Response of Bank Loans to the Bank of Japan's Quantitative and Qualitative Easing Policy: A Panel Data Analysis

Etsuro Shioji

In recent years, many central banks around the world have conducted quantitative easing, namely a massive expansion of their balance sheets. This paper studies commercial banks' lending behaviors under such a policy regime, using the Japanese data. Since April 2013, the Bank of Japan has executed quantitative easing of an extraordinary magnitude. This is known as the "Quantitative and Qualitative Monetary Easing (QQE)". During this period, the overall size of bank reserves outstanding has become eight times larger in just six years. Yet aggregate data indicates that bank lending and money stock hardly responded. This seems to indicate that the traditional money creation process has totally collapsed. But is the money multiplier really completely "dead"? This paper utilizes a panel data on balance sheets of Japan's regional banks to answer this question. The data is semiannual, consisting of observations from March and September between years 2013 and 2019. I study if a bank, which inherited a larger stock of reserves at the end of a period, would tend to expand its loans more aggressively in the subsequent period.

It turns out to be important to divide the entire QQE period into two. During the first half of our sample period, between March 2013 and September 2015, I find no significant response of bank lending to an increased bank reserves. In the second half, between March 2016 and September 2019, a significantly positive response is observed. However, even for the latter period, the coefficients on bank reserves and government bonds turn out to be about the same: this suggests that injection of bank reserves by the central bank through purchases of government bonds, which has been the most dominant form of central bank transactions under the QQE, has not been effective.

Keywords: Unconventional monetary policy, Quantitative easing, Money multiplier, Panel data, Japanese economy

JEL Classification: E51, G21

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I. Introduction

When a bank, that is already flooded with a sea of excess reserves, is supplied with even more reserves, what do they do with them subsequently? In response to the Global Financial Crisis in 2008-2009, many central banks in advanced countries adopted various measures of unconventional monetary policies, including quantitative easing, or a massive expansion of their balance sheets. Understanding the banking sector's reactions to such policies is crucial for evaluating their effectiveness. In particular, we are interested in the extent to which those extra reserves supplied to the banking sector "leak" out to the non-financial side of the economy through bank lending, and start circulating around there. This is because it is widely believed that it is an increase in money stock, not monetary base per se, that stimulates economic activities.

The Japanese economy during the 2010s offers an ideal ground for investigating this issue. In March 2013, the Bank of Japan started a new policy named the "Quantitative and Qualitative Monetary Easing (QQE)". Under this policy, the overall size of bank reserves outstanding has been blown up to as much as eight times larger in just six years. The sheer size of the policy gives us a hope that we might be able to detect its impact on private banks' lending behaviors, however small it might be in its relative size.

On the surface, it looks like the policy did not have an intended effect. From aggregate data, it does not appear that either bank lending or money stock responded to this policy. This leads one to suspect that there has been a total collapse of the textbook-style money creation process. But is the money multiplier completely "dead"? This paper utilizes a panel data on individual banks' balance sheets to answer this question. I study how a bank, left with a larger stock of reserves at the end of a period, would change its portfolio in the subsequent period.

The data set consists of most of the financial institutions that are legally labelled as "banks" in Japan, with the exception of a few "mega banks" and trust banks that are excluded due to data reasons which will be discussed later. This leaves us with 98 cross sectional observations per period, at the maximum. The data is semiannual, consisting of March and September of every year between 2013 and 2019. This means we have 14 observations per bank, at the maximum.

This study's main findings are as follows. It turns out to be important to divide the sample into two sub-periods. During the first half of the sample period, between March 2013 and September 2015, we find that reserves have no significant impact on lending. This result appears to reinforce the impressions we receive from macro data. In the second half of the sample, which starts from March 2016, we find that the responses turn significantly positive. This period coincides with the time when the QQE was supplemented by the Negative Interest Rate Policy and the Yield Curve Control. However, even for the latter period, the coefficients on bank reserves and government bonds turn out to be about the same. Hence, if the central bank purchases government bonds from commercial banks and provides bank reserves in exchange (which has been the dominant route through which bank reserves have been injected into the economy under the QQE), it would have no effect. This finding casts doubt on the overall effectiveness of this policy framework.

The rest of the paper is organized as follows. Section II reviews the recent evolution the Japanese monetary policy. Section III reviews the related literature. Section IV introduces the data set. Section V overviews the recent behaviors of the Japanese banks based on this data set. Section V explains the empirical strategy of the paper. Section VI offers an overview of the data. Sections VII-IX report the estimation results. Section 10 concludes.

II. Background: Japanese Monetary Policy before and during the 2010s

A. Evolution of the interest rate prior to the QQE

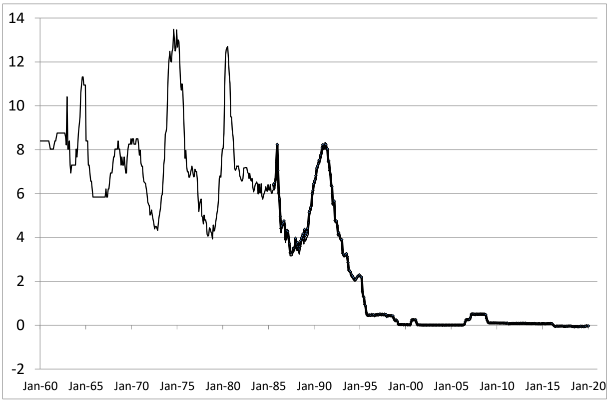
Japan has the longest history of unconventional monetary policies among developed economies in the modern era.[1] This period is characterized first and foremost by the “low for long” phenomenon: a persistently low short term interest rate. Figure 1 shows the evolution of the call rate, which is the representative short-term money market rate in Japan. Panel (A) presents a long view starting way back from 1960. The most typical data on the call rate we see these days on the media is that of the uncollateralized overnight rate. This series is shown with a thick line with markers in the figure. However, for earlier periods, only data on the call rate for collateralized daily transactions is available: this is shown with thin lines. As the figure shows, after the collapse of the asset price bubble in the early 1990s, the BOJ responded by a series of rate cuts. In October 1995, the call rate goes down to as low as around 0.5 percent. Since then, it has never gone above that level, at least until the time of this writing (March 2020). In fact, since the BOJ adopted the so-called Zero Interest Rate Policy (ZIRP) in February 1999, the rate has never been much above 0.1 percent, except for the two brief episodes of "lift-offs" in years 2000 and 2006-2008.

An important event concerning the short term money market in Japan was the introduction of the Interest Rate on Excess Reserves (hereafter IOER) in 2008, which formed a new effective lower bound for the call rate. It was initially set at 0.1 percent and remained at that level until 2016.

B. Evolution of monetary aggregates prior to the QQE

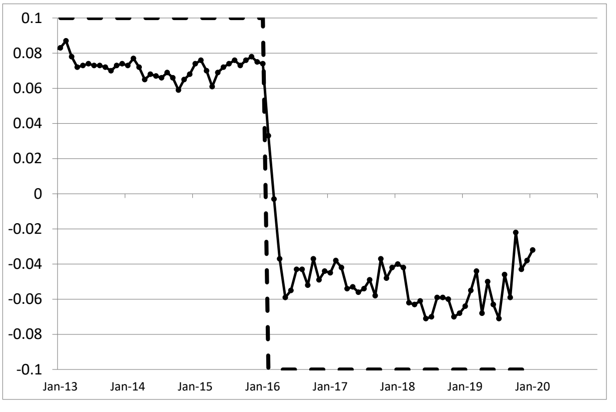
With the call rate stuck at the lower bound, the BOJ turned to other policy measures. Most notably, it adopted outstanding quantities of

[1] Refer to Walsh (2011) for an overview of unconventional monetary policy in the US, which was introduced mainly as a reaction to the Global Financial Crisis in 2008-2009. Refer to Braun and Shioji (2006) for a time series analysis of the effects of monetary policy in Japan (and also in Korea and the US).



(A) Long data since 1960 (in %)

Thin line: with collateral, one day
Thick line with markers: without collateral, overnight
Data source: Bank of Japan Web Site



(B) Data since 2013 (in %)

Thick line with markers: without collateral, overnight
Dashed line: Interest Rate on Excess Reserves (IOER; since February 2016, the lowest applicable rate is shown)
Data source: Bank of Japan Web Site.

Figure 1
Evolution of the call rate (short term money market rate) in Japan

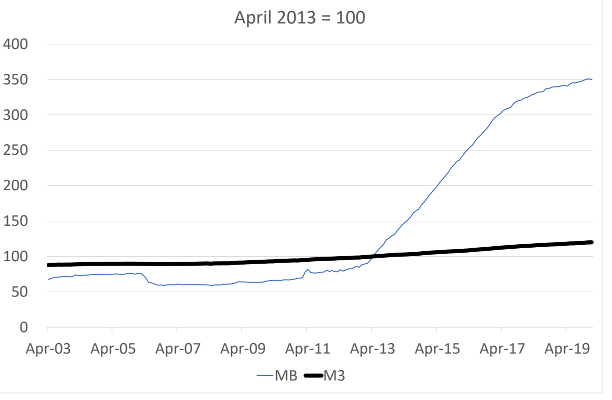
bank reserves (the BOJ Current Account Balance, to be exact) as a new policy tool. This happened twice during the pre-QQE period. First, in March 2001, the BOJ introduced a new policy framework called the Quantitative Easing Policy (QE), and started expanding its balance sheet aggressively. Between this month and February 2006, monetary base became about 1.7 times larger. The BOJ ended this policy in March 2006, based on the economic outlook that was deemed sufficiently good. It began an orderly process of absorbing the massive excess reserves from the market. The BOJ then terminated the ZIRP in July of the same year and re-adopted the call rate as their main policy tool.

The subsequent "normal" regime lasted only momentarily, due to the Global Financial Crisis. In December 2008, the BOJ lowered its target for the call rate to 0.1 percent, or the same level as the IOER. The call rate was thus back at its effective lower bound. In October 2010, the BOJ introduced a new policy framework called the Comprehensive Monetary Easing Policy (CE). Under this policy, the BOJ would expand its balance sheet again. This would be achieved through purchases of various types of unconventional assets, consisting mostly of long-term (as opposed to short-term) Japanese Government Bonds (JGBs hereafter) but also including such exotic items like ETFs (Exchange Traded Funds) and REITs (Real Estate Investment Trusts). This policy was continued until the QQE started.

Figure 2 plots the historical evolution of various monetary aggregates in Japan. All the series are normalized at their respective levels as of April 2013, when the QQE started. In Panel (A), the thin line corresponds to Monetary Base (adjusted for the required reserve ratio and seasonally adjusted). The sample starts from 2003, because there were some drastic definitional changes in monetary statistics in Japan in that year (though it did not affect the data on Monetary Base). We can observe that Monetary Base stayed at a high level until 2006 and then declined once, but then started increasing again near the end of 2010. But all those movements, which seemed drastic then, pale in comparison to what happened afterwards.

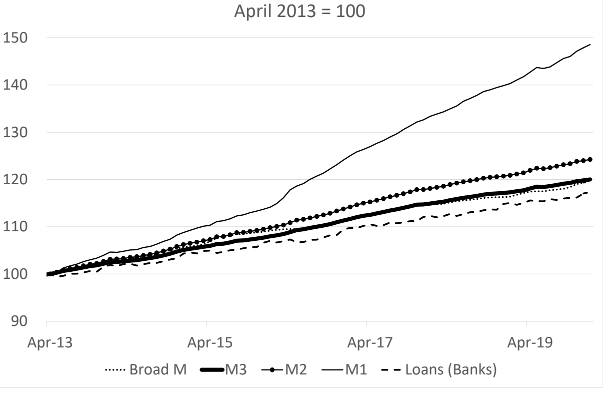
C. The "QQE-1" period: April 2013-September 2014

During the campaign period for the parliamentary election held in December of 2012, the Liberal Democratic Party led by Shinzo Abe promised a massive monetary expansion. They had been projected to win, and in fact claimed a landslide victory in the election. Abe became the new Prime Minister and appointed Haruhiko Kuroda as



(A) Monetary Base (Seasonally adjusted and adjusted for required reserve ratio changes) and M3 (Seasonally adjusted), both normalized to equal 100 in April 2013

Data source: Bank of Japan Web Site.



(B) Broad Money, M3, M2, M1 and Bank loans (all seasonally adjusted), all normalized to equal 100 in April 2013

Data source: Bank of Japan Web Site..

Figure 2
Evolution of monetary aggregates in Japan.

the Governor of the BOJ, who took over the office in March 2013. In the following month, Kuroda declared the introduction of the QQE. It was announced that the outstanding amount of Monetary Base, as well as the BOJ's holdings of the long-term JGBs, were to be doubled in just two years. The goal of this policy was to achieve the two percent

CPI inflation target. Looking at Panel (A) of Figure 2 again, we see that Monetary Base indeed started increasing very rapidly after this announcement.

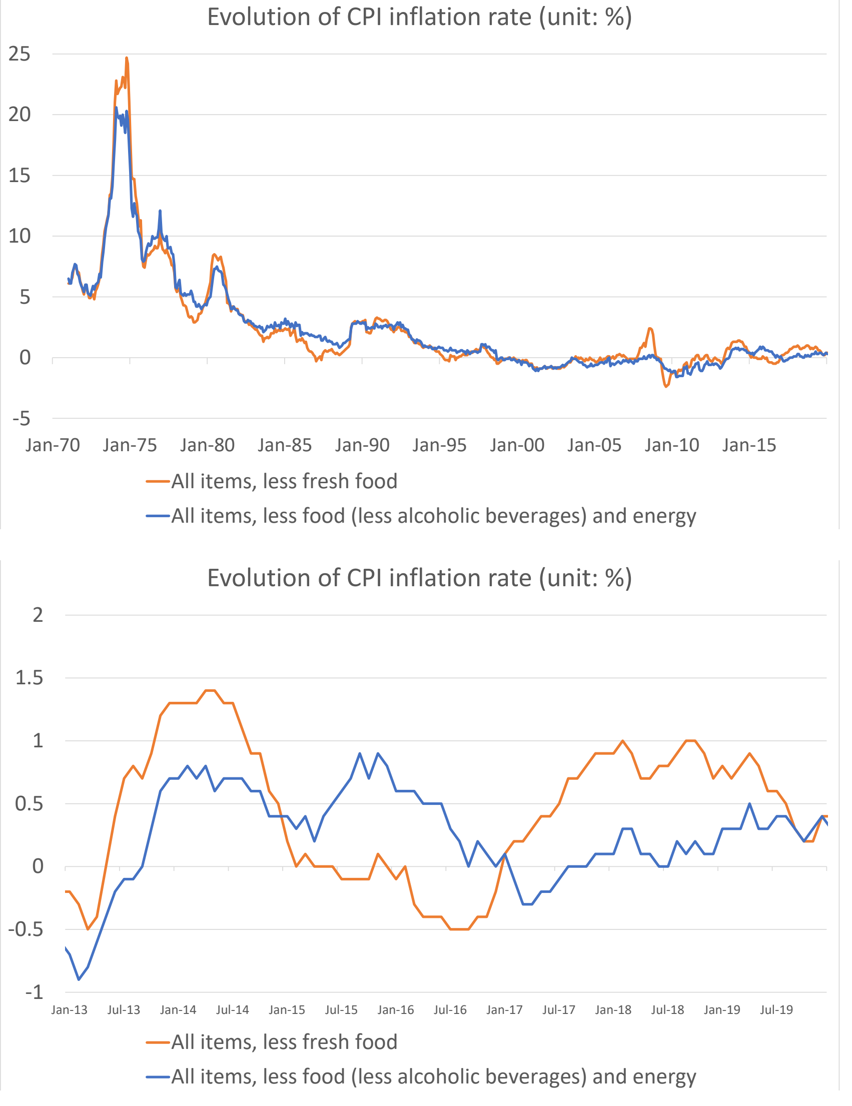
This series of events seems to have had big impacts on the asset market. The stock market responded favorably. And the exchange rate depreciated substantially, starting from the time when the election results were still unknown. The price of the USD in the units of the JPY moved from 78 in early October 2012 to 103 in May 2013, and then to 120 in March 2015. On the other hand, the responses of monetary aggregates were practically non-existent. Going back to Figure 2(A), the thick line shows the evolution of M3 since 2003. It is not possible to detect any notable change in its behavior. This pattern is not confined to this particular measure. In Panel (B) in Figure 2, evolution of other aggregates are compared that of M3. All the series are normalized to equal 100 in April 2013, which is the starting point of this panel. Again, the thick line corresponds to M3. Along with it, evolution of Broadly-defined Liquidity, M2, M1, as well as Loans[2] are shown. None of those series exhibit a rate of increase that is comparable to that of Monetary Base during this period. It seems apparent that the textbook style money creation process failed to work in Japan.

The two panels of Figure 3 show evolution of the CPI inflation. Among various CPI measures, two are shown here. One is “All items, less fresh food”, which the BOJ pays a close attention to. The other is “All items, less food (less alcoholic beverages) and energy”. This indicator is believed to be less sensitive to external shocks such as world oil price fluctuations and exchange rate changes. Panel (A) offers a long historical view starting from 1971. Panel (B) focuses on the period since 2013. From the latter, we can see that, since late 2012, both indices increased. This can be partly attributable to the currency depreciation (Shioji (2015)). However, neither of them reached the BOJ’s target of two percent.

D. The “QQE-2” period: October 2014-January 2016

In the spring and the summer of 2014, the Japanese economy

[2] This is taken from "Loans and Discounts/Total of Major and Regional Banks" from *Principal Figures of Financial Institutions*, available from the BOJ web site.



Source: Ministry of Internal Affairs and Communications of Japan.

FIGURE 3
EVOLUTION OF CPI INFLATION RATE IN JAPAN (MONTHLY)
ABOVE: PANEL (A) PERIOD = 1970-PRESENT, BELOW=PANEL (B) PERIOD = 2013-PRESENT

started to show some signs of weakness, with certain indicators of inflation declining (refer, again, to Figure 3(A)). In October 2014, the BOJ announced a further expansion of the supply of Monetary Base and purchases of long term JGBs. Both were to be increased by 80 trillion yen per year. Unlike the first QQE announcement in 2013, no explicit deadline was set. They simply stated that this policy was to be continued until the two percent inflation target was met. This reinforced version of the policy is now known as "QQE-2". Going back to Figure 2(A), we can see that Monetary Base continued to increase at a fast pace during this period. The same panel also shows that growth in M3 remained modest. Panel (B) of the same figure shows that the situation was similar for other types of monetary aggregates and loans. Figure 3(B) shows that both of the two measures of CPI inflation remained below one percent.

E. The Negative Interest Rate Policy (NIRP) period: February -August 2016

The Negative Interest Rate Policy (NIRP) was announced in January 2016 and was implemented in February. This policy set the marginal IOER applicable to banks with large excess reserves to be negative. To be more specific, they introduced the following three tier system.

[Tier 1] For the part of excess reserves that a bank already held in 2015, the BOJ would continue to pay the 0.1 percent interest.
[Tier 2] For much of the incremental reserves (whose precise definition to be specified by the BOJ), 0 percent interest rate would be applied.
[Tier 3] Only to the remaining excess reserves, the BOJ would apply -0.1 percent interest rate.

Note that Tier 3 would determine the marginal return from putting a bank's fund at the central bank. Hence, by arbitrage, the market interest rate should come down to the level on par with this Tier 3 rate.[3]

[3] It should be pointed out that some banks opted for limiting their reserve holdings up to the amount that would correspond to the Tier 1 plus Tier 2 level. However, even in this case, if they are at the upper limit of the amount which exempts them from the negative rate, their marginal return from putting an additional yen into their BOJ account is determined by the Tier 3 rate.

In fact, Figure 1(B) shows that the call rate was immediately adjusted downward, to a level comparable to the Tier 3 IOER.[4]

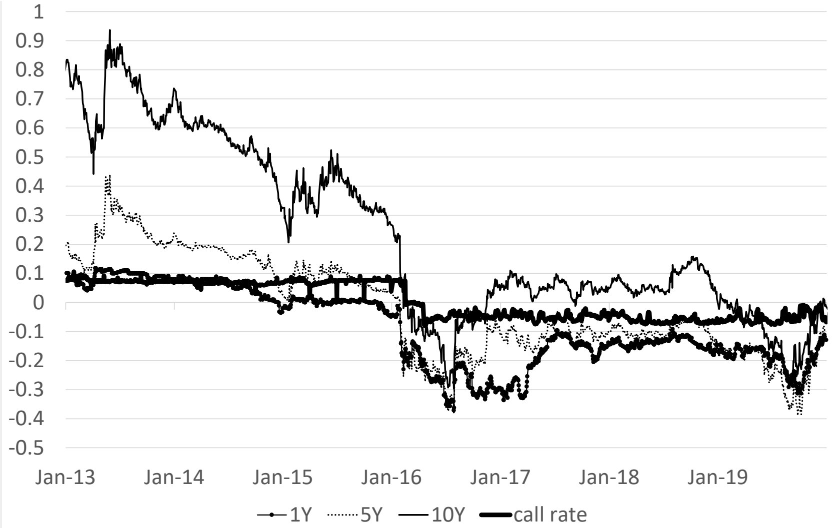
One of (probably unintended) consequences of the new policy was an extreme flattening of the yield curve. Figure 4 plots evolution of the JGB yields. It shows three lines that correspond to yields of newly issued JGBs with different maturities; the line with markers, the dotted line and the thin line each corresponds to 1, 5 and 10 years of maturities. For the sake of comparison, the call rate is shown with a thick line. All of them, that were already at very low levels (the 1 year yield was already negative), experience massive declines at the introduction of the NIPR. For example, for July of that year, monthly average yields for the 1, 5 and 10 year bonds were -0.34, -0.35, and -0.26 percent, respectively. This raised a concern that the policy might harm profitability of private financial institutions, as they held substantial shares of their asset in the form of the JGBs. Possibly motivated by this concern, the BOJ introduces an unprecedented additional policy measure which will be discussed below.

F. The Yield Curve Control (YCC) period: September 2016 -

In September of the same year, the BOJ decided to supplement the NIRP by the Yield Curve Control (YCC). This meant that the BOJ would try to stabilize the 10 year JGB yield around 0%. Figure 4 shows that the yield curve steepened to some extent, thanks to this policy. This policy continued throughout the rest of the sample period of this study.

Going back to Figure 2(A), we notice that Monetary Base continued to increase, but the pace has slowed down somewhat. This is because the amount of JGB purchases by the BOJ that was required to maintain the target yield decreased during this period. The same panel shows that this change of pace hardly affected the evolution of M3. We can say the same thing about the other monetary aggregates shown in Figure 2(B).

[4] The gap between the Tier 3 IOER and the call rate can be explained by the presence of financial institutions that do not have access to the BOJ Current Account. Also, the presence of some banks which restricted their overall holding of reserves to the Tier 1 plus 2 levels (refer to the previous footnote) might be contributing to this.



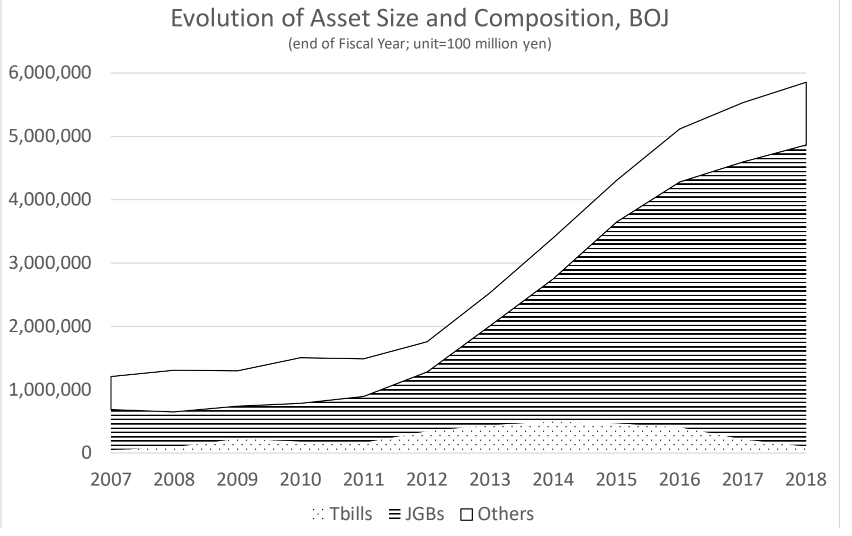
Sources: JGB Yields: Ministry of Finance, Call Rate: Bank of Japan.

FIGURE 4
EVOLUTION OF THE JGB (JAPANESE GOVERNMENT BOND) YIELDS AND THE CALL RATE (DAILY DATA, UNIT = PERCENTAGE.)

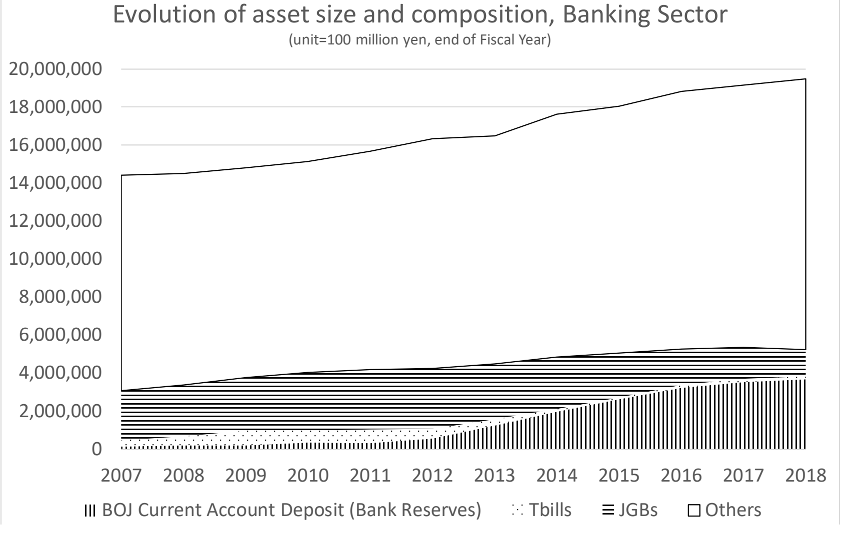
G. How has the QQE transformed the Japanese Financial Sector?

Before closing this review section, it would be useful to look back and observe how this sequence of radical policies has changed the landscape of the Japanese financial system. The most important change was undoubtedly the massive expansion of the size of the central bank balance sheet.[5] It should also be noted that this policy resulted in drastic shifts in the composition of assets for both the BOJ and the banking sector. Figure 5(A) depicts the evolution of the total size as well as the composition of the BOJ's asset since the Fiscal Year (hereafter FY) 2007 (the Japanese fiscal year starts from April and ends in March of the following year). By the end of FY 2018 (namely March 2019), the

[5] It should be noted, however, that this was achieved mainly through purchases of government debt in the hands of the private sector. Hence, the size of the total debt that the "consolidated government", namely the government in the conventional sense plus the central bank, owed to the private sector was hardly affected by this policy



(A) Bank of Japan



(B) Banks

Source: Flow of Funds, Bank of Japan.

FIGURE 5
EVOLUTION OF ASSET SIZE AND COMPOSITION BY SECTOR

share of the Tbills and the JGBs combined had surpassed 80% of its total asset. Figure 5(B) shows how the private banking sector's asset size and its composition have evolved over time. It can be seen that Bank Reserves soared in its share, while the shares of the Tbills and the JGBs declined, as they were purchased en masse by the BOJ.

III. Related Work: Evidence on the QE's Effects on Bank Lending

Here I will briefly review the literature, focusing narrowly on papers that have studied the effects of the QE on bank lending.

A. Evidence from the US

Several studies have looked at the QE's effects on bank lending using panel data sets of banks. Chakraborty, Goldstein and MacKinlay (2017) and Rodnyansky and Darmouni (2017) both study the effects of the QE on bank lending in the US. The idea is to take advantage of differences in banks' exposure to different types of QEs. To give an example, a bank that has a large MBS-to-asset ratio is deemed more exposed to the central bank's MBS purchases. This kind of information can be utilized to estimate the effects of various types of central bank asset purchases. Luck and Zimmermann (2018) use the same idea to gauge the effects of the QE on employment.[6]

On the other hand, Kandrac and Schlusche (2017)'s idea is to pick up an event that caused an exogenous change in the supply of bank reserves, that affected some banks but not the others. Specifically, they used the Dodd-Frank Act of 2010. This legislation augmented the cost of reserves holding for most banks, except for some foreign banks (as they do not receive deposit insurance). By utilizing this distinction for estimation, they conclude that an exogenous increase in reserves induces banks to expand their lending, especially loans that are risky.

B. Evidence from Europe

Joyce and Spaltro (2014) and Butt, Churm, McMahon, Morotz, and

[6] Chakraborty, Goldstein and MacKinlay (2017) is also unique in that they utilize a bank-firm matched data set.

Schanz (2014) study the UK data. They ask if a bank, that has seen an increase in their deposits due to the QE, is more likely to increase its loans later. The first paper uses a sample including a long period prior to the QE. The second paper uses data just from the QE period. The results turn out to be very different. Tischer (2018) studies German data.

C. Evidence from Japan

Again, I will focus on empirical work that studies the QE's effects on bank loans.[7] Hosono (2006) studies the bank lending channel of conventional monetary policy (*i.e.*, interest rate control) using a panel data on Japanese banks. Shioji (2004) adopts his empirical framework to study the effects of bank reserves. Shioji (2019) revisits the topic with much longer sample periods: he uses annual data for the years 1975-2013 and semi-annual data for 1995-2017. The semi-annual data used in the current study is taken from the same source, but this paper focuses exclusively on regional banks, and the sample period is limited to the QQE era. Also, the dataset is updated all the way up to 2019, which enables us to look for a structural change between the first and the second phases of the QQE.

Bowman, Cai, Davies, and Kamin (2015) also study a panel data of Japanese banks, for the period 2000-2009. They find that a bank's liquidity asset to total asset ratio has a significantly positive impact on loan growth. Inoue (2013) uses a similar empirical framework and estimates effects of changes in the BOJ's target for total reserves outstanding (at the macro level) on lending by individual banks. Tachibana, Inoue and Honda (2017) estimate effects of bank reserves at the level of each individual bank on its loans. For the years 2001-2014 (or 2013 in some cases), they find that a larger supply of bank reserves promotes loan growth subsequently.

Finally, Hosono and Miyakawa (2014) study a bank-firm matched data. They find that QE has helped weaken a negative effect of liquidity constraint on bank lending.

[7] Fukunaga, Kato and Koeda (2015) and Koeda (2017) study portfolio rebalancing effects of the QE on the bonds market.

IV. Data Set

A. Basics

Data on individual Japanese regional banks' balance sheets (and related financial statements) are used. The main source of information is *Nikkei NEEDS Financial Quest*. The original dataset contains information on all the commercial banks since 1975. This paper utilizes the Consolidated Financial Statements. The data is semi-annual. At the end of each Japanese fiscal year, namely at the end of March, banks issue their annual financial reports. In addition, the interim financial reports are issued at the end of every September. By combining those two, despite the relative shortness of the QQE era, we can construct a data set of a respectable size.

B. Why Use Consolidated Financial Statements?

The main reason for the use of Consolidated Accounts is that the most crucial piece of information cannot be obtained from Standalone Financial Statements of individual banks. Until March 2013, banks were reporting their Bank Reserves outstanding in their Standalone Balance Sheets issued every March. However, most of them stopped this practice since March 2014. Fortunately, there exists a close alternative, but only in Consolidated Financial Reports. In the Cash Flow Statement (not the Balance Sheet), there is an item called "Cash and Equivalents". This is essentially equal to Cash plus Reserves.[8] Hence the main difference between the standard measure and my proxy is the inclusion of cash in the latter.

To get a sense on how closely this proxy tracks the true number, I do the following analysis. As indicated above, banks used to report both numbers, at least for March. Hence, on the one hand, I compute the ratio between Bank Reserves and Total Asset, both taken from the Standalone Statement. On the other hand, I calculate the share of Cash and Equivalents in Total Asset, both taken from the Consolidated Statement. I compute the correlation between the two shares across

[8] This item includes deposits that each bank makes at other institutions. However, it excludes deposits made at the other private financial institutions. This practically leaves deposits made at the central bank, or bank reserves, as the only remaining component.

regional banks, for every March between 2000 (when banks started reporting my proxy measure) and 2013. I found that the correlation is always over 0.9 except for 2000. Importantly, in the years 2012 and 2013, it exceeds 0.988. This is presumably because, under the CE policy regime mentioned in Section 2, Bank Reserves greatly expanded. This should have lowered the relative importance of Cash, which creates a wedge between the two measures. It is thus likely that, during the QQE era, in which Bank Reserves expanded much further, their differences have become negligible. For this reason, I feel comfortable using this proxy for the purpose of this study.

C. Treatment of Potential Seasonality

One potential pitfall with the use of the semiannual data is the possibility of seasonality in the series. For example, a bank might face loan demand that fluctuates regularly over the course of a year. Supply of deposits could be equally seasonal. The situation is further complicated by the possibility that those patterns could be different across the banks. For example, seasonality experienced by a bank in an agricultural area could be very different from that of another bank in a region that relies on fishing. Thus, standard approaches to deal with seasonality that is common across cross sectional units, such as inclusion of seasonal dummies, are likely to be inappropriate. For this reason, in this paper, much of attention will be paid to year-on-year type measures, namely March-to-March as well as September-to-September changes.

D. Why Focus on Regional Banks?

A major disadvantage with the use of the Consolidated Account is that it is not suitable for analyzing big banking corporations. They are often characterized by very complicated corporate structure with many group firms, including some that are engaged in completely non-financial activities. And a group might consist of more than one bank under an umbrella of a holding company, and those banks could be quite different in nature and could be acting mostly independently with each other in their day to day businesses. For this reason, I have decided to focus on regional banks, which tend to have simpler corporate structure.

In the Japanese regulatory definition, among the financial institutions that hold Banking Licenses (thus excluding smaller entities such as Credit Unions and Credit Associations), those banks that are in my dataset correspond to “Regional Bank” and “Regional Bank II”. This means excluding all the banks that fall into the category of “City Bank”. I also exclude “Trust Bank” and “Others” (such as Sony Bank and Postal Bank), and foreign bank subsidiaries. As of December 2019, there were 4 City Banks, namely Mizuho, Sumitomo-Mitsui, MUFG, and Resona, 14 Trust Banks, 15 Others, and 56 Foreign Bank Subsidiaries, while there were 64 Regional Banks and 38 Regional Banks II. In addition, there was 1 bank which was in neither of those categories (because it is under jurisdiction of a regional office of the Ministry of Finance), namely Saitama Resona Bank, which is included in the data set.

According to the Bank of Japan Statistics, during our sample period, Regional Banks represented around 35-37% of the total asset of the Domestically Licensed Banks in Japan. They also represented 48-51% of total lending of the same broad sector. The entire sector of Domestically Licensed Banks, in turn, accounted for around 56-57% of the total asset and 71-73% of loans of the entire sector of Depository Corporations, which includes the Postal Bank, Credit Unions, etc.

E. On Bank Mergers

In recent years, some of the regional banks in Japan are also forming corporate groups through mergers. For example, in 2006, Fukuoka Bank and Kumamoto Family Bank (now called Kumamoto Bank) agreed to set up a stock holding company called Fukuoka Financial Group. They both became its subsidiaries and were delisted from the market. The group later added Shinwa Bank in 2007 and Ju Hachi Bank in 2019. In such cases, the stock holding company itself is excluded from the sample, while each member bank is included, to the extent that it still issues a consolidated financial report (which may not be the case if it has no subsidiary of its own) and reports all the necessary statistics.

Appendix summarizes major cases of data discontinuity within this paper’s sample. A bank may be dropped from our data source when it merges with another bank or joins a financial group and stops issuing its own Consolidated Financial Statement. Sometimes, a bank simply stops reporting relevant numbers. This happens when a bank is already a part of a financial group and obtains an official permission to terminate issuance of its own financial statement, leaving the burden to the stock holding company. In one instance, two banks, which had been a part of the same financial group, suddenly started reporting their own numbers.

F. Sample Size

The frequent occurrence of mergers during this period inevitably means that the sample size tends to shrink over time, as there has been no new entrant into the regional banking business. Figure 6 depicts how the number of banks per year, included in our GMM estimation sample which will be discussed later, evolved. As we can see, the number starts from around 90 but eventually goes down, at the end of the sample period, to 62.

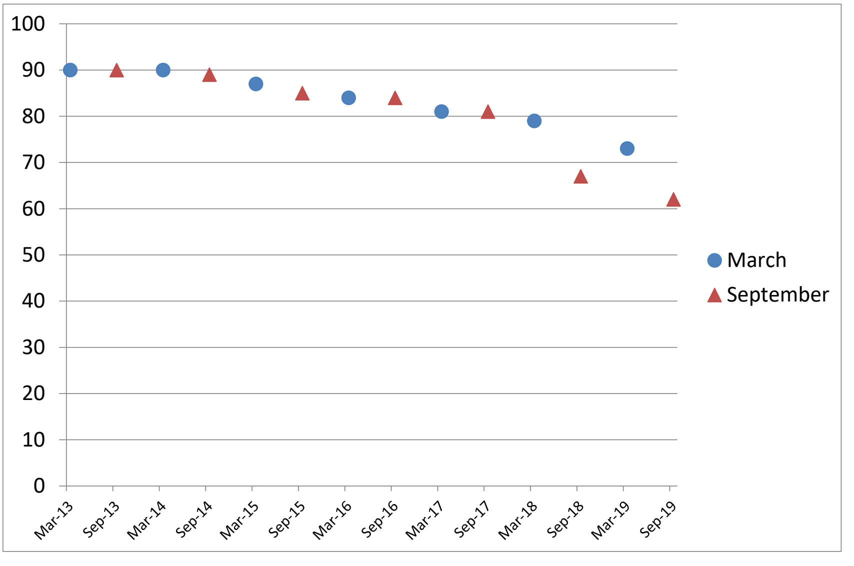


FIGURE 6
EVOLUTION OF THE NUMBER OF OBSERVATIONS (I.E., BANKS IN THE DATA SET) PER YEAR, FOR THE GMM ESTIMATION

G. Variables

Here, I will list variables used in the estimation. For the sake of exposition, I will omit the subscripts for an individual bank and time period, *i* and *t*, respectively.

(i) Variables from Balance Sheets

- *ASSET*: Total amount of asset outstanding.
- *LOAN*: Loans and Bills Discounted (includes overseas loans)
- *JGB*: Government Bonds[9]
- *MUNI*: Local Government Bonds (issued by prefectures, city governments, etc.)
- *OTHERSEC*: Securities other than government bonds, corporate bonds or stocks (examples are foreign securities, such as securities issued by foreign entities and foreign currency denominated bonds issued by Japanese nationals).
- *DEPOSIT*: Sum of Deposits and CDs (Negotiable certificates of deposit).

(ii) Other bank-level variables

- *CASHEQ*: Cash and Equivalents (refer to the above discussion)
- *NPL*: Non-Performing Loans (outstanding amount of "Risk Monitored Loans" as defined by the Financial Reconstruction Act)
- *PROFIT*: Net Income (from the Profit and Loss Statement)
- *LOAN_LOSS*: Written-off of Loans (same source as above)
- *PROVISION*: Provision of Allowance for Loan Losses (same source as above)
- *CAPRATIO*: Capital Adequacy Ratio (as defined by the Bank for International Settlement, whenever available; otherwise, I used the Ratio as defined by the Japanese National Standard).
- *LOAN_RATE*: Loan Interest Rate, estimated by dividing Interest on Loans and Discounts (from the Profit and Loss Statement) by the total amount of Loans (evaluated at the beginning of the period)

[9] In the midyear financial reports submitted in September, most banks report only the total value of securities holdings, and do not provide its breakdowns in their Balance Sheets. However, in the "note" section of the PDF version of their financial reports, inside the section on "securities-related matters", they report their holdings of the JGBs etc., broken down into several items. I have collected those numbers and computed the sums for each type of security.

(iii) Variables used for construction of instruments

Those variable will be discussed later when I introduce the GMM approach.

V. Overview of the Data

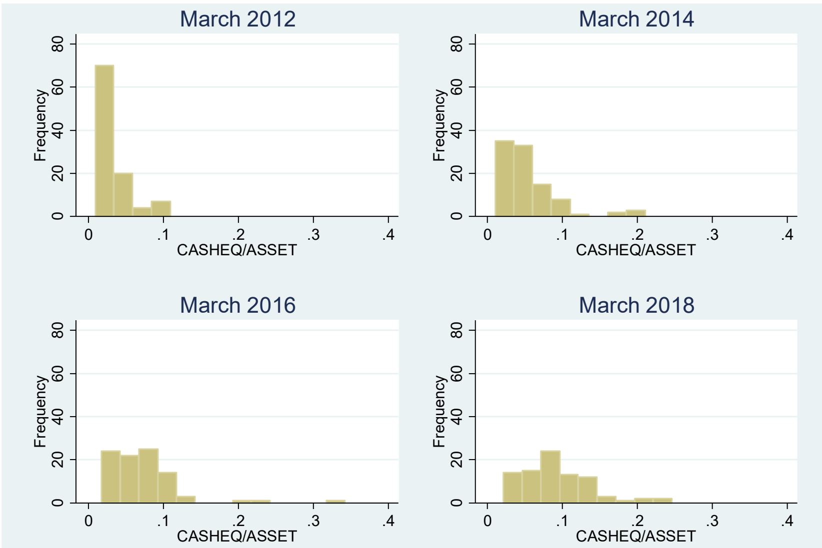
A. Evolution of the Cross Sectional Distribution of Asset Composition

In *Figure 7(*A), each of the four panels shows cross sectional distribution of Cash and Equivalents as a share of Total Asset, or $CASHEQ_{i,t}/ASSET_{i,t}$, using the notations introduced above. The upper-left panel shows the histogram for March 2012, a year before the QQE policy started. The upper-right panel is for March 2014, which is during the QQE1 era. The lower-left panel corresponds to March 2016, that is, right at the beginning of the NIRP period. Lastly, the lower-right panel is the histogram for March 2018. A contrast between the upper-left panel with the others is visible. Even in March 2012, when Japan was already in the era of the CE policy, the distribution was far more concentrated, at relatively low levels. Moving across the panels, the heterogeneity across the banks increases greatly in March 2014, and the distribution flattens further in March 2016. Between March 2016 and March 2018, the difference is small.

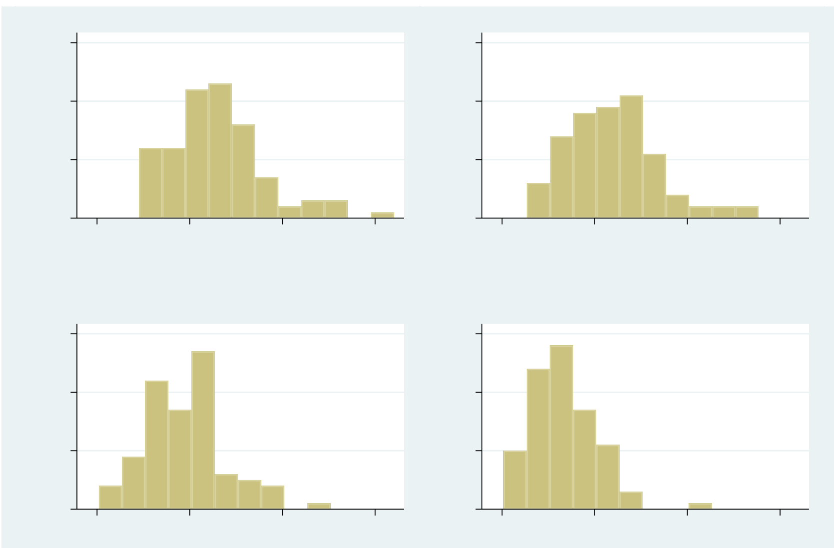
In *Figure 8*, I repeat the same exercise for the JGB-to-Asset ratio, namely $JGB_{i,t}/ASSET_{i,t}$. We see that the distribution gradually moves to the left over time, and, between March 2016 and March 2018, banks are being concentrated into a very low level. In fact, when I did a similar exercise for CASHEQ+JGB, the distribution no longer exhibited a notable change in either direction over time.

B. Did the Flood of Reserves Translate into More Lending? A First Look

It would be interesting to see how the differences in the amount of CASHEQ supplied from the BOJ would impact subsequent behaviors of the receiving banks differently. As a first pass, I create some simple plots to see what the raw data can tell us. In Figure 8(A), I pool all the observations and plot the change in Loans from a year ago (namely two periods before, as the data is half yearly) against the level of Cash and Equivalents a year ago. Both are normalized by the level of Asset a year ago. That is, the vertical axis corresponds to $(LOAN_{i,t}-LOAN_{i,t-2})/ASSET_{i,t-2}$, while the horizontal axis is $CASHEQ_{i,t-2}/ASSET_{i,t-2}$. I excluded



(A) Histogram of CASHEQ/ASSET across banks at each point in time



(B) Histogram of JGB/ASSET across banks at each point in time

Figure 7

Figure 8

Scatter plot of loan growth during a one-year period against CASHEQ/ASSET at the beginning of the period

some outliers (specifically, seven observations with the loan growth measure exceeding 0.2). We observe no clearly systematic pattern here.

In Panel (B), I redo the figure after taking out bank-specific means from both variables. This is an attempt to purge bank fixed effects that might affect the two variables in systematic ways. In Panel (C), I subtract time-specific means from the two and redo the plot. In both cases, the correlation remains essentially zero. Finally, in Panel (D), I take deviations of both variables from their respective bank-specific means, compute time-specific means of those deviations, and then subtract those means from the deviations. It is hard to see from the figure, but the correlation turns just slightly positive; it is now around 0.05, even after taking out some extreme observations.

In Panels (E) and (F), I split the sample period into two and redo the analysis that I did in Panel (D). Panel (E) corresponds to the First Half, which is March 2013-September 2015. Panel (F) is for the Second Half, which spans the period March 2016-September 2019. While we lose any trace of a positive relationship in Panel (E), Panel (F) appears to indicate a positive correlation which is slightly more visible compared to the one we found in Panel (D). In fact, the correlation is now around 0.1, even after dropping some extreme observations.

It would be important to see this casual observation would withstand a further scrutiny, especially for the Second Half. I now turn to a more formal statistical analysis.

VI. Empirical Specification

This paper employs dynamic panel data approaches to estimate the relationship between the level of CASHEQ at one point in time and the subsequent growth in LOAN, holding constant other possible determinants of the latter. Two different methodologies will be tried: the System GMM and the Mean Group Estimator.

I will first specify our empirical model. The left-hand side variable will be the amount of bank loans outstanding at time *t*. On the right-hand side will be the past level of bank loans and other Balance Sheet variables that characterize the composition of the bank's assets, as well as CASHEQ, all evaluated at time *t*-2. In addition, it is known that, when more deposits flow into a bank, the bank tends to increase its loan. For that reason, I include the contemporaneous amount of deposits on the right-hand side.

It would be convenient to standardize all those Balance Sheet variables and *CASHEQ* on both sides of the equation in the same manner, as it would facilitate us in deriving quantitative implications of estimated results later. I have chosen *ASSET* at time *t*-2 as the common normalizing variable.

Other control variables include the share of non-performing loans, the capital adequacy ratio, etc. Below is the list of the variables used for the estimation.

[Dependent Variable]

- **LOAN_NOLAG**: loan outstanding at time *t*, normalized by total asset outstanding two periods (*i.e.*, one year) ago; in equation, it is defined as $LOAN_{i,t}$ / $ASSET_{i,t\text{-}2}$.

[Lagged Dependent Variable as an Explanatory Variable]

- **LOAN_LAG**: lagged loan, defined as $LOAN_{i,t\text{-}2}$ / $ASSET_{i,t\text{-}2}$.

[Other Lagged Explanatory Variables]

- **CASHEQ_LAG**: $CASHEQ_{i,t-2}$ / $ASSET_{i,t-2}$.
- **JGB_LAG**: $JGB_{i,t-2}$ / $ASSET_{i,t-2}$.
- **MUNI_LAG**: $MUNI_{i,t-2}$ / $ASSET_{i,t-2}$.
- **OTHERSEC_LAG**: $OTHERSEC_{i,t-2}$ / $ASSET_{i,t-2}$.
- **NPL_LAG**: $NPL_{i,t-2}$ / $ASSET_{i,t-2}$.
- **PROFIT_LAG**: $PROFIT_{i,t-2}$ / $ASSET_{i,t-2}$.
- **LOAN_LOSS_LAG**: $LOAN\_LOSS_{i,t-2}$ / $ASSET_{i,t-2}$.
- **PROVISION_LAG**: $PROVISION_{i,t-2}$ / $ASSET_{i,t-2}$.

[Contemporaneous Explanatory Variables]

- **DEPOSIT_NOLAG**: deposit, defined as $DEPOSIT_{i,t}$ / $ASSET_{i,t-2}$.
- **CAPRATIO_NOLAG**: simply defined as $CAPRATIO_{i,t}$.
- **LOAN_RATE_NOLAG**: likewise, defined as $LOAN\_RATE_{i,t}$.

[Time dummies]

- Time dummies for all the periods will be included (except for the analyses in Section 8, as will be discussed later).

VII. Results I: System GMM

A. Why GMM?

The most commonly used methodology for panel data analyses would be the Fixed Effect Approach. However, this method could introduce biases into the estimated coefficients, for three reasons. First, in a "dynamic panel" setting, this approach is known to produce a downward bias in the estimated coefficient on the lagged dependent variable.

Second, some might argue that CASHEQ on the right-hand side could be endogenous, even if we are using its lagged value. For example, suppose that a bank has just decided to expand its loans in future. Then it might also wish to increase its reserves holdings, to prepare for a greater default risk. It is not totally inconceivable to argue that, if it takes a long time to build up the reserves, the bank might start doing it now rather than later.

Third, some of the other right-hand side variables could also be endogenous, especially those ones that are not lagged. For example, we could argue that the contemporaneous deposit on the right-hand side is jointly determined with loans on the left-hand side. It is said that some Japanese banks, when making loans, routinely ask borrowers to open a deposit account and to put a part of their borrowings that they do not need to spend immediately into this account.

In an attempt to overcome those problems, in this section, I employ the System GMM approach developed by Blundell and Bond (1998).[10] This methodology involves estimating two types of equations simultaneously. First, in the "difference" equation, we take time differences of the left-hand side as well as all the right-hand side variables. Lagged levels of the explanatory variables are used as instruments. Second, in the "levels" equation, variables on both sides of the equation enter in their levels. Lagged differences of the regressors are used as instruments.

B. Estimation details

Note that, in this study, there are two sets of observations for each bank, one consisting of observations from March, and the other from September. I have decided to treat those two as independent observations; in other words, I pretend as if they are observations on different banks. On the one hand, this treatment causes inefficiency. In reality, there are almost certainly some correlations between the March and the September observations for the same bank. They could be exploited to improve efficiency of the estimation, if correctly specified. Such a chance is lost with this approach. On the other hand, the above treatment allows me to ignore the tricky issue of how to deal with the correlation structure between the two overlapping observations, namely the March-to-March changes and the September-to-September changes, while taking into account possible bank-specific seasonality.

In implementing the system GMM, we must decide on up to how many lags of the explanatory variables should be used for the purpose of instrumenting, both for the differences equations and the levels equations. I have decided to use just one lag (note that one period here means one year). This is because using too many instruments, especially those that are lagged many periods, often leads to a weak instrument problem.

Also, for this estimation, I use a one-step GMM. That is, I do *not* use

[10] Shioji (2019) uses the Difference GMM of Arellano and Bond (1991).

the estimated variance-covariance matrix obtained from the first step to construct the weighting matrix for the second step and re-estimate. Theoretically speaking, a two-step GMM should provide an efficient estimate, asymptotically. In practice, it is known that a potential cost of imprecisely estimating the weighting matrix often outweighs the benefit.

C. Additional instruments: Macro shock variables

In addition to the standard instruments, namely lagged levels and differences of the regressors, as well as the time dummies, I introduce some instruments that are meant to capture demand side disturbances. Effects of a macro shock, if it truly impacts all the banks uniformly, would be eliminated by the time dummies. However, it is often the case that different regions are characterized by varying degrees of exposure to certain types of macro shocks. Hence, in response to such shocks, loan demands for banks in various regions would move differently. The following instruments are meant to capture such region-specific aspects of macro shocks.

(i) Earthquake variables: In March 2011, Japan was hit by a strong earthquake. Damages were especially large for three prefectures in the northern part of the country, Iwate, Miyagi, and Fukushima. For much of our sample period, they were in a continuing process of recovery. It is likely that banks in those regions experienced changes in loan demand that were very different from those of other regions but largely common within the region. To take into account such region-specific demand shocks, I include interaction terms between dummies for each of those three prefectures and each of the 14 time dummies (in the case we use the whole sample). This adds 42 new variables to the list of instruments.

(ii) Public investment dependency variables: During this period, the Japanese government increased public investment spending substantially. This policy likely benefited regions that are heavily dependent on public works, mostly in the rural area. Here, I first measure each prefecture's exposure to a public investment shock by the share of public investment in the prefectural GDP in the year 2014. Then I multiply this variable with each of the 14 time dummies (if the sample is for the whole period), resulting in 14 additional instruments.

(iii) Export dependency variables: Many regions in Japan are heavily reliant on foreign exports. An example is Aichi, where Toyota's headquarters is located. They are likely to be susceptible to export demand fluctuations. Each prefecture's export dependence is measured by the share of exports in GDP as of 2014, and it is multiplied with each of the 14 time dummies (again, this number is for the whole sample), to create 14 new instruments.

Table 1
Summary statistics

(1) Whole Sample

	Mean	Std. Dev.	Min	Max
LOAN_NOLAG	0.6532	0.0740	0.4673	0.8707
LOAN_LAG	0.6333	0.0713	0.4540	0.8613
DEPOSIT_NOLAG	0.9130	0.0471	0.6323	1.1116
CASHEQ_LAG	0.0614	0.0416	0.0092	0.2424
JGB_LAG	0.1049	0.0490	0.0000	0.2743
MUNI_LAG	0.0354	0.0242	0.0000	0.1353
OTHERSEC_LAG	0.0504	0.0292	0.0000	0.1697
NPL_LAG	0.0181	0.0081	0.0046	0.0754
PROFIT_LAG	0.0026	0.0013	0.0000	0.0231
LOAN_LOSS_LAG	0.0001	0.0003	-0.0001	0.0080
PROVISION_LAG	0.0002	0.0010	-0.0009	0.0321
CAPRATIO_NOLAG	11.08	2.42	6.17	21.41
LOAN_RATE_NOLAG	0.0073	0.0020	0.0042	0.0192

(2) First Half

	Mean	Std. Dev.	Min	Max
LOAN_NOLAG	0.6568	0.0734	0.4673	0.8697
LOAN_LAG	0.6367	0.0698	0.4555	0.8613
DEPOSIT_NOLAG	0.9330	0.0367	0.8090	1.1116
CASHEQ_LAG	0.0400	0.0295	0.0092	0.2030
JGB_LAG	0.1254	0.0486	0.0206	0.2743
MUNI_LAG	0.0369	0.0252	0.0000	0.1353
OTHERSEC_LAG	0.0365	0.0216	0.0000	0.1386
NPL_LAG	0.0216	0.0081	0.0077	0.0552
PROFIT_LAG	0.0024	0.0012	0.0000	0.0102
LOAN_LOSS_LAG	0.0001	0.0004	0.0000	0.0080
PROVISION_LAG	0.0003	0.0005	-0.0009	0.0048
CAPRATIO_NOLAG	11.54	2.13	6.97	19.90
LOAN_RATE_NOLAG	0.0081	0.0018	0.0054	0.0184

(3) Second Half

	Mean	Std. Dev.	Min	Max
LOAN_NOLAG	0.6502	0.0745	0.4753	0.8707
LOAN_LAG	0.6304	0.0726	0.4540	0.8432
DEPOSIT_NOLAG	0.8957	0.0483	0.6323	1.0760
CASHEQ_LAG	0.0800	0.0416	0.0129	0.2424
JGB_LAG	0.0871	0.0420	0.0000	0.2514
MUNI_LAG	0.0341	0.0233	0.0000	0.1244
OTHERSEC_LAG	0.0626	0.0295	0.0000	0.1697
NPL_LAG	0.0150	0.0068	0.0046	0.0754
PROFIT_LAG	0.0027	0.0014	0.0002	0.0231
LOAN_LOSS_LAG	0.0001	0.0002	-0.0001	0.0040
PROVISION_LAG	0.0002	0.0013	-0.0006	0.0321
CAPRATIO_NOLAG	10.69	2.59	6.17	21.41
LOAN_RATE_NOLAG	0.0065	0.0019	0.0042	0.0192

Note: First Half is March 2013-September 2015, Second Half is March 2016-September 2019, and Whole Sample is the combination of the two.

D. Estimation results

Table 1 reports summary statistics for the Whole Sample, the First Half, and the Second Half. *Table 2* presents the estimation results. Three columns correspond to different sample periods. Column 1 shows the result when the entire sample is used, Column 2 corresponds to the First Half (March 2013 – September 2015), and Column 3 is for the Second Half (March 2016 – September 2019). Robust standard errors of White (1980) are used. The Arellano-Bond test rejects presence of second order autocorrelation in all the cases. The coefficient on LOAN_LAG is significant and the point estimate exceeds 1. DEPOSIT_NOLAG turns out to be insignificant in two cases and only weakly significant in one.

For the most important variable of this study, CASHEQ_LAG, the coefficient is significantly positive, both for the Whole Sample and for the Second Half. It is insignificant for the First Half. The estimate is smaller for the Whole Sample than for the Second Half, reflecting the contrast between the First Half and the Second Half. This is the chief finding of this paper: an additional supply of bank reserves appears to have no effect on bank loans during the First Half, but seems to gain a significant power to influence bank lending behaviors in the Second

TABLE 2

RESULTS FROM THE SYSTEM GMM: LEFT-HAND SIDE = LOAN_NOLAG

	Whole Sample	First Half	Second Half
LOAN_LAG	1.157***	1.139***	1.182***
	(23.63)	(17.33)	(16.73)
DEPOSIT_NOLAG	0.0560	0.0149	0.138*
	(1.44)	(0.25)	(2.54)
CASHEQ_LAG	0.157**	0.0451	0.271**
	(3.27)	(0.79)	(3.27)
JGB_LAG	0.144*	-0.0812	0.105
	(2.36)	(-0.51)	(0.79)
MUNI_LAG	0.00812	-0.0812	0.105
	(0.07)	(-0.51)	(0.79)
OTHERSEC_LAG	0.177**	0.106	0.184*
	(2.80)	(0.88)	(2.13)
NPL_LAG	-0.106	-0.433	-0.132
	(-0.58)	(-1.54)	(-0.44)
PROFIT_LAG	-0.502	1.896*	-0.950
	(-0.66)	(2.07)	(-0.92)
LOAN_LOSS_LAG	0.233	-2.501	1.647
	(0.21)	(-1.87)	(0.66)
PROVISION_LAG	-2.974***	2.069	-3.266***
	(-4.29)	(1.58)	(-4.23)
CAPRATIO_NOLAG	-0.001333	-0.00342**	0.000615
	(-1.39)	(-2.84)	(0.51)
LOAN_RATE_NOLAG	0.941	-0.468	-0.157
	(1.05)	(-0.43)	(-0.12)
Constant	-0.157**	-0.0557	-0.279**
	(-2.88)	(-0.67)	(-2.98)
Observations	1142	531	611

t statistics in parentheses: *p <0.05, ** p<0.01, *** p<0.001

Note: 1. First Half is March 2013-September 2015, Second Half is March 2016-September 2019, and Whole Sample is the combination of the two.
2. Refer to the main text for the list of instruments.
3. Time Dummies are included but their coefficients are omitted from the table.
4. Based on White (1980)'s robust standard errors.

Half. The point estimate for the Second Half is 0.271, which means (considering that bank reserves outstanding in Japan was about half the size of bank lending in March 2019) that a 1% increase in reserves increases lending by a little over 0.1%. This may sound small: if the money multiplier were constant, the relationship would be 1-to-1, in percentage terms. On the other hand, considering the staggering size of the reserves expansion under the QQE (reflected in Figure 2A), this is sizable.

Among the results for the other variables, it is notable that the coefficient on PROVISION_LAG is negative and very significant for the Whole Sample and the Second Half. This makes sense; if a bank has to make a larger provision for possible loan losses in future, it would have less money to lend to borrowers.[11]

E. Hypothesis tests

It is also of interest to see if the banks view different types of safe assets, namely CASHEQ, JGB, and MUNI, as perfect (or at least close) substitutes. The question of equivalence between CASHEQ and JGB is of special relevance here, as the QQE is essentially a policy to replace the JGBs in the hands of the banks with CASHEQ. To check this point, *Figure 9* plots each bank's annual growth of JGB against that of CASHEQ, both normalized by the bank's total asset of two periods (1 year) ago; they are evidently correlated negatively. Thus, I have tested the following hypothesis.

Hypothesis I The coefficient on JGB_LAG is the same as that on CASHEQ_LAG.

This hypothesis was not rejected for both the Whole Sample and the Second Half, as might have been expected from the fact that their point estimates are quite similar. The same hypothesis is also not rejected

[11] As I discussed above, the definition of CAPRATIO_NOLAG mixes two different types of measures of capital adequacy ratio, namely the BIS standard and the Japanese local standard. This is unlikely to cause a serious problem, as much of the impact that this difference could create is likely to be absorbed by the bank fixed effect (only one bank switched from one standard to the other in our sample), which is properly taken care of by the system GMM methodology. To confirm this expectation, I tried putting each of the two types of capital adequacy ratio, multiplied by the dummy variable which is equal to 1 when this particular type of standard is adopted by the bank, separately. The results remained largely the same. I would like to thank the anonymous referee for suggesting this robustness check.

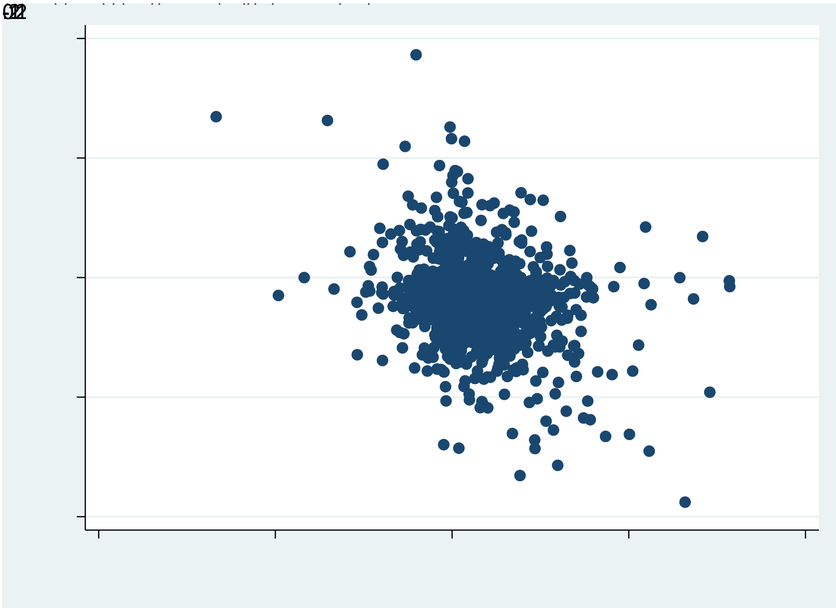


FIGURE 9

SCATTER PLOT OF JGB GROWTH DURING A ONE-YEAR PERIOD AGAINST GROWTH IN CASHEQ DURING THE SAME PERIOD

for the First Half, but this could be just reflecting imprecise estimates. Hence, we cannot refute the notion that, even under the QQE, banks viewed the JGBs and bank reserves as close substitutes. To confirm this finding from another angle, I tried re-estimating a modified version of the previous empirical model, putting the sum of CASHEQ_LAG and JGB_LAG, as well as the difference between the two, in place of those two variables. I found that the coefficient on the sum was significant both for the Whole Sample and the Second Half, while that on the difference was always insignificant.

This finding has an important policy implication. As I discussed previously, under the QQE regime, much of the additional reserves were supplied through purchases of the JGBs. If so, from the central bank's viewpoint, simply purchasing the JGBs in exchange for bank reserves would not have been an effective policy tool.

Next, I test if the banks during this period always perceived JGB and MUNI as close substitutes. There are reasons to believe that, during the Second Half of the sample, JGB and MUNI might have ceased to be near substitutes. Yields on MUNI, which is guaranteed by the central government, used to be almost identical to, or at least tended to comove almost perfectly with, that of JGB. However, as the BOJ continued to soak up JGBs from the market, their supplies became scarce, and their yields started to diverge from those of MUNI. This tendency became clear since the NIRP's introduction. Hence, the following hypothesis is tested.

Hypothesis II The coefficient on JGB is equal to that on MUNI.

This hypothesis was not rejected in the Whole Sample, the First Half as well as the Second Half. Thus, from the data, I could not find evidence that, at some point in time, JGB and MUNI ceased to be close substitutes.

F. Macroeconomic impacts: back of the envelop calculations

To assess quantitative implications of the estimated coefficients on CASHEQ_LAG, as well as JGB_LAG, I do the following back of the envelop calculations. According to the BOJ's *Flow of Funds Statistics*, for the Japanese Commercial Banking Sector as a whole, each component of the asset side of its Balance Sheet as a share of total asset has evolved as follows. Each number is for March of the year inside the parentheses.

Cash and Reserves: 4.0% (2013), 15.5% (2016), 19.7% (2019)
JGBs: 20.3% (2013), 13.3% (2016), 7.3% (2019)
Loans: 43.1% (2013), 40.9% (2016), 40.8% (2019).

Let us consider the largest estimated coefficient on CASHEQ_LAG that we can find in Table 2, namely 0.271. Note that this number is actually for the Second Half only. Applying this number to the entire period is likely to lead us to overestimate its impact on loans. According to the above statistics, between March 2013 and March 2019, the share of Cash and Reserves increased by 15.7% (=19.7%-4.0%). If we simply multiply 0.271 with this number, we get 4.2% as the predicted increase in the share of loans. As can be seen above, the actual share of loans during this period was hovering around 40%. In that sense, the above predicted number could be considered as substantial.

On the other hand, if we also take into account the estimated coefficient on JGB_LAG for the same sample period, namely 0.25, the picture changes completely. Assuming that all the decrease in the share of JGBs, namely 13.0% (=20.3%-7.3%), is a result of the QQE, this would mean a 3.2% decrease in the share of loans. Putting this number together with the above 4.2% implies a net increase of just 1.0%. I conclude that the overall impact of the policy on bank lending is likely to have been modest at best.

VIII. Results II: Mean Group Estimator

A. Model Specifications

As an alternative methodology, I try the Mean Group Estimator of Pesaran and Smith (1995).[12] The idea is essentially to estimate the above model bank-by-bank, and take the averages of the estimates. A major advantage of this methodology is that it produces a consistent result even when there is heterogeneity in the coefficients on some of the regressors. Rebucci (2003) extends this methodology to a Panel VAR setting. This method is considered suitable for a "moderate-T, moderate-N" panel, where T is the number of periods and N is the number of cross sectional units, and "moderate" means somewhere around 15 (Eberhardt (2012)). In the current study, T is at most 12, even for the Whole Sample, and data availability is even more limited for some banks. In fact, I have found that the estimation is not possible for either the First Half or the Second Half. For that reason, I will report only the results from the Whole Sample.

I estimate three versions of the model, which differ only in their treatment of bank reserves.

[Model 1] This is the same as the one estimated in the previous section, and uses an individual bank's CASHEQ_LAG.

[Model 2] With this methodology, as the first-stage estimation is carried out bank-by-bank, it is possible to include macro level regressors. In this second model, I replace an individual bank's CASHEQ_LAG with bank reserves at the aggregate level (as a share of total asset of the banking sector), which

[12] I would like to thank Alessandro Rebucci for suggesting this idea to me.

TABLE 3

RESULTS FROM MEAN GROUP ESTIMATOR: LEFT-HAND SIDE = LOAN_NOLAG

	Whole Sample	First Half	Second Half
LOAN_LAG	0.715**	0.685**	0.438***
	(3.07)	(2.64)	(3.56)
DEPOSIT_NOLAG	0.303***	0.283	0.245**
	(3.29)	(1.46)	(3.05)
JGB_LAG	-0.0613	0.0455	0.0981
	(-0.30)	(0.28)	(0.64)
MUNI_LAG	-0.113	0.807	0.393
	(-0.17)	(1.53)	(1.02)
OTHERSEC_LAG	0.352	0.201	-0.0873
	(1.22)	(0.96)	(-0.55)
NPL_LAG	-2.444	-0.0714	1.222
	(-1.33)	(-0.03)	(0.92)
PROFIT_LAG	3.809	1.859	6.964*
	(1.12)	(0.39)	(2.24)
LOAN_LOSS_LAG	-200.5	367.9	708.7
	(-0.33)	(0.82)	(1.30)
PROVISION_LAG	19.21*	28.45	8.228
	(2.21)	(1.37)	(1.23)
CAPRATIO_NOLAG	0.00669	0.00140	-0.00340
	(1.19)	(0.22)	(-1.09)
LOAN_RATE_NOLAG	3.902	3.252	5.270
	(0.34)	(0.16)	(0.35)
CASHEQ_LAG	-0.0690		
	(-0.33)		
MACRORESERVE_LAG		0.164	
		(0.37)	
MACRORESERVE_NOLAG			0.175
			(0.78)
Constant	-0.164	-0.114	0.0802
	(-0.67)	(-0.37)	(0.58)
Observations	812	812	812

t statistics in parentheses: *p <0.05, ** p<0.01, *** p<0.001

Note: First Half is March 2013-September 2015, Second Half is March 2016-September 2019, and Whole Sample is the combination of the two.

is arguably “more exogenous” from the viewpoint of each bank. This variable is denoted as MACRORESERVE_LAG.

[Model 3] If the aggregate reserves can be used as a policy

> variable, we might not need to use its lagged values, out of concern for endogeneity, as such macro variables can be safely considered as exogenous to each bank, even contemporaneously. For that reason, I will use contemporaneous reserves-to-asset ratio at the macro level, denoted MACRORESERVE_NOLAG, as an alternative regressor.

Also note that, as the first stage estimation is run bank-by-bank, the time dummies must be dropped from the list of the explanatory variables.

B. Estimation Results

Results are shown in *Table 3*. Each column corresponds to a model (not a time period). Unfortunately, in all the cases, bank reserve variables are insignificant. It seems that, to uncover a positive impact of reserves on loans, use of instrumental variables is essential.

IX. Results III: Additional Studies and Robustness Checks

A. Has the QQE encouraged risky lending behaviors?

I have also studied how a reserves expansion affects some components of bank loans, as opposed to the total amount of loans. There are concerns in Japan that the expansionary monetary policies might have encouraged too much risk taking by commercial banks. Some have speculated that banks have extended loans to less credit-worthy individuals and lent too aggressively to the real estate sector. To check those ideas, I have tried replacing total loans in the previous estimations with loans to individuals and real estate loans (data is taken from the BOJ Web Site). But I have found no evidence that bank reserves have had significant effects on either type of loans in the subsequent period.

B. Robustness studies

I have checked robustness of the main results along two dimensions. First, I have tried switching the normalization variable. Whereas the preceding analyses used lagged total asset to standardize all the variables, I have tried using lagged deposit instead. We could argue that, in the short run, deposits are "more exogenous" than assets to each bank. Note that, for a typical commercial bank, most of the assets are financial. And, if a bank wishes to expand loans, it could raise funds through the call market, thus expanding both the asset and the liability sides of the Balance Sheet simultaneously. On the other hand, at least in the short run, banks cannot just "tell" firms and households to increase or to decrease deposits; they take depositors' behaviors as given. Hence, it seems worthwhile trying deposits as an alternative normalizing variable. When I did that, I did not find much qualitative difference in comparison to the results presented above. The results thus seem robust to the choice of the normalization variable.

As the second robustness study, I tried changing the lengths of both the First Half and the Second Half of the sample for the GMM estimation. When I extended the First Half up to the year 2016 (or 2017), as opposed to 2015, while shortening the Second Half to start from the year afterwards, CASHEQ_LAG turned significant for the First Half, while it became insignificant for the Second Half. Thus, it appears that inclusion of the year 2016 into the sample tends to strengthen the estimated impact of CASHEQ.

X. Conclusions

This paper has studied the effects of an increased supply of bank reserves on subsequent lending behaviors, using the Japanese data from the QQE period. The GMM results have indicated that the effect was non-existent during the First Half of the sample (*i.e.*, 2013-2015), but that there was a significant positive effect during the Second Half, when the QQE was supplemented by the NIRP and (later) the YCC. However, more importantly, evidence suggests that the composition between the two types of liquid assets on the banks' Balance Sheets, namely the JGBs and bank reserves, has not had much impact on their lending behaviors. This suggests that the macroeconomic effect of the QQE, which provided bank reserves mainly through purchases of the JGBs, is likely to have been limited.

The question is what the mechanism was behind this resurgence of bank reserves (plus JGBs) as an important determinant of bank lending. As the estimation conducted in this paper is strictly reduced-form in its nature, one could only speculate the reason. A distinguishing feature of the Second Half of our sample, compared with the First Half, is the negative short-term interest rate and the very low (or even negative at times) long-term JGB yields (refer back to Figure 4). Under such an environment, it would be understandable if banks wished to reduce their holdings of those liquid/safe assets to the extent that was possible. This could have been the reason why those banks that were previously holding larger shares of their assets in the form of those assets were more eager to lend to the non-financial sectors. If this explanation is correct, it could mean that, for a QQE-type policy to have an intended effect on bank lending, it needs to be supplemented by a policy to suppress the interest rates to extremely low levels.

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