the asset side does not increase profits, it was thought that banks might increase the risk-taking incentive to increase the credit line, but they did not seem to be inclined to take such a strong risk take.

On the other hand, after the BoJ moved from QE to QT, positive interest rates are attached to liabilities other than demandable deposits, which creates incentives for households and firms to shift their deposits from demandable deposits to time deposits and other financial assets. Thus, if banks use this as leverage in their efforts to shift demandable deposits to time deposits, the demand for bank liquidity would decline. Alternatively, if banks sell assets such as government bonds, their liquidity demand would also decrease. In practice, however, the shift from demandable deposits to time deposits has not progressed. There may be some imperative reasons for Japanese banks such as maintaining corporate relationships, but they are even trying to collect demandable deposits from a cost-cutting perspective. In view of this, the fact that demandable deposits are not reduced in the QT period may be related to the funding strategy of Japanese banks.

Then, if interest rates continue to rise while some Japanese banks are ratcheting up the risk of liquidity risk, is there any risk of bank liquidity risk materializing in some cases?

In Japan banks of different sizes are regulated differently. Liquidity coverage ratio (LCR) regulations have been applied to internationally active banks, but not to the other smaller banks.

That said, it is important to point out that in Japan, the deposit insurance by the Deposit Insurance Corporation is broader than that of the US. Awareness of the differences between the Japanese and U.S. financial systems is important when considering the impact of BoJ policies and how Japanese banks responded. In the U.S., if a Federal Deposit Insurance Corporation (FDIC) member bank fails, only up to USD 250,000 (approximately JPY 39 million) per account is protected.[10] In contrast, in Japan, deposits for settlement purposes, including current and non-interest-bearing ordinary deposits that meet the following three requirements, are fully protected: (1) they can provide settlement services, (2) the depositor can request reimbursement at any time, and (3) they do not earn interest. Interest bearing ordinary deposits, time deposits, installment savings, money trusts with contracts for compensating the principal, and financial bonds are protected up to 10 million yen in principal per depositor and their interests up to the date of bankruptcy per financial institution. More simply, the most significant difference is that corporate deposits in Japan are fully protected, whereas in the U.S., a large amount of corporate deposits are not protected. Thus, depositor corporations can potentially instantly withdraw those funds, which ultimately led to the collapse of SVB and Signature Bank. Another characteristic of Japanese banks is that they have diversified their yen funding sources by combining a variety of funding sources, especially small, sticky retail deposits. This suggests that the amount of deposits in Japanese banks is also diversified to include uncovered deposits to some extent (Figure 5 and 6). This may lead to stability during normal periods, but could lead to instability when households withdraw funds during a crisis period.

The monitoring by the Financial Services Agency and the Bank of Japan is also to some extent well established. The BoJ monitors the cash flows of individual banks on a daily basis, and the FSA also alerts banks to liquidity risk as necessary.

This extensive deposit protection and meticulous supervision and monitoring by the financial supervisory authorities have reduced liquidity risk in the Japanese financial

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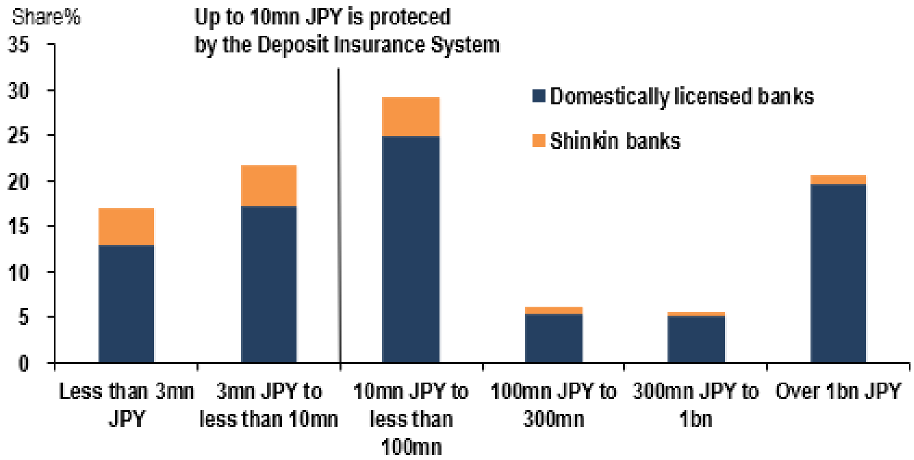
[10] Following the failures of SVB and Signature Bank, the FDIC published its report "Options for Deposit Insurance Reform" on May 1, 2023, the report considers reform of the deposit insurance system in response to the increased likelihood of a bank run due to the increase in uninsured deposits, as well as the increased speed of deposit withdrawals associated with technological advances. Further, the report proposes options for increased deposit insurance coverage: (i) maintaining the current deposit insurance framework and increasing the deposit insurance limit, (ii) introducing full protection, and (iii) applying preferential protection to certain deposits.

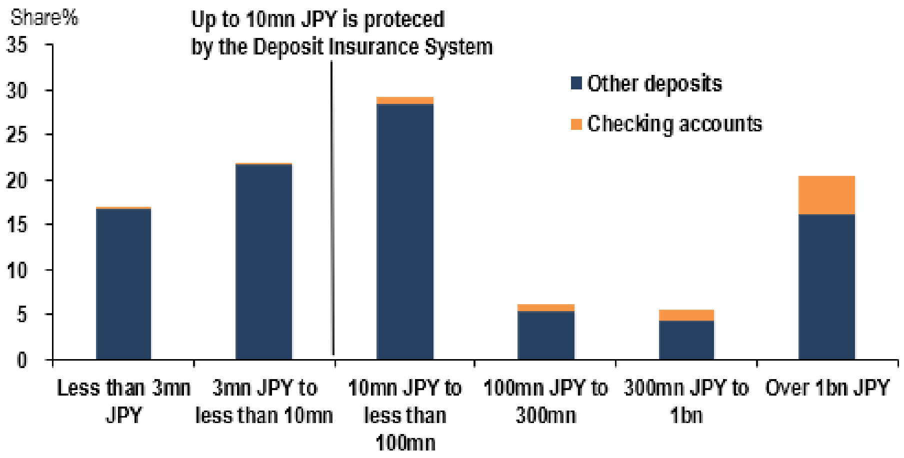
system. However, from the flip side of the coin, this can be interpreted as a sign that Japanese financial institutions have already become, in a broad sense, liquidity dependent, i.e. dependent on the public authorities.

Figure 5：Distribution of Deposit Amounts by type of depository institution



Note: As of the end of March 2024. Shares of deposits of domestically licensed banks and Shikin banks in all deposits (amount basis), excluding financial institution deposits. Source: BoJ, JST

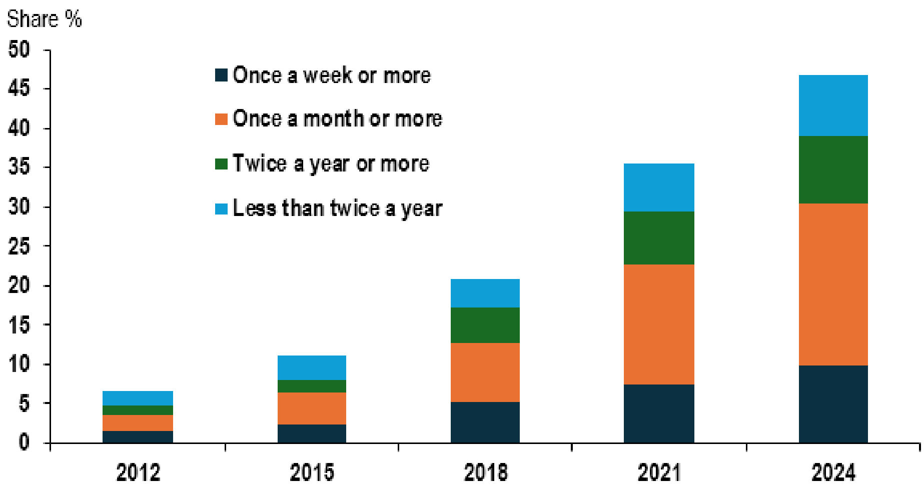
Figure 6：Distribution of Deposit Amounts by type of deposit



Note: As of the end of March 2024. Shares of checking accounts and other deposits in all deposits (amount basis), excluding financial institution deposits. Source: BoJ, JST

On the other hand, the development of digital banking, especially the permeation of mobile apps, has increased the sensitivity of deposits to higher interest rates and risks, as studied by Koont et al. (2024) and others. They find that in the U.S. this deposit sensitivity to changes in FF rate is pronounced (the stickiness of deposits is reduced) for the deposits of banks with a digital platform, which facilitates customers' reallocation of savings from low interest paying deposits to more profitable investments without the need to switch institutions. As for the failure of SVB, they find that the reduced value of the deposit franchise can explain why SVB was insolvent in early March 2023, even before the bank run occurred. Even in Japan, internet banks have emerged, and even the use of mobile apps by regular banks is approaching 50% (Figure 7). From this perspective, it can be inferred that liquidity mismatches increase the likelihood of liquidity risk materializing. This is a subject for future research.

Figure 7：Utilization rate of digital banking in Japan (mobile app)



Source: Japanese Bankers Association

5. Conclusion and Further Research

This study empirically examines liquidity dependence in the Japanese banking system. Acharya and Rajan (2024) and Acharya et al. (2024) pointed out the liquidity dependence phenomenon that was observed during the quantitative easing and tightening policies in the United States and is regarded as a possible factor in liquidity crises in September 2019 and March 2023 crises in the US. Since quantitative easing was introduced in March 2001, the Japanese economy had experienced a longer period of quantitative easing than that in the United States, lasting more than 20 years. Our macro and micro analyses, which use more than 20 years of macroeconomic and bank-level accounting data, revealed the existence of the same phenomenon in the Japanese economy.

Our findings have implications for both financial stability and monetary policy. On the financial stability side, the main takeaway from our findings is that the BoJ's QE may have incentivized an accumulation of liquidity risk in some banks, while the impending QT could not significantly alleviate the accumulation. Interestingly, the central bank's reserve provision could induce bank movements that would make the financial system potentially more vulnerable to liquidity risk. The Japanese economy has a deposit insurance system that is superior to the U.S. system, so an incident like the SVB bankruptcy is unlikely to occur in Japan. In addition, while the Fed raised the policy rate rapidly from 0-0.25% to 5.25-5.5% between 2022 and 2024, accompanied by aggressive QT, the BoJ increased the policy rate much more moderately from -0.1% to 0.5% between 2024 and early 2025, with milder QT. This has also created a significant divergence in financial conditions. Even so, however, we suggest that the Japanese economy needs to prepare for the major quantitative tightening, the exit from the long-term quantitative easing policy. If the sticky retail deposits become more flexible or large shocks affect banks that hold large amounts of flexible retail deposits, a bankruptcy might happen when bank solvency is in question. What conditions could trigger such situations and what types of banks would be vulnerable appear to be fertile areas for future analyses.

On the monetary policy side, one of the channels through which QE is intended to work is "portfolio rebalancing" under the preferred habitat theory (Vayanos and Vila 2021). However, our evidence shows that although the BoJ compressed long-term yields, banks are shortening the maturity of their liabilities by increasing demandable deposits. This limits the maturity-lengthening effect of QE on bank assets (loans), weakening some portion of the portfolio rebalancing channel. It may be necessary to revisit the desirable scale, scope, and duration of the next QE, giving due consideration to the financial stability issue and weakening effect of monetary policy, which also appear to be areas for future research. After eliminating the YCC framework and negative interest rate policy, the BoJ is heading toward a significant QT process. The asymmetric behaviors in transforming the maturity of their liabilities suggests that QT's maturity-shortening effect on their assets may be maintained. This would, ceteris paribus, at least not weaken the tightening effect of QT, contrary to QE's easing effect.

However, if QT has a potentially destabilizing effect on the financial system, as mentioned above, we should reconsider the potential side effects when implementing QE or take preemptive measures to mitigate such effects during the QT period.

References

Acharya, V. V., Chauhan, R. S., Rajan, R., and Steffen, S. (2022) "Liquidity dependence: Why shrinking central bank balance sheets is an uphill task," Jackson Hole Economic Policy Symposium 2022 of the Federal Reserve Bank of Kansas City

Acharya, V. V., Chauhan, R. S., Rajan, R., and Steffen, S. (2024) "Liquidity dependence and the waxing and waning of central bank balance sheets," No. w31050, National Bureau of Economic Research.

Acharya V. V., and Rajan, R. (2024) "Liquidity, liquidity everywhere, not a drop to use: Why flooding banks with central bank reserves may not expand liquidity", Journal of Finance.

Bank of Japan (2023a) "Financial System Report April 2023"

－(2023b), "Financial System Report October 2023"

－(2024) "Outlook Report April 2024"

Charoenwong, B., Morck, R., & Wiwattanakantang, Y. (2021) "Bank of Japan equity purchases: The (non-) effects of extreme quantitative easing," Review of Finance, 25(3), 713-743.

Greenwood, R., Hanson, S. G., and Stein, J. (2016) "The Federal Reserve's balance sheet as a financial-stability tool," 2016 Economic Policy Symposium Proceedings, Jackson Hole: Federal Reserve Bank of Kansas City

Jiang, E. X., Matvos, G., Piskorski, T., and Seru, A. (2024) "Monetary tightening and US bank fragility in 2023: Mark-to-market losses and uninsured depositor runs?", Journal of Financial Economics, 159, 103899

Koont, N., Santos, T., and Zingales, L. (2024) "Destabilizing digital 'Bank Walks'", NBER Working Paper 32601

Lopez-Salido, D., and Vissing-Jorgensen, A. (2023) "Reserve demand, interest rate control, and quantitative tightening," Working Paper, Federal Reserve Board of Governors

Ogawa, K. (2007) "Why commercial banks held excess reserves: The Japanese experience of the late 1990s," Journal of Money, Credit and Banking, 39(1), 241-257

Osada, T., and Liu, C. Y. A. (2021) "Excess reserve accumulation under unconventional monetary policies in Japan," Discussion Paper series, SU-RCSDEA, 002 2021

Rajan, R., (2023) "Less is more," New directions for monetary policy, IMF Finance & Development, Vol. 60, Issue 001

Ugai, H. (2023) "Quantitative easing and tightening that accelerated the recent US banking crisis: Implications for Japan (*Konkai no beiginkō kiki wo kasoku sa seta ryōteki kanwa hikishime: Nihon e no gani*)" *Keizai wo Yomu Me*, 9th issue, Japan Science and Technology Agency

Vayanos, D., and Vila, J. (2021) "A preferred-habitat model of the term structure of interest rates," Econometrica, Vol. 89, No.1