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Portfolio Rebalancing Following the Bank of Japan's Government Bond Purchases: Empirical Analysis Using Data on Bank Loans and Investment Flows[*]

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Abstract

This paper organizes facts and conducts an empirical analysis related to the portfolio rebalancing effect of government bond purchases by the Bank of Japan (BOJ). Our analysis uses data on bank loans and investment flows that are classified by type of entity, primarily taken from the Flow of Funds Accounts Statistics. Following the introduction of Quantitative and Qualitative Monetary Easing (QQE) by the BOJ in April 2013, entities other than the BOJ, as a group, have increased loans and investment in equities, mutual funds, and corporate bonds in Japan, while reducing their holdings of Japanese government bonds. Such portfolio rebalancing is mainly led by domestic banks and nonresidents. Meanwhile, so far, insurance companies, corporate pension funds, and public pensions have not reduced government bond holdings when the BOJ purchased government bonds. In addition to changes in financial and economic conditions, such as the balance sheet conditions of domestic banks and loan demand faced by domestic banks, purchases of government bonds with a longer remaining maturity by the BOJ have played a role in the increase in bank loans observed during the QQE period.

Keywords: portfolio rebalancing, government bond purchases, Quantitative and Qualitative Monetary Easing (QQE), Flow of Funds Accounts Statistics

JEL Classifications: E52, E58, G11, G2, H63

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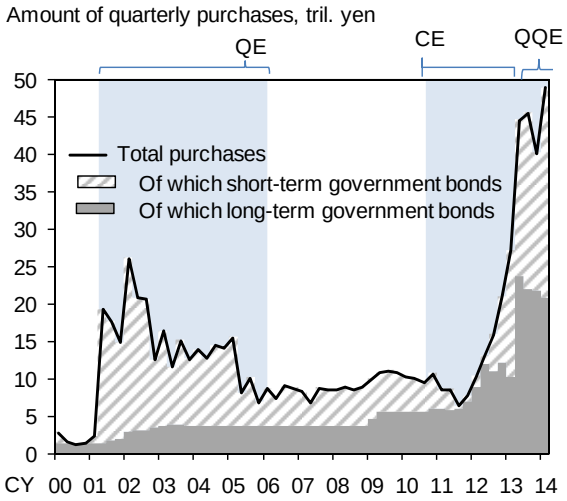
1 Introduction

After the Bank of Japan (BOJ) introduced Quantitative and Qualitative Monetary Easing (QQE) in April 2013, government bond purchases by the BOJ increased by a large amount (Chart 1). Moreover, the average remaining maturity of government bonds purchased by the BOJ became approximately twice as long as that prior to the introduction of QQE (Chart 2).[1]

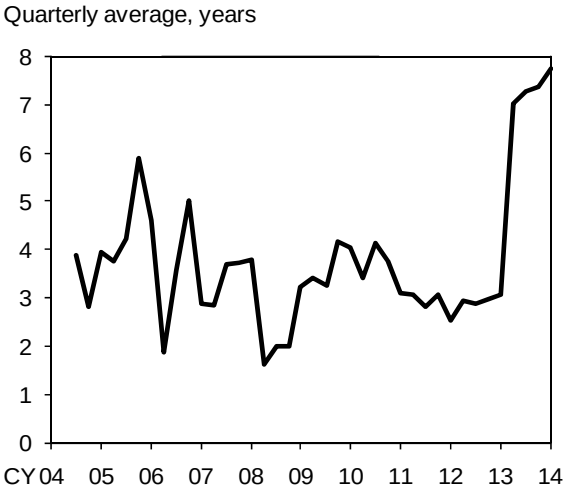
Chart 1: Bank of Japan's Purchases of Government Bonds



Note: Short-term bonds consist of treasury bills (TBs) and financing bills (FBs) before January 2009, and treasury discount bills after February 2009.

Source: Bank of Japan, "Monetary Base and the Bank of Japan's Transactions."

Chart 2: Average Remaining Maturity of Long-Term Government Bonds Purchased by the Bank of Japan



Note: The most recent figure available is that for 14/Q1.

Source: Calculated using information from Bank of Japan, "Japanese Government Bonds held by the Bank of Japan."

One of the transmission mechanisms of government bond purchases by the central bank is portfolio rebalancing.[2] This paper lays out the characteristics of portfolio rebalancing in Japan and assesses its workings especially after the introduction of QQE. Various definitions and evaluation methods exist for portfolio rebalancing. This paper uses data on bank loans and securities investment flows to examine whether entities other than the BOJ reduce government bond holdings when the BOJ purchases government bonds. We also

[1] In this paper, unless otherwise stated, we refer to treasury discount bills as short-term government bonds and to bonds issued domestically by the Japanese government excluding treasury discount bills as long-term government bonds or Japanese government bonds (JGBs). The latter mainly consist of revenue bonds and Fiscal Investment and Loan Program bonds issued by the Fiscal Loan Funds Special Accounts.

[2] In this paper, we are using the term portfolio rebalancing in a narrow sense. Some studies use the term to represent both a decline in long-term interest rates and investors' rebalancing across assets. See, for example, Gagnon et al. (2011) and Joyce et al. (2011).

consider in which assets other than deposits at the BOJ entities that reduce government bond holdings increase investment.

We assume that central bank government bond purchases lead to portfolio rebalancing mainly through the following two channels. First, when long-term interest rates decline as a result of central bank government bond purchases, this leaves little room for a further decline in long-term interest rates, so that prospects for capital gains from holding long-term government bonds are also limited. Under these circumstances, financial institutions and investors have an incentive to reduce their holdings of government bonds and increase investment in other assets that have higher expected returns. When long-term government bond rates decline to a sufficiently low level, entities that hold government bonds with the intention of holding them until maturity also lose the incentive to invest in government bonds and increase investment in other assets.

The second channel through which portfolio rebalancing occurs is a reduction in the amount of interest rate risk related to the holding of government bonds.[3] Holding long-term government bonds entails interest rate risk: investors suffer capital losses on long-term government bonds when long-term government bond rates rise. Bond prices fall by a larger amount when the bonds have a longer time to maturity; reducing holdings of government bonds with longer maturity leads to a larger decrease in the amount of interest rate risk. Entities that reduce holdings of long-term government bonds, as a result of the first mechanism indicated above, end up with a smaller amount of interest rate risk. Since these entities now have greater capacity to take on additional risk in their portfolio, they are likely to increase investment in assets other than government bonds or to increase loans if the entity in question is a bank. This channel can be expected to reinforce the first channel described above.[4]

A number of studies have analyzed portfolio rebalancing during the BOJ's Quantitative Easing (QE) policy from March 2001 to March 2006. The approach of many of these studies is to examine the presence of portfolio rebalancing by looking at the effects of the BOJ's government bond purchases on interest rate spreads and asset prices. For example, Kimura and Small (2006) analyze the effect of the BOJ's government bond purchases during the QE period using data on corporate bond spreads and the equity risk premium. They

[3] The amount of interest rate risk increases when holdings of government bonds increase or when the duration of governments bonds held increases.

[4] This channel that works through changes in the interest rate risk is close to what Krishnamurthy and Vissing-Jorgensen (2011) call the "duration risk channel."

present empirical results that suggest that the BOJ's QE had some effect on high-grade corporate bonds, but had little impact on low-grade corporate bonds and equities, implying that portfolio rebalancing was limited to a narrow range of assets during the QE period. A considerable number of other empirical studies on the BOJ's QE policy have also used information on asset prices.[5]

To more directly check the existence of portfolio rebalancing -- for instance, to see which entities reduce government bond holdings and in which assets these entities increase their investment -- it is useful to employ information on investment flows and bank lending rather than information on asset prices. Carpenter et al. (2013), for instance, use the Flow of Funds Accounts Statistics for the United States to empirically examine portfolio rebalancing following asset purchases by the Federal Reserve. They report that, following the Fed's purchases of government bonds and mortgage backed securities (MBSs), it was mainly hedge funds that reduced their holdings of government bonds and MBSs and increased investment in corporate bonds. Another example is the study by Fratzscher et al. (2013), who use investment flows data for funds domiciled in advanced and emerging economies to analyze portfolio rebalancing arising from the Fed's asset purchases. Their findings suggest that portfolio rebalancing took place not only within the United States (i.e., rebalancing from bonds to equities within the United States), but also across countries (for example, rebalancing from U.S. bonds to bonds in other advanced countries). They also argue that the nature of portfolio rebalancing differed between the first and the second phase of the Fed's large-scale asset purchase (LSAP) program.

Following these previous studies, we also use data on investment flows and bank lending, primarily the Flow of Funds Accounts Statistics, to analyze portfolio rebalancing following the BOJ's government bond purchases. Specifically, we examine the characteristics of portfolio rebalancing following the BOJ's government bond purchases focusing on the following three differences: (i) differences among entities, (ii) differences in portfolio rebalancing depending on whether the BOJ purchased short-term or long-term government bonds, and (iii) differences in portfolio rebalancing between the period of Quantitative Easing (QE) from March 2001 to March 2006 on the one hand and the period of Comprehensive Monetary Easing (CE) from October 2010 to March 2013 and QQE since April 2013 on the

[5] For a survey of empirical studies on the BOJ's QE policy using asset prices, see Ugai (2007). Many of the empirical studies on the effect of asset purchases by the Federal Reserve and the Bank of England also use information on asset prices. See Gagnon et al. (2011) and Joyce et al. (2011) for examples of empirical studies using asset prices.

other. As for entities that we focus on, these consist of domestic financial institutions and nonresidents; the latter include foreign financial institutions and foreign governments. We also examine portfolio rebalancing at the macro level by aggregating investment flows over different entities.

The main findings of this paper can be summarized as follows. First, looking at portfolio rebalancing at the macro level after the introduction of QQE, we find that -- following the increase in the BOJ's purchases of government bonds with long durations -- entities other than the BOJ, as a group, decreased their government bond holdings and increased loans and investment in equities, mutual funds, and corporate bonds in Japan. Looking at each type of entity separately, however, we find that the nature of portfolio rebalancing differs across entities, reflecting factors such as entities' liability structure and investment strategy. The nature of portfolio rebalancing also differs depending on the duration of government bonds purchased by the BOJ, i.e., whether it purchased short-term or long-term government bonds. Specifically, domestic banks and the overseas sector tended to reduce government bond holdings and increase investment in relatively risky assets such as loans, equities, and corporate bonds in Japan when the BOJ purchased government bonds. Among these entities, domestic banks tended to reduce government bond holdings and increase loans when the BOJ purchased long-term government bonds -- especially bonds with a relatively long remaining maturity --, while they did not tend to increase loans when the BOJ purchased mainly short-term government bonds. Underlying this difference appears to be the fact that the amount of interest rate risk related to government bond holdings decreases by a large amount when domestic banks reduce their holdings of government bonds with long duration, while the reduction in the amount of interest rate risk is relatively small when domestic banks reduce their holdings of short-term government bonds. The overseas sector also tended to reduce government bond holdings when the return on government bonds fell following the BOJ's purchases of government bonds; it also increased investment in Japanese equities and corporate bonds in response to the BOJ's government bond purchases, especially in the more recent period, i.e., the period of CE and QQE.

In contrast to these types of entities, insurance companies and corporate pension funds did not show a tendency to reduce government bond holdings when the BOJ purchased government bonds. Since these entities have liabilities with a long duration -- that is, their liability structure is characterized by predetermined payment flows that last for a long time into the future --, they have a strong incentive to hold government bonds with a long remaining maturity as assets to match the duration of liabilities.

The rest of this paper is structured as follows. In Section 2, we provide an overview of government bond holdings by various entities, with an eye on the relationship between their government bond holdings and the BOJ's purchase of government bonds. We also explore formally, using regression analysis, which entities tend to reduce government bond holdings when the BOJ increases government bond purchases. Next, in Section 3, we first examine developments in portfolio rebalancing at the macro level by aggregating the behavior of different entities. In Section 4, we then look in more detail, for each type of entity that tended to reduce government bond holdings in response to the BOJ's purchases, in which assets they increased investment. Finally, in Section 5, we summarize the main findings of this paper, discuss several caveats regarding our analysis, and point out remaining issues to be addressed in future research.

2 Changes in Government Bond Holdings Following BOJ Government Bond Purchases

In this section, we first provide an overview of government bond holdings by each type of entity. We then conduct a regression analysis to examine which entities tended to reduce government bond holdings when the BOJ purchased government bonds. In this paper, we mostly focus on the ten types of entities listed in Chart 3; because this paper is concerned with portfolio shifts from government bonds to other assets, we do not focus on households and private nonfinancial corporations that hold a relatively small amount of government bonds.[6]

2.1 Overview of Government Bond Holdings by Type of Entity

Looking at the government bond holdings of each type of entity at the end of 2013 using the Flow of Funds Accounts Statistics (Chart 4), we find that the largest holders of government bonds are the BOJ, financial institutions for small businesses (which include Japan Post Bank), insurance companies, domestically licensed bank (referred to simply as "domestic banks" hereafter), the overseas sector, and public pensions (which include the Government Pension Investment Fund, GPIF), in that order. If we look at short-term and long-term government bond holdings separately, the BOJ and domestic banks are the largest holders of both. We also find that a large volume of short-term government bonds is held by the overseas sector,

[6] This does not mean that we consider other kinds of portfolio shifts, such as a shift from bank deposits to equities and mutual funds, as unimportant for economic activity.

Chart 3: Types of Entities

Sector	Main Entities
Domestically licensed banks (domestic banks)	City banks[*,T], Regional banks I and II[☆,T], Trust banks[☆,T]
Foreign-owned banks in Japan	Branches of foreign-owned banks in Japan[☆,T]
Financial institutions for agriculture, forestry and fishery	Norin Chukin Bank[*,T], Agricultural cooperatives, Credit federations of agricultural cooperatives, Fishery cooperatives, Credit federations of fishery cooperatives
Financial institutions for small businesses	Japan Post Bank[T], Shinkin banks, etc.
Insurance companies	Private life insurance companies (including Japan Post Insurance), Private nonlife insurance companies
Corporate pension funds	Employees' pension funds, Former qualified retirement pension plans, Defined-contribution pension plans (corporate-type), Defined benefit corporate pensions
Public pensions	Government Pension Investment Fund (GPIF), etc.
Financial dealers and brokers (broker-dealers)	Securities companies[☆,T] (including foreign security companies[☆,T]) , "Tanshi" companies[*,T]
Securities investment trusts	Bond investment trusts, Stock investment trusts
Overseas sector	International organizations, Foreign governments, Non-residents including foreign companies

Notes: [*]: All members of this group can participate in the Bank of Japan's outright purchase/sales operations of JGBs and treasury discount bills.

[☆]: Some members of this group can participate in the Bank of Japan's outright purchase/sales operations of JGBs and treasury discount bills.

[T]: All members of this group hold BOJ current account balances.

and a large volume of long-term government bonds is held by financial institutions for small businesses, insurance companies (which include Japan Post Insurance), and public pensions.

Looking next at developments in the share of government bonds held by each type of entity (Chart 5), the share of the BOJ increased during the early phase of QE around 2001 and 2002 and then increased greatly from the latter half of 2012 onward, while the shares of domestic banks and the overseas sector decreased during these periods.[7] Meanwhile, the

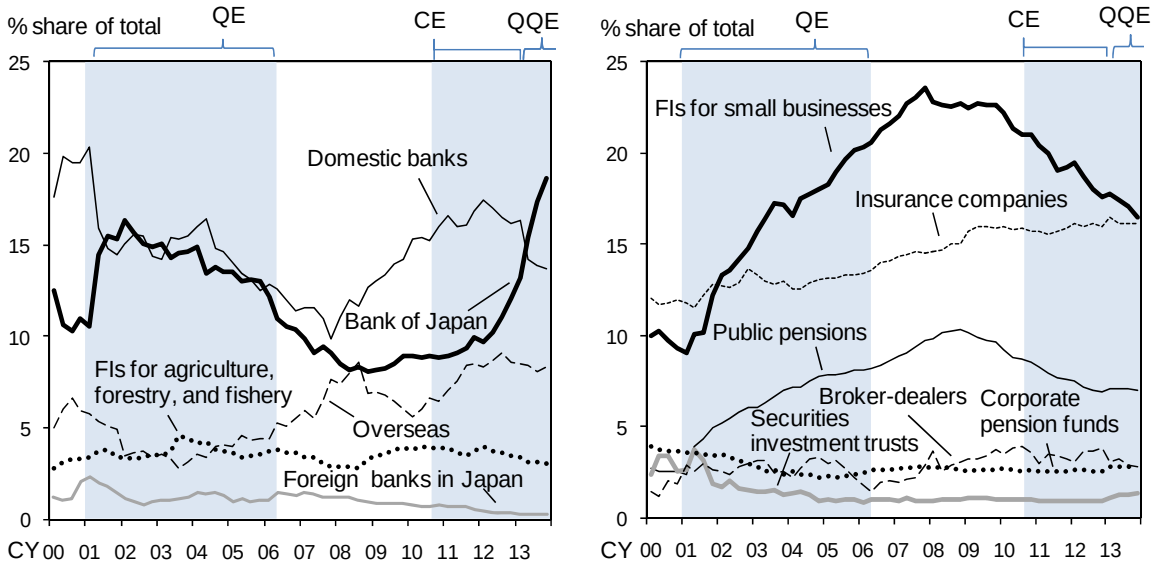
[7] The share of government bonds held by the overseas sector nevertheless displays a moderate upward trend from a long-run perspective.

Chart 4: Government Bond Holdings by Type of Entity

	Stock (tril. yen) Figures in ( ) are share of total (%)			Flow (tril. yen)		
	Government bonds (end of 2013/Q4)			CY2011	CY2012	CY2013
		Of which short-term	Of which long-term			
Domestic banks	134.6 (13.7)	32.8 (20.7)	101.9 (12.3)	13.3	-2.2	-23.0
Foreign-owned banks in Japan	2.6 (0.3)	1.9 (1.2)	0.7 (0.1)	-1.6	-1.5	-0.6
Financial institutions for agriculture, forestry and fishery	29.8 (3.0)	7.3 (4.6)	22.6 (2.7)	-0.2	-1.2	-3.4
Financial institutions for small businesses (including Japan Post Bank)	162.4 (16.5)	0.1 (0.1)	162.3 (19.6)	-7.7	-5.9	-4.7
Insurance companies (including Japan Post Insurance)	158.6 (16.1)	3.0 (1.9)	155.6 (18.8)	6.4	6.3	2.9
Corporate pension funds	27.7 (2.8)	0.0 (0.0)	27.7 (3.3)	0.5	0.9	2.9
Public pensions (including the GPIF)	68.6 (7.0)	0.0 (0.0)	68.6 (8.3)	-4.6	-3.8	2.0
Broker-dealers	27.2 (2.8)	1.3 (0.8)	25.9 (3.1)	-2.2	6.5	-8.9
Securities investment trusts	13.2 (1.3)	8.8 (5.6)	4.4 (0.5)	-0.6	1.0	4.1
Overseas sector	81.9 (8.3)	49.4 (31.2)	32.6 (3.9)	21.4	5.9	-0.9
Bank of Japan	183.4 (18.6)	39.8 (25.1)	143.6 (19.6)	13.4	23.3	66.7
Nonfinancial corporations	10.4 (1.1)	0.0 (0.0)	10.4 (1.3)	3.5	-0.3	-0.4
Households	21.4 (2.2)	0.0 (0.0)	21.4 (2.6)	-4.5	-3.8	-3.0
Other	63.6 (6.5)	14.1 (8.9)	49.5 (6.0)	0.2	13.4	-13.1
Total	985.5 (100.0)	158.4 (100.0)	827.1 (100.0)	37.4	38.6	20.4

Notes: Government bonds are the sum of short-term government bonds and long-term government bonds.
Figures for flows do not include changes in the amount outstanding due to valuation changes.
Source: Bank of Japan, "Flow of Funds Accounts Statistics."

Chart 5: Developments in the Share of Government Bonds Held by Each Entity



Source: Bank of Japan, "Flow of Funds Accounts Statistics."

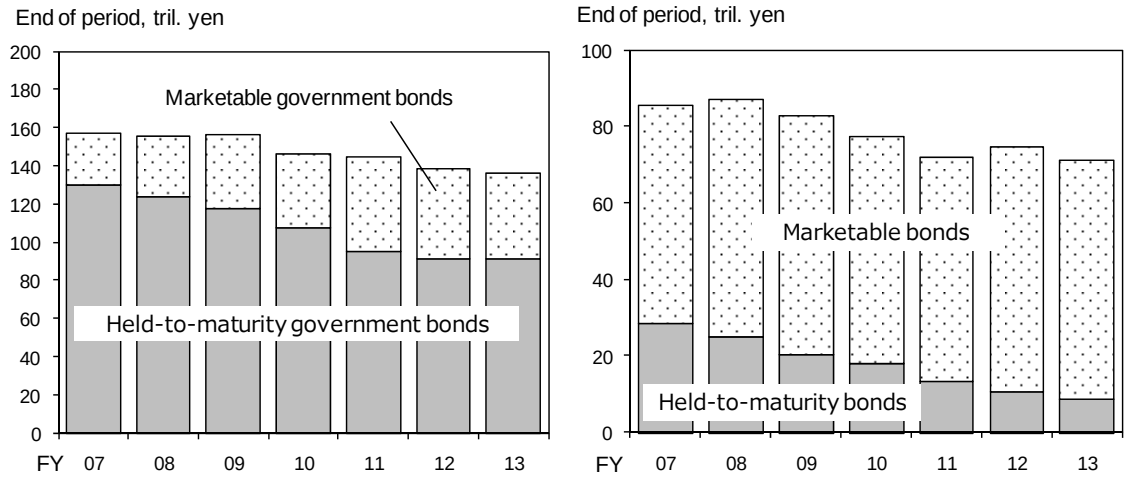
share of government bonds held by corporate pension funds has remained more or less constant, while the share of government bonds held by insurance companies has increased moderately; both types of entities have shown no tendency to reduce government bond holdings when the BOJ increased government bond purchases.[8] Insurance and corporate pension funds (especially defined benefit pension plans) have a liability structure with long duration, which implies that payment flows will last for a long time into the future. Consequently, these entities have a strong incentive to hold government bonds with a long remaining maturity in order to match the duration of assets to the duration of liabilities.

The shares of government bonds held by financial institutions for small businesses (which include Japan Post Bank) and by public pensions (which include the GPIF) steadily increased during the 2000s, mainly because of the underwriting of the Fiscal Investment and Loan Program Agency Bonds, before starting to decline again from around 2008 (Chart 5). The decline in the share of government bonds held by these entities, however, is not directly related to the BOJ's government bond purchases, for the following reasons. As for the GPIF, its pension payments have exceeded its revenues in recent years. Since the GPIF covers its deficit with cash flows generated from the redemption of government bonds at maturity, the GPIF has reduced its holdings of government bonds that are held to maturity, not those held to trade (Chart 6). This fact suggests that so far the GPIF has not reduced government bond

[8] Similarly, no clear decrease in the shares of government bonds held by financial institutions for agriculture, forestry, and fishery, foreign banks in Japan, broker-dealers, and securities investment trusts can be observed when the share of government bonds held by the BOJ increases.

Chart 6: Government Bond Holdings of Japan Post Bank and the GPIF

(Government Bond Holdings of Japan Post Bank) (Domestic Bond Holdings of the GPIF)



Notes: Figures for FY2013 are the amount outstanding as of end September 2013 for Japan Post Bank and end December 2013 for the GPIF.
Figures for the GPIF's held-to-maturity bonds are the amount outstanding of Fiscal Investment and Loan Program bonds.

Source: Annual and quarterly reports of Japan Post Bank and the GPIF.

holdings in response to an increase in the BOJ's government bond purchases. Similarly, for Japan Post Bank, which makes up a large proportion of the government bonds holdings of financial institutions for small businesses, we also see a decrease in the holdings of government bonds that are held to maturity (Chart 6). As a result, the relationship between reductions in government bond holdings by this type of entity and the BOJ's government purchases also appears to be weak.

2.2 Specification for the Regression Analysis

Following the overview above, we present a more formal regression analysis regarding which entities tend to reduce government bond holdings when the BOJ purchases government bonds. Specifically, following Carpenter et al. (2013), we regress the net change in government bonds held by entity type *i* in period *t* (y_t^i , in trillion yen) on its one-period lag, the amount of BOJ government bond purchases in period *t* (X_t, in trillion yen), and on other variables that likely affect the net change in government bonds held by entity type *i* (z_t). The parameter β^i takes a negative value if entity type *i* tends to reduce government bond holdings when the BOJ purchases government bonds. Thus, we run regressions using the following specification:

$$y_t^i = \alpha^i + \rho^i y_{t-1}^i + \beta^i x_t + \gamma^i z_t + \varepsilon_t^i$$

We run this regression for each of the ten types of entities listed in Chart 3 using quarterly data for the period from 1999:Q4 to 2013:Q4.[9] The sample period includes periods in which the BOJ purchased government bonds through a series of asset purchase programs -- i.e., the QE, CE, QQE programs -- as well as periods in which the BOJ purchased government bonds outside these programs such as during the so-called "rinban" operations.

For the dependent variable (y_t^i), we use data on net changes in government bond holdings of entity type *i*. This variable reflects transactions in government bonds as well as the redemption of government bonds at maturity and is unaffected by changes in the amount of government bond holdings due to changes in their market value.[10] The data source for this variable is the "Financial Transactions" table in the Flow of Funds Accounts Statistics. Note that some entities considered in our analysis are not counterparts to the BOJ's outright purchases of Japanese government bonds and treasury discount bills (Chart 3). Thus, a decrease in government bond holdings by entities during a period of purchases by the BOJ does not necessarily imply that the entities participated in the BOJ's bond purchase operations; instead, these entities may have sold government bonds in the market.

The reason for including the lagged value of entity type *i*'s net change in government bond holdings is to capture ongoing gradual portfolio adjustments unrelated to current purchase operations by the BOJ. Next, the data for the BOJ's government bond purchases (x_t) come from the "Flow Table" in the statistics on the Monetary Base and the Bank of Japan's Transactions published by the BOJ. The vector of control variables (z_t) consists of the following three variables: (i) the overall change in the amount of government bonds outstanding in the economy as a whole, (ii) the one-period lag of the equity yield spread (the difference between the dividend yield on equities and the interest rate on government bonds with two years to maturity), and (iii) the one-period lag of implied volatility of government bond futures.[11] The reason for including the overall change in government bonds

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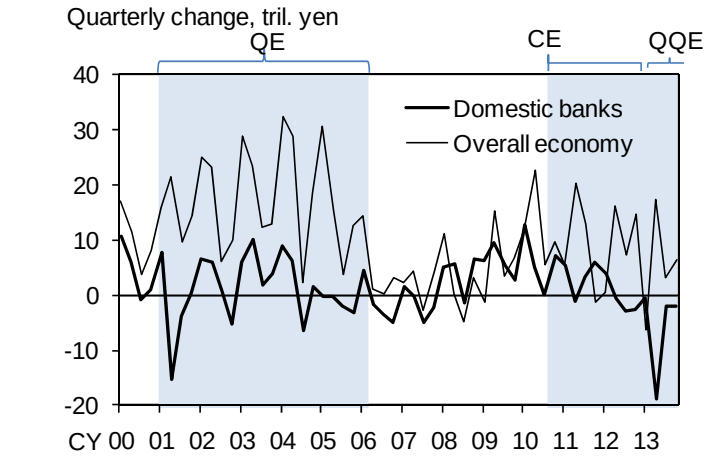
[9] Our sample period begins in 1999:Q4 because the BOJ started its purchases of short-term government bonds in October 1999.

[10] Alternatively, one might consider using the ratio of the stock of government bonds held by entity type *i* to the stock of total assets held by the same entity type as the dependent variable. However, we did not use this ratio since it can be affected by changes in the stock of government bonds due to valuation changes.

[11] For the equity yield spread and the implied volatility of government bond futures, we use the average values for each period. Note that our choice of control variables closely follows that of other studies. Carpenter et al. (2013), for example, also use the total change in the amount of government bonds outstanding, while Fratzscher et al. (2013) use the VIX, government bond yields, and equity returns as control variables.

outstanding in the regression is to take the role of the issuance and redemption of government bonds in the net investment of each type of entity into account. In fact, when we compare the change in government bonds held by domestic banks with the overall change in government bonds outstanding, we find that these are positively correlated (Chart 7). Including this variable allows us to examine the role of the BOJ's government bond purchases in the net change in each type of entity's government bond holdings by removing the effects of the issuance and redemption of government bonds on the bond holdings of each type of entity. Next, the purpose of including the equity yield spread in the control variables is to take into account the impact of return differences between government bonds and equities.[12] Finally, an increase in the implied volatility of government bond futures is expected to have a negative impact on the net investment in government bonds by each type of entity.

Chart 7: Change in Government Bonds Outstanding in the Overall Economy and in Government Bond Holdings by Domestic Banks



Source: Bank of Japan, "Flow of Funds Accounts Statistics."

2.3 Estimation Results

The results of the regressions are presented in Chart 8. They show that among the ten types of entities, domestic banks show the strongest tendency to reduce net investment in government bonds during periods of bond purchases by the BOJ. Significant (or weakly significant) results are also obtained for the overseas sector, broker-dealers, and financial institutions for agriculture, forestry, and fishery, indicating that these also tend to decrease

[12] As pointed out by Campbell and Viceira (1999), the impact of a change in the equity yield spread on net investment in government bonds can differ depending on the degree of an entity's risk aversion. We therefore expect the sign of the parameter on the equity yield spread to differ across types of entities.

Chart 8: Response of Government Bond Holdings to Bank of Japan Purchases

(a) All Government Bonds

	Domestic banks	Foreign banks in Japan	FIs for agriculture, forestry, and fishery	Insurance companies	Corporate pension funds	Broker-dealers	Securities investment trusts	Overseas sector	FIs for small businesses	Public pensions
Constant	-5.90*** (1.76)	0.88 (0.83)	-0.10 (1.41)	1.11 (0.77)	0.59 (0.45)	0.17 (1.76)	-1.33 (1.02)	6.13*** (1.46)	3.64 (2.21)	1.73** (0.69)
Lagged dependent variable	-0.03 (0.09)	0.02 (0.12)	0.09 (0.12)	0.20 (0.13)	-0.16 (0.19)	-0.20 (0.13)	0.13 (0.10)	-0.06 (0.05)	0.28*** (0.10)	0.32* (0.19)
Government bond purchases by the Bank of Japan	-0.32*** (0.07)	-0.02 (0.02)	-0.04** (0.01)	0.00 (0.02)	0.01 (0.01)	-0.05* (0.03)	0.02 (0.04)	-0.10*** (0.02)	-0.02 (0.06)	0.04 (0.04)
Change in government bonds outstanding in economy overall	0.17** (0.08)	0.00 (0.02)	0.02 (0.02)	0.03* (0.02)	0.00 (0.01)	0.07* (0.04)	0.03 (0.03)	-0.02 (0.03)	0.16*** (0.05)	0.03 (0.02)
Equity yield spread (lagged one period)	4.01*** (0.67)	-0.33 (0.24)	0.52 (0.41)	-0.17 (0.27)	-0.01 (0.15)	-0.57 (0.67)	0.03 (0.15)	-0.75* (0.45)	-1.73* (0.93)	-1.34*** (0.49)
Implied volatility of government bond futures (lagged one period)	1.37*** (0.49)	-0.08 (0.11)	0.01 (0.28)	0.05 (0.12)	-0.14 (0.08)	0.24 (0.24)	0.24 (0.23)	-0.63** (0.25)	-0.42 (0.33)	-0.10 (0.15)
Sample period	1999/Q4-2013/Q4									

Notes: Figures in parentheses are Newey-West standard errors.
***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.
Shaded cells indicate a statistically significant decrease in government bond holdings when the Bank of Japan purchases government bonds.

government bond holdings when the BOJ purchases government bonds, although the size of the decrease is considerably smaller than in the case of domestic banks.

On the other hand, foreign banks in Japan, insurance companies, corporate pension funds, securities investment trusts, financial institutions for small businesses, and public pensions do not show a tendency to reduce their government bond holdings when the BOJ purchases government bonds. Because insurance companies and corporate pension funds (especially defined benefit pension funds) have liabilities with a long duration, they have a strong incentive to hold a certain amount of long-term government bonds in order to keep the duration mismatch between assets and liabilities small.

Next, Chart 9 shows the regression results when we separate the BOJ's government bond purchases into purchases of short-term and long-term government bonds. The results again indicate that different types of entities responded differently to the BOJ's purchases of short-term and long-term government bonds. Specifically, starting with short-term government bond purchases by the BOJ, domestic banks and the overseas sector tend to significantly reduce their government bond holdings. Significant reductions can also be observed for broker-dealers as well as foreign banks in Japan, although the size of these

Chart 9: Response of Government Bond Holdings to Bank of Japan Purchases

(b) Short-Term and Long-Term Bonds Separately

	Domestic banks	Foreign banks in Japan	FIs for agriculture, forestry, and fishery	Insurance companies	Corporate pension funds	Broker-dealers	Securities investment trusts	Overseas sector	FIs for small businesses	Public pensions
Constant	-5.85*** (1.41)	0.88 (0.81)	-0.14 (1.14)	1.37** (0.58)	0.59 (0.42)	-0.02 (1.66)	-1.58* (0.85)	6.45*** (1.40)	5.14** (2.16)	2.31*** (0.70)
Lagged dependent variable	-0.03 (0.09)	0.00 (0.11)	0.04 (0.12)	0.09 (0.09)	-0.15 (0.19)	-0.16 (0.13)	0.11 (0.08)	-0.11** (0.05)	0.07 (0.10)	0.04 (0.22)
Short-term government bond purchases by the Bank of Japan	-0.26* (0.15)	-0.05** (0.02)	0.02 (0.03)	0.06*** (0.02)	0.01 (0.02)	-0.13* (0.08)	-0.02 (0.03)	-0.27*** (0.07)	0.25*** (0.06)	0.18** (0.07)
Long-term government bond purchases by the Bank of Japan	-0.43** (0.18)	0.04* (0.02)	-0.15*** (0.05)	-0.11*** (0.02)	0.00 (0.02)	0.13 (0.11)	0.14*** (0.04)	0.17*** (0.03)	-0.45*** (0.06)	-0.15** (0.06)
Change in government bonds outstanding in economy overall	0.15 (0.10)	0.01 (0.02)	0.00 (0.02)	0.02 (0.02)	0.00 (0.02)	0.10* (0.05)	0.04 (0.03)	0.03 (0.03)	0.10** (0.04)	0.00 (0.02)
Equity yield spread (lagged one period)	4.39*** (0.68)	-0.56* (0.29)	0.94** (0.37)	0.15 (0.29)	0.02 (0.18)	-1.19 (0.74)	-0.37* (0.21)	-1.77*** (0.49)	-0.88 (0.83)	-1.20*** (0.36)
Implied volatility of government bond futures (lagged one period)	1.32*** (0.42)	-0.06 (0.11)	-0.02 (0.23)	-0.01 (0.08)	-0.14 (0.09)	0.32 (0.25)	0.31 (0.19)	-0.56*** (0.19)	-0.71** (0.28)	-0.17 (0.12)
Sample period	1999/Q4-2013/Q4									

Notes: Figures in parentheses are Newey-West standard errors.
***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.
Shaded cells indicate a statistically significant decrease in government bond holdings when the Bank of Japan purchases government bonds.

reductions is comparatively small. Next, looking at the impact of long-term government bond purchases by the BOJ, we find that domestic banks and, to a lesser extent, financial institutions for agriculture, forestry, and fishery as well as insurance companies reduce their government bond holdings. The estimation results in Chart 9 further indicate that financial institutions for small businesses and public pensions also tend to reduce their government bond holdings when the BOJ purchases long-term government bonds. However, as mentioned above, the reductions in government bond holdings by these entities likely are unrelated to the BOJ's monetary policy.

3 Portfolio Rebalancing

The analysis in the previous section suggests that although patterns differ somewhat depending on whether the BOJ purchases short-term or long-term government bonds, it is mainly domestic banks and the overseas sector that tend to reduce government bond holdings in response to such purchases. In this section, we examine this kind of portfolio rebalancing in greater detail. Specifically, we first examine portfolio rebalancing at the macro level by aggregating the investment of all types of entities. We then analyze in which assets domestic

banks' and the overseas sector's investment increased when the BOJ purchased government bonds, focusing on the seven types of assets listed in Chart 10.[13]

Chart 10: Types of Assets Covered in this Paper

Types of Assets	Detail
Government bonds	Treasury discount bills, Central government securities, Fiscal Investment and Loan Program bonds
Currency and deposits (excluding deposits with the Bank of Japan)	Currency, Transferable deposits, Time and savings deposits, Certificates of deposit, Foreign currency deposits
Deposits with the Bank of Japan	
Loans	Loans by private financial institutions, Loans by the nonfinancial sector, Bills purchased and sold, Installment credit, Repurchase agreements and securities lending transactions
Corporate bonds	Industrial securities, External securities issued by residents
Equities and mutual funds	Shares, Investment trust beneficiary certificates, Trust beneficiary rights
Outward investment	Outward investment in securities, Outward direct investment

3.1 Portfolio Rebalancing at the Macro Level

Looking at portfolio rebalancing at the macro level, we find that since the beginning of 2013, entities other than the BOJ, as a group, have been increasing loans as well as investment in equities and mutual funds and to a lesser extent in corporate bonds, while reducing their holdings of government bonds (Chart 11). During the same period, the BOJ has been increasing government bond holdings through QQE.

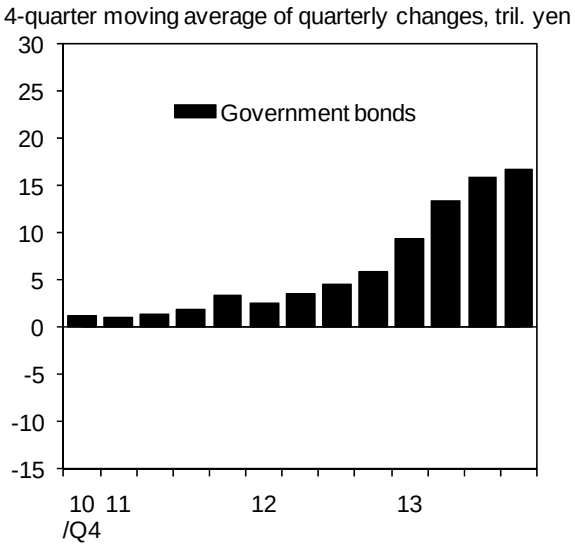
Next, we take a brief look at the contribution of each type of entity to the macro-level investment in equities and mutual funds, corporate bonds, and outward securities investment.[14] Note that for investment in a certain asset to increase at the macro level,

[13] There are three caveats regarding the data used in this section. First, we do not include call loans when we use the Flow of Funds Accounts data for loans. Second, loans made by domestic banks include only loans made by domestic branches of Japanese banks and do not include loans made by foreign branches of Japanese banks. Loans made by domestic banks, however, include loans made by domestic branches of Japanese banks to foreign branches of Japanese banks (so called interoffice accounts). Third, corporate bonds include only industrial securities and external securities issued by residents, and do not include bank debentures, structured financing instruments, and commercial paper.

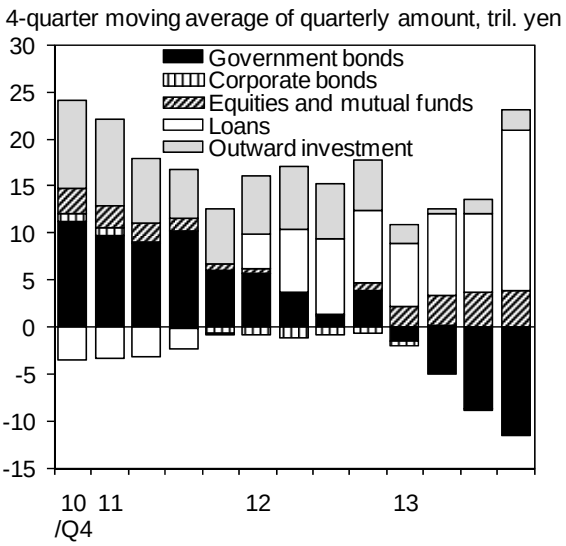
[14] Loans at the macro level can be mostly explained by the behavior of domestic banks, as will be seen shortly.

Chart 11: Portfolio Rebalancing from Government Bonds to Other Assets at the Macro Level

(a) Changes in Government Bond Holdings of the BOJ



(b) Investment Flows of Entities Other than the BOJ



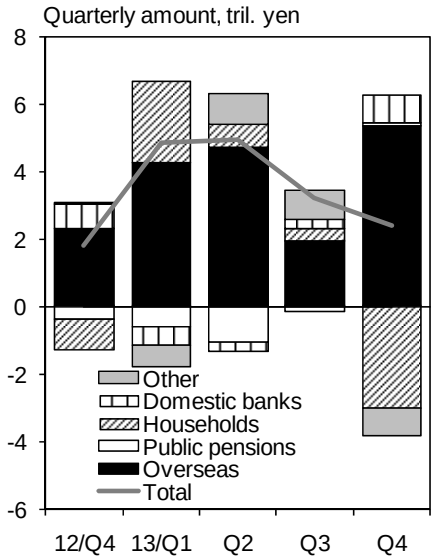
Notes: "Entities other than the BOJ" in (b) includes all entities covered in the Flow of Funds (listed in Chart 4) except for the Bank of Japan. Outward investment consists of outward securities investment and outward direct investment.

Source: Bank of Japan, "Flow of Funds Accounts Statistics."

issuances of that asset must increase. Looking at the results, we find the following. First, total net investment in equities and mutual funds has been positive since the end of 2012, led by the overseas sector (Chart 12). As for investment in corporate bonds, unlike that in equities and mutual funds, no substantial net increase can be observed. Yet, investment in corporate bonds has been positive since the beginning of 2013, implying that the issuance of corporate bonds has increased (Chart 13). As for outward securities investment, no clear pattern since the end of 2012 can be observed: positive net investment by financial institutions for agriculture, forestry, and fishery as well as nonfinancial corporations tends to be offset by negative net investment by domestic banks, public pensions, and corporate pension funds (Chart 14).[15]

[15] Outward investment flows of domestic banks are negative in the second quarter of 2013 (Chart 14). Domestic banks sold medium- to long-term foreign bonds during that period in order to cover losses on Japanese government bonds owing to the increase in long-term interest rates in Japan.

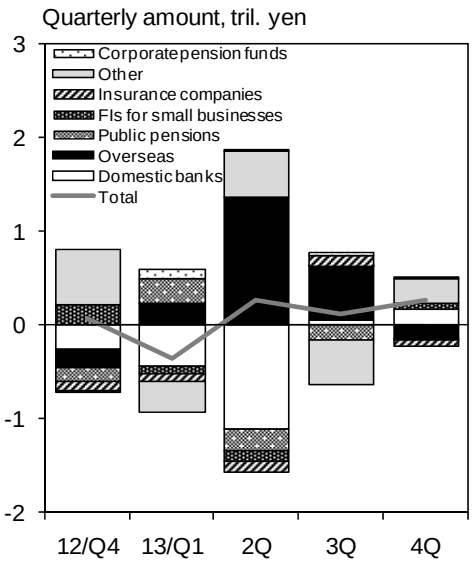
Chart 12: Investment in Equities and Mutual Funds at the Macro Level

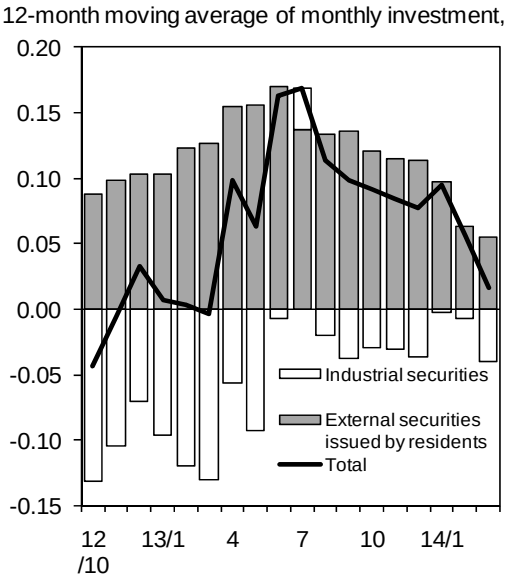


Source: Bank of Japan, "Flow of Funds Accounts Statistics."

Chart 13: Investment in Corporate Bonds at the Macro Level

(a) Investment in Corporate Bonds by Type of Entity (b) Investment in Corporate Bonds by Type

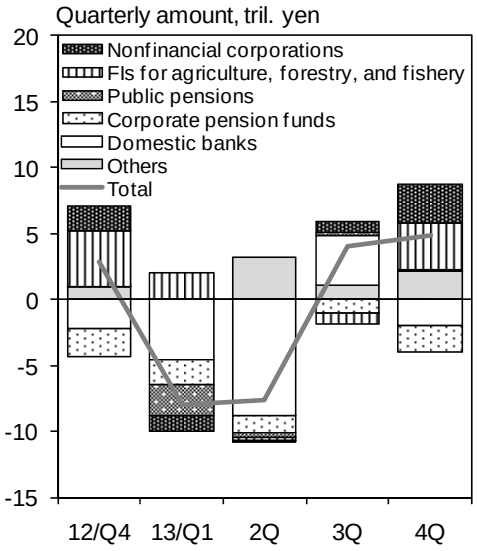




Notes: In panel (a), corporate bonds consist of industrial securities and external securities issued by residents. In panel (b), corporate bonds are domestically issued bonds. Monthly investment is calculated as the difference in the amount outstanding from the previous month.

Sources: For (a), Bank of Japan, "Flow of Funds Accounts Statistics."
For (b), Japan Securities Depository Center and I-N Information Systems "Funding Eye."

Chart 14: Outward Securities Investment at the Macro Level



Note: Outward securities investment is calculated by subtracting outward direct investment and the central government's outward securities investment from outward investment.
Source: Bank of Japan, "Flow of Funds Accounts Statistics."

3. 2 Portfolio Rebalancing of Domestic Banks

We next examine in which assets domestic banks and the overseas sector tend to increase their investment when the BOJ purchases government bonds. Specifically, following Carpenter et al. (2013), we estimate the following regression equation using the Flow of Funds Accounts Statistics: we regress the changes in asset *j* held by each type of entity (A_t^j , in trillion yen) on its one-period lag, on the BOJ's government bond purchases (x_t , in trillion yen), and on other variables that are expected to influence the portfolio choice of domestic banks and the overseas sector (z_t). We are interested in the parameter on the BOJ's government bond purchases (β^j). Specifically, we run the following regression:

$$A_t^j = \alpha^j + \rho^j A_{t-1}^j + \beta^j x_t + \gamma^j z_t + \varepsilon_t^j$$

In this specification, A_t^j represents the seven types of assets listed in Chart 10. Thus, seven equations are estimated for each type of entity. In the estimation, we use seemingly unrelated regression (SUR) to account for potential correlation among the error terms in the seven equations, which may arise when changes in the holdings of the seven types of assets are correlated due to factors not captured by our explanatory variables. As controls (z_t), we use the following three variables: (i) the change in the amount outstanding of asset type *j* in the economy as a whole (in trillion yen), (ii) the one-period lag of the equity yield spread, and

(iii) the one-period lag of the implied volatility of government bond futures.[16] The estimation period is from 1999:Q4 to 2013:Q4.

3.2.1 Estimation Results

Chart 15 presents the estimation results for domestic banks, which indicate that while domestic banks' deposits with the BOJ increase when the BOJ purchases government bonds, their investment in equities and corporate bonds remains unchanged. The coefficient for loans is positive but not statistically significant.

Chart 15: Portfolio Rebalancing of Domestic Banks

(a) All Government Bonds

	Government bonds	Currency and deposits (excluding deposits with the BOJ)	Deposits with the Bank of Japan	Loans	Corporate bonds	Equities and mutual funds	Outward investment
Constant	-5.90*** (1.98)	2.17 (1.43)	-7.50*** (2.64)	4.00 (2.37)	0.37 (0.26)	-0.45 (0.69)	-0.57 (1.47)
Lagged dependent variable	-0.03 (0.11)	-0.24*** (0.07)	-0.41*** (0.11)	0.03 (0.11)	0.23 (0.14)	-0.20 (0.14)	-0.31*** (0.09)
Government bond purchases by the Bank of Japan	-0.32*** (0.09)	-0.02 (0.01)	0.43*** (0.07)	0.04 (0.05)	0.00 (0.01)	0.00 (0.01)	-0.09** (0.03)
Change in assets outstanding in economy overall	0.17** (0.07)	0.08*** (0.02)		0.16*** (0.02)	0.08 (0.08)	0.18*** (0.03)	0.41*** (0.07)
Equity yield spread (lagged one period)	4.01*** (0.85)	-1.19** (0.50)	1.00 (0.95)	-1.56 (1.05)	-0.15 (0.10)	-0.02 (0.20)	0.03 (0.35)
Implied volatility of government bond futures (lagged one period)	1.37** (0.50)	-0.26 (0.19)	0.60 (0.62)	-0.37 (0.70)	0.00 (0.04)	-0.12 (0.13)	-0.02 (0.18)
Sample period	1999/Q4-2013/Q4						

Notes: Figures in parentheses are standard errors obtained from heteroskedasticity and autocorrelation consistent (HAC) covariance matrix estimation.
***, **, and * indicate significance at the 1%, 5%, and 10% significance level, respectively.
Shaded cells indicate a statistically significant decrease in government bond holdings and a statistically significant increase in investments in other assets when the Bank of Japan purchases government bonds.

[16] The reason for including the change in the total amount of assets in the economy as a whole among the control variables is to isolate the effects of the BOJ's government bond purchases from the effects of the issuance and redemption of assets. As for the equity yield spread and the implied volatility of government bond futures, we use the average for each period.

When we separate the BOJ's government bond purchases into purchases of short-term and long-term government bonds, however, domestic banks tend to increase loans when the BOJ purchases long-term government bonds, although bank loans tend to remain unchanged when the BOJ purchases short-term government bonds (Chart 16). In addition, domestic banks also increase investment in equities and mutual funds when the BOJ purchases long-term government bonds, although the size of the increase is relatively small compared to the increase in loans.

Chart 16: Portfolio Rebalancing of Domestic Banks

(b) Short-Term and Long-Term Government Bonds Separately

	Government bonds	Currency and deposits (excluding deposits with the BOJ)	Deposits with the Bank of Japan	Loans	Corporate bonds	Equities and mutual funds	Outward investment
Constant	-5.85*** (1.47)	2.28* (1.34)	-7.48*** (1.68)	4.23** (1.91)	0.46** (0.20)	-0.30 (0.64)	-0.59 (1.56)
Lagged dependent variable	-0.03 (0.09)	-0.26*** (0.08)	-0.44*** (0.10)	-0.02 (0.10)	0.02 (0.17)	-0.23** (0.10)	-0.32*** (0.09)
Short-term government bond purchases by the Bank of Japan	-0.26* (0.15)	-0.05** (0.02)	0.36*** (0.05)	-0.10 (0.07)	0.02* (0.01)	-0.03* (0.02)	-0.06** (0.03)
Long-term government bond purchases by the Bank of Japan	-0.43** (0.18)	0.04* (0.03)	0.59*** (0.09)	0.32** (0.14)	-0.05*** (0.01)	0.06*** (0.02)	-0.13*** (0.04)
Change in assets outstanding in economy overall	0.15 (0.10)	0.07*** (0.02)		0.15*** (0.03)	0.09* (0.05)	0.16*** (0.03)	0.41*** (0.07)
Equity yield spread (lagged one period)	4.39*** (0.68)	-1.38*** (0.32)	0.54 (0.74)	-2.43** (1.09)	-0.04 (0.10)	-0.22* (0.13)	0.19 (0.28)
Implied volatility of government bond futures (lagged one period)	1.32*** (0.43)	-0.24 (0.20)	0.67 (0.55)	-0.26 (0.69)	-0.02 (0.03)	-0.11 (0.13)	-0.04 (0.18)
Sample period	1999/Q4-2013/Q4						

Notes: Figures in parentheses are standard errors obtained from heteroskedasticity and autocorrelation consistent (HAC) covariance matrix estimation.

***, **, and * indicate significance at the 1%, 5%, and 10% significance level, respectively.

Shaded cells indicate a statistically significant decrease in government bond holdings and a statistically significant increase in investments in other assets when the Bank of Japan purchases government bonds.

Further, when we compare the effects of long-term government bond purchases by the BOJ between the periods before and after the introduction of CE in October 2010 -- with the former including the QE period and the latter corresponding to the CE and QQE period --, the increase in bank loans in response to the BOJ's purchases is statistically significant only in the latter period (Chart 17). Chart 18 presents the changes in the assets of domestic banks during CE and QQE period. Especially since 2013, when QQE was introduced, domestic

banks have tended to increase bank loans and decrease government bond holdings.[17] This pattern is consistent with the results from the estimation presented in Chart 17.

Chart 17: Portfolio Rebalancing of Domestic Banks

(c) Period before CE and CE/QQE period

	Government bonds	Currency and deposits (excluding deposits with the BOJ)	Deposits with the Bank of Japan	Loans	Corporate bonds	Equities and mutual funds	Outward investment
Constant	-6.57*** (1.30)	1.88 (1.44)	-6.07*** (1.61)	4.91*** (1.87)	0.28 (0.23)	-0.16 (0.54)	-0.27 (1.47)
Lagged dependent variable	-0.04 (0.10)	-0.26*** (0.08)	-0.45*** (0.09)	-0.03 (0.10)	-0.09 (0.18)	-0.24*** (0.09)	-0.32*** (0.09)
Short-term government bond purchases by the Bank of Japan	-0.28* (0.15)	-0.05*** (0.02)	0.39*** (0.06)	-0.09 (0.06)	0.01 (0.01)	-0.02 (0.02)	-0.05* (0.03)
Long-term government bond purchases by the Bank of Japan (Period before CE)	-0.11 (0.37)	0.23** (0.11)	-0.11 (0.19)	0.00 (0.38)	0.04 (0.03)	-0.03 (0.03)	-0.33** (0.14)
Long-term government bond purchases by the Bank of Japan (CE/QQE period)	-0.38* (0.20)	0.07** (0.03)	0.48*** (0.10)	0.28* (0.15)	-0.04*** (0.01)	0.04*** (0.01)	-0.16*** (0.04)
Change in assets outstanding in economy overall	0.15 (0.10)	0.07*** (0.02)		0.14*** (0.02)	0.02 (0.04)	0.17*** (0.02)	0.43*** (0.07)
Equity yield spread (lagged one period)	4.34*** (0.79)	-1.43*** (0.34)	0.70 (0.53)	-2.38** (1.04)	-0.05 (0.11)	-0.18 (0.12)	0.21 (0.25)
Implied volatility of government bond futures (lagged one period)	1.29** (0.45)	-0.26 (0.22)	0.76 (0.52)	-0.22 (0.74)	-0.02 (0.03)	-0.10 (0.12)	-0.02 (0.20)
Sample period	1999/Q4-2013/Q4						

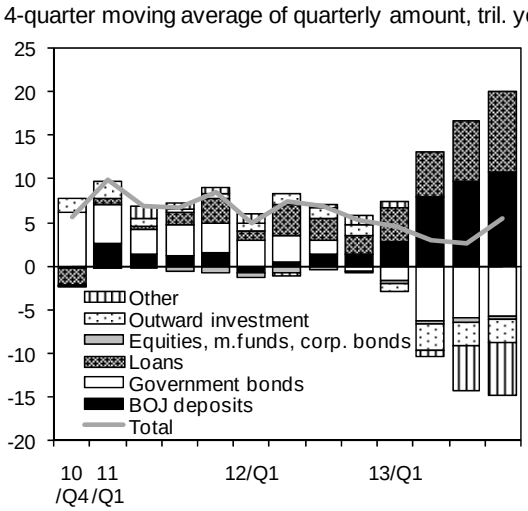
Notes: Figures in parentheses are standard errors obtained from heteroskedasticity and autocorrelation consistent (HAC) covariance matrix estimation.

***, **, and * indicate significance at the 1%, 5%, and 10% significance level, respectively.

Shaded cells indicate a statistically significant decrease in government bond holdings and a statistically significant increase in investments in other assets when the Bank of Japan purchases government bonds.

[17] In addition, domestic banks substantially reduced outward investment in 2013:Q2 (Chart 18). In this quarter, domestic banks sold foreign bonds to cover the valuation losses on Japanese government bonds resulting from the rise in long-term interest rates in Japan. This also seems to influence our estimation results in Charts 16 and 17, which indicate that domestic banks tend to reduce outward investment when the Bank of Japan purchases long-term government bonds.

Chart 18: Changes in Assets of Domestic Banks



Notes: Corporate bonds consist of industrial securities and external securities issued by residents. Loans exclude call loans.
Source: Bank of Japan, "Flow of Funds Accounts Statistics."

3.2.2 The Effects of Interest Rate Risk and the Lending Rate Spread on Bank Lending

It is very likely that financial and economic conditions, such as demand for bank loans and domestic banks' balance sheets, play an important role in the increase in bank loans during the QQE period. However, another factor likely is the fact that the BOJ purchased long-term government bonds with a relatively long remaining maturity during the QQE period (Charts 1 and 2).

From a theoretical perspective, long-term government bond purchases by the central bank -- especially purchases of long-term bonds with long durations -- have two opposing effects on bank lending, namely through the impact of such purchases on interest rate risk and through the impact on the spread between lending and deposit rates. As for the first effect, when banks' government bond holdings decrease as a result of bond purchases by the central bank, banks' interest rate risk on government bond holdings decreases. This frees up risk taking capacity at the banks and therefore should result in an increase in bank lending. Moreover, interest rate risk should decrease more the more banks reduce government bonds with longer time to maturity. These considerations suggest that the BOJ's purchases of long-term bonds with long duration during the QQE period likely reduced banks' interest rate risk and hence promoted lending.

As for the second effect regarding the interest rate spread, central bank purchases of government bonds with a long remaining maturity reduce the term spread (i.e., the spread between long-term and short-term rates) and the spread between banks' lending and deposit rates, reflecting the fact that banks' loans tend to be long term while the deposits they take tend to be short term.[18] A narrowing of the interest rate spread can be expected to weaken the incentive for banks to make loans.

In addition, although this may not be directly related to bond purchases by the central bank, bank lending can be also influenced by factors such as the demand for loans as well as banks' balance sheet conditions, as indicated, for example, by their capital adequacy ratio or nonperforming loan ratio.

To quantitatively examine the role of the two effects outlined above, we conduct a regression analysis as described below. It should be noted that in doing so, we focus on the behavior of "major banks," because it is these banks that greatly reduced their holdings of long-term government bonds in recent period.[19, 20] Specifically, we regress the aggregate monthly lending (in trillion yen) of the major banks on four variables: (i) the interest rate risk of major banks on their government bond holdings (monthly change, in trillion yen),[21] (ii) the interest rate spread (in percentage points), (iii) the diffusion index representing the loan demand of large nonfinancial firms (the data are taken from the Bank of Japan's Senior Loan Officer Opinion Survey, in percentage points), and (iv) the nonperforming loan ratio. We

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[18] This is true for unconventional monetary easing when short-term nominal interest rates are at the zero lower bound, but it is not necessarily true for conventional monetary easing when short-term nominal interest rates are not at the zero lower bound: in the former case, long-term interest rates fall while short-term interest rates remain unchanged, resulting in a decrease in the term spread; in the latter case, short-run nominal interest rates typically fall by a larger amount than long-term interest rates, resulting in a widening in the term spread. For an empirical analysis of this issue for the United States, see Gilchrist et al. (2014).

[19] The group of "major banks" here consists of the following ten banks: five "city banks" (Bank of Tokyo-Mitsubishi UFJ, Mizuho Bank, Sumitomo Mitsui Banking Corporation, Resona Bank, and Saitama Resona Bank), three trust banks (Mitsubishi UFJ Trust and Banking Corporation, Mizuho Trust and Banking Company, and Sumitomo Mitsui Trust Bank), and two other banks (Shinsei Bank and Aozora Bank).

[20] Although not considered in this paper, regional banks in Japan have also started to reduce government bond holdings since the middle of 2013 -- somewhat later than when city banks started to reduce government bond holdings --, and regional banks have been steadily increasing loans in recent years.

[21] The amount of interest rate risk related to the holding of government bonds is calculated as (major banks' aggregate government bond holdings) × (average remaining maturity for the government bonds held by major banks) × 0.01. The monthly change is obtained by taking the difference in the amount of interest rate risk.

use monthly data from April 2007 to September 2013 in the estimation.[22] For further details on the data used in the estimation, see Appendix 1. Since monthly data are subject to seasonality, we use the difference from the same month in the previous year in the estimation.

Chart 19 presents the estimation results. We find that, as expected, both major banks' interest rate risk and their nonperforming loan ratio have a negative impact on bank lending, while both the interest rate spread and loan demand have a positive impact on bank lending.[23] Using the estimation result above, Chart 20 shows the contribution of each of the four explanatory variables to changes in the amount of bank loans outstanding. It indicates that the decrease in interest rate risk related government bond holdings against the background of purchases of long-term government bonds by the BOJ has made a positive contribution to bank lending, especially in 2013. On the other hand, the narrowing of the interest rate spread has continued to work to reduce bank lending since 2010.

Chart 19: Estimation Results Regarding Factors Underlying Bank Lending

Dependent variable: Loans made by domestic branches of major banks (y/y difference of monthly changes)

Constant	Interest rate risk related to government bond holdings (y/y difference of monthly changes)	Interest rate spread (y/y difference)	D.I. for loan demand of large nonfinancial firms (y/y difference)	Nonperforming loan ratio (y/y difference)
0.10***	-2.79***	0.57***	0.04***	-1.49***
(0.01)	(0.83)	(0.20)	(0.00)	(0.10)

Adjusted R^2 : 0.259.

Sample period: April 2007 - September 2013.

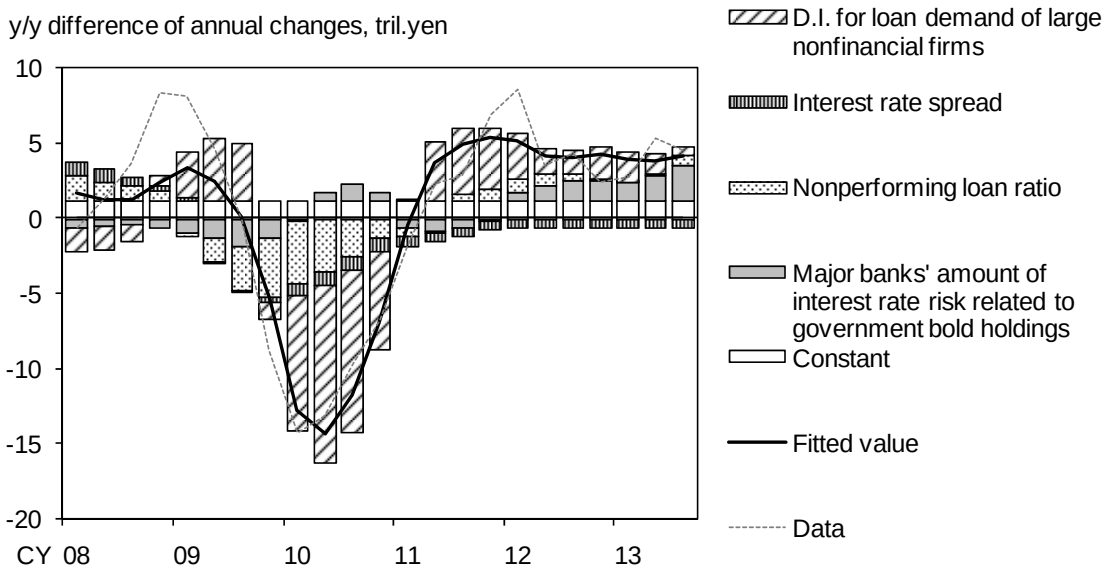
Notes: Figures in parentheses are Newey-West standard errors.

***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

[22] Our sample period ends in September 2013 because data on major banks' interest rate risk are available only up to the first half of fiscal 2013.

[23] The specification here assumes that major banks' interest rate risk has a causal impact on bank lending. Causality, however, may run in the other direction. See Appendix 2 on this point.

Chart 20: Decomposition of the Factors Behind Bank Lending (Domestic Branches of Major Banks)



3.2.3 Changes in the Composition of Bank Loans

So far, we have looked at portfolio rebalancing by domestic banks in terms of the volume of bank lending. We now examine whether there have been any changes in the composition of bank lending under QQE.

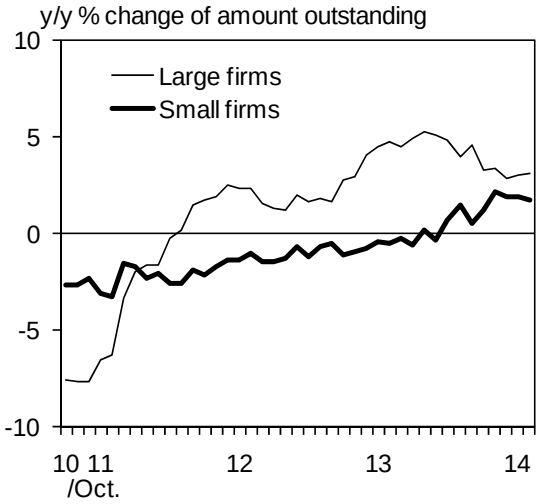
(i) Loans by Firm Size

We first look at loans to large and small firms separately. Chart 21 shows that until the first half of 2013, loans to small firms increased at a much slower pace than loans to large firms. Since the latter half of 2013, however, loans to small firms have increased at a similar pace as loans to large firms. This suggests that the increase in bank lending has become more broad-based.

(ii) Loans by Sector

Next, we look at bank loans to firms by sector. As shown in Chart 22(a), loans to the manufacturing sector and to the nonmanufacturing sector in recent years, and especially since 2013, have been increasing in a balanced manner. This situation contrasts with the latter half of the 1980s, when loans to the nonmanufacturing sector (especially real estate) grew rapidly, while loans to the manufacturing sector lost momentum. That loan growth has been

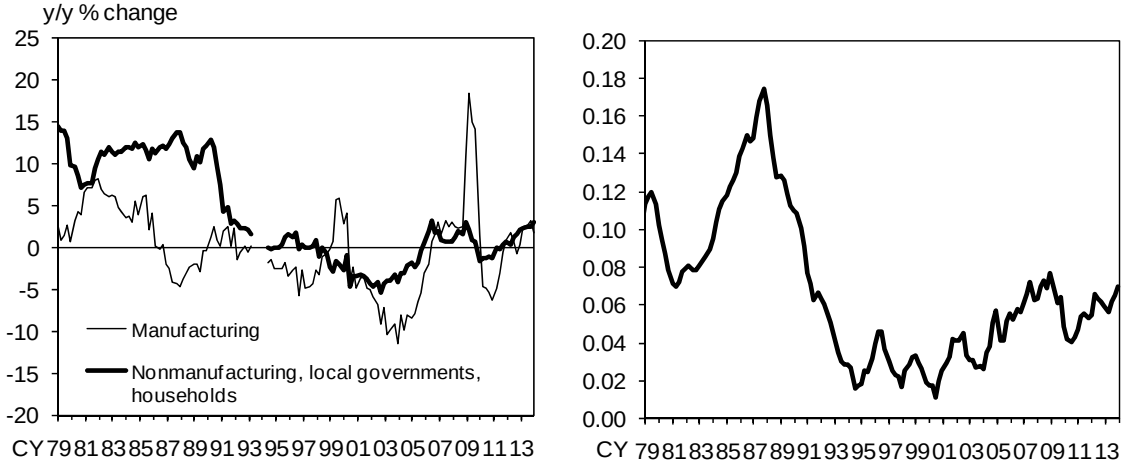
Chart 21: Bank Loans to Large and Small Nonfinancial Firms



Source: Bank of Japan, "Deposits, Vault Cash, and Loans and Bills Discounted."

Chart 22: Bank Lending to Firms by Sector

(a) Amount Outstanding of Loans by Sector (b) Dispersion of Sectoral Loan Growth Rates



Notes: The most recent figures available are those for 2013/Q4. The amount of loans outstanding by sector in panel (a) covers all types of total loans. The discontinuity in the panel is due to the inclusion of overdrafts from June 1993. The dispersion of sectoral loans growth rates in panel (b) is calculated using loans for fixed investment.

Source: Bank of Japan, "Loans and Bills Discounted by Sector."

relatively balanced in recent years can also been seen when measuring the dispersion of sectoral loan growth rates, which is shown Chart 22(b).[24] This also suggests that bank lending has not been substantially biased to any specific sectors.

(iii) Loans by Domestic and Foreign Branches

So far, we have been mainly concerned with loans made by domestic branches of domestic banks. When we look at loans made by foreign branches of city banks separately from loans made by domestic branches, we find that in recent years loans by foreign branches have been increasing at a faster pace than loans by domestic branches of city banks (Chart 23).[25] The increase in loans made by foreign branches is financed not only through local funding obtained by foreign branches (deposits and CDs) but also through loans made by domestic branches to foreign branches (interoffice accounts) (Chart 24). The portfolio rebalancing following the BOJ's government bond purchases may be also contributing to the increase in outward loans, in addition to the increase in domestic loans which we have seen earlier.[26]

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[24] The dispersion of loan growth across sectors is calculated as follows (Saita and Sekine (2001)):

$$\sigma_t^L = \left[\sum_{i=1}^{N} \left(\frac{l_{i,t}}{L_t} \right) \left(\frac{\sum_{k=0}^{3} \tilde{l}_{i,t-k}}{l_{i,t-4}} - \frac{\sum_{k=0}^{3} \tilde{L}_{t-k}}{L_{t-4}} \right)^2 \right]^{1/2}$$

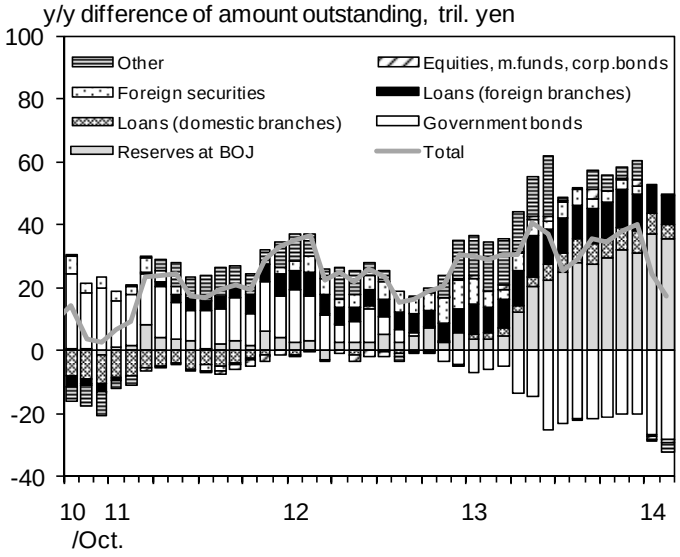
where $l_{i,t}$ is the stock of loans to sector i, $\tilde{l}_{i,t-k}$ is the flow of loans to sector i, L_t is the stock of total loans in the economy as a whole, and $\tilde{L}_{i,t}$ is the flow of total loans in the economy as a whole. The data for loans used here are loans for fixed investment.

[25] The rapid increase in loans made by foreign branches in 2011 reflects the decrease in lending by European banks. The increase in loans made by foreign branches since the latter half of 2012 is influenced by the depreciation of Japanese yen during this period. Note, however, that even if we exclude the effects of exchange rate fluctuations by converting loans made by foreign branches into U.S. dollars, loans made by foreign branches grew faster than loans made by domestic branches (Chart 23(b)).

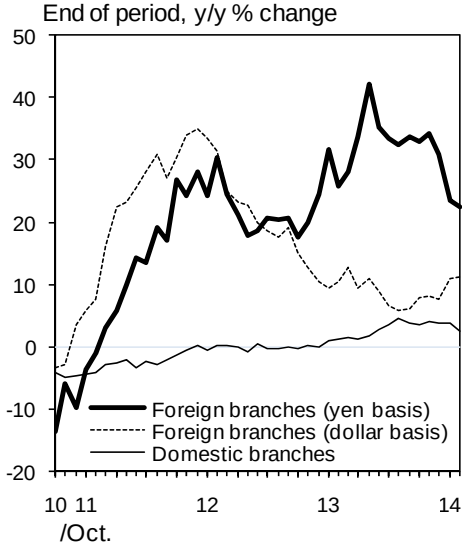
[26] In the Flow of Funds Accounts Statistics used elsewhere in this paper, loans made by domestic branches of domestic banks to foreign branches of domestic banks are classified as loans by domestic banks.

Chart 23: Change in Assets of City Banks

(a) Assets (Total of Domestic and Foreign Branches)



(b) Loans Made by Domestic and Foreign Branches

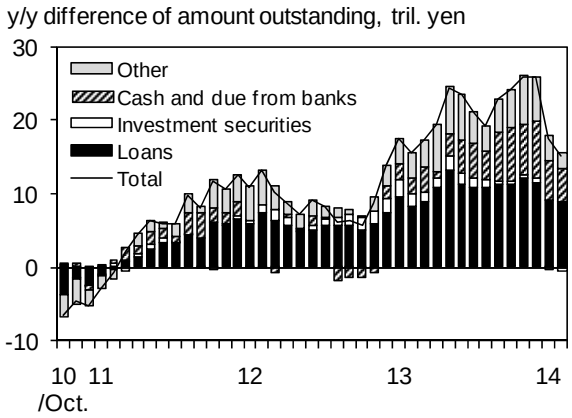


Notes: Assets of city banks do not include interoffice accounts of domestic branches.
In panel (a), the data for "mutual funds" are calculated by subtracting central government bonds, local government bonds, short-term corporate securities, corporate bonds, stocks, foreign securities, and securities loaned from investment securities. Figures include changes in the amount outstanding due to valuation changes. "Loans (domestic branches)" include loans to financial institutions.
In panel (b), "Foreign branches (dollar basis)" is calculated using the end of month yen/dollar rates.

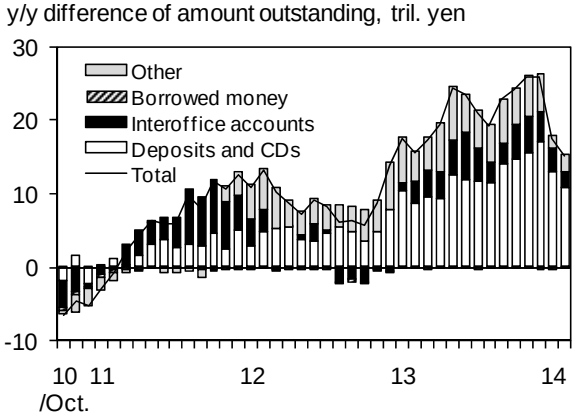
Sources: For "Reserves at BOJ" in panel (a): Bank of Japan, "BOJ Current Account Balances by Sector." All other data are from Bank of Japan, "Financial Institutions Accounts."

Chart 24: Change in Assets and Liabilities of Foreign Branches of City Banks

(Assets)



(Liabilities)



Source: Bank of Japan, "Financial Institutions Accounts."

3.3 Portfolio Rebalancing of the Overseas Sector

Our analysis in Section 2 suggests that the overseas sector tends to reduce government bond holdings when the BOJ purchases government bonds. Here, we examine in which assets the overseas sector increases investment during such periods.

We run a similar regression for the overseas sector as the one we ran earlier for domestic banks using the Flow of Funds Accounts Statistics. The estimation results are presented in Chart 25 and suggest that the overseas sector tends to increase investment in Japanese equities and mutual funds as well as in Japanese corporate bonds when the BOJ purchases government bonds.[27] When we split the sample into the periods before and after the introduction of CE in October 2010, this pattern is more pronounced in the latter period (Chart 26).[28]

Chart 25: Portfolio Rebalancing of the Overseas Sector

(a) Whole Sample Period

	Government bonds	Currency and deposits (excluding deposits with the BOJ)	Deposits with the Bank of Japan	Loans	Corporate bonds	Equities and mutual funds	Outward investment
Constant	6.13*** (1.46)	0.46*** (0.13)		1.35 (1.08)	-0.07 (0.24)	1.24*** (0.45)	
Lagged dependent variable	-0.06 (0.05)	-0.44*** (0.05)		-0.34*** (0.09)	0.15** (0.07)	0.13*** (0.05)	
Government bond purchases by the Bank of Japan	-0.10*** (0.02)	0.00 (0.00)		0.06 (0.04)	0.02*** (0.00)	0.05*** (0.02)	
Change in assets outstanding in economy overall	-0.02 (0.03)	-0.01*** (0.00)		0.10*** (0.01)	0.21*** (0.08)	0.19*** (0.06)	
Equity yield spread (lagged one period)	-0.75* (0.45)	0.01 (0.04)		1.44*** (0.31)	-0.14 (0.08)	-0.18 (0.17)	
Implied volatility of government bond futures (lagged one period)	-0.63** (0.25)	-0.12*** (0.02)		-0.67*** (0.24)	-0.03 (0.03)	-0.21 (0.15)	
Sample period	1999/Q4-2013/Q4						

Notes: Figures in parentheses are standard errors obtained from heteroskedasticity and autocorrelation consistent (HAC) covariance matrix estimation.
***, **, and * indicate significance at the 1%, 5%, and 10% significance level, respectively.
Shaded cells indicate a statistically significant decrease in government bond holdings and a statistically significant increase in investments in other assets when the Bank of Japan purchases government bonds.

[27] The Flow of Funds Accounts Statistics do not cover investment by the overseas sector outside Japan. For this reason, the column labeled "outward investment" in Chart 25 is empty.

[28] According to the estimation results presented in Chart 26, the overseas sector tends to increase loans inside Japan when the BOJ purchases government bonds. Such increase in loans, however, mainly reflects the increase in repurchase agreements and securities lending transactions as well as the increase in loans to Japanese branches of foreign-owned banks. These types of loans are likely to have a smaller impact on the spending of Japanese firms and households than loans to firms and mortgage loans made by domestic banks.

Chart 26: Portfolio Rebalancing of the Overseas Sector

(b) Period before CE and CE/QQE period

	Government bonds	Currency and deposits (excluding deposits with the BOJ)	Deposits with the Bank of Japan	Loans	Corporate bonds	Equities and mutual funds	Outward investment
Constant	7.29*** (1.89)	0.53*** (0.15)		1.82 (1.37)	-0.03 (0.29)	1.33*** (0.31)	
Lagged dependent variable	-0.11** (0.05)	-0.45*** (0.05)		-0.34*** (0.09)	0.14** (0.08)	0.13*** (0.05)	
Government bond purchases by the Bank of Japan (Period before CE)	-0.23*** (0.09)	-0.01** (0.00)		0.01 (0.06)	0.01* (0.01)	0.04 (0.04)	
Government bond purchases by the Bank of Japan (CE/QQE period)	-0.09*** (0.03)	0.00 (0.00)		0.06*** (0.03)	0.02*** (0.00)	0.05*** (0.01)	
Change in assets outstanding in economy overall	0.02 (0.04)	-0.01*** (0.00)		0.10*** (0.02)	0.21** (0.08)	0.19** (0.08)	
Equity yield spread (lagged one period)	-1.24** (0.60)	-0.01 (0.04)		1.27*** (0.29)	-0.16 (0.11)	-0.21 (0.17)	
Implied volatility of government bond futures (lagged one period)	-0.60*** (0.20)	-0.11*** (0.02)		-0.66** (0.26)	-0.02 (0.04)	-0.21 (0.16)	
Sample period	1999/Q4-2013/Q4						

Notes: Figures in parentheses are standard errors obtained from heteroskedasticity and autocorrelation consistent (HAC) covariance matrix estimation.

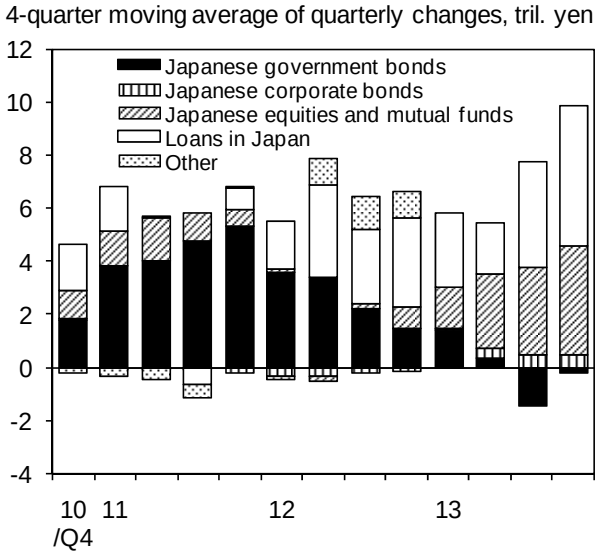
***, **, and * indicate significance at the 1%, 5%, and 10% significance level, respectively.

Shaded cells indicate a statistically significant decrease in government bond holdings and a statistically significant increase in investments in other assets when the Bank of Japan purchases government bonds.

To examine the investment behavior of the overseas sector that underlies the empirical results obtained above, Chart 27 presents the overseas sector's investment flows inside Japan. Since late 2012, the overseas sector has been increasing investment in Japanese equities while reducing holdings of Japanese government bonds. Investment in Japanese corporate bonds has also started to increase since the beginning of 2013. However, it should be noted that because changes in investors' attitude to risk taking in global financial markets likely also play a role in this portfolio shift, not all of this rebalancing can be attributed to portfolio rebalancing in response to BOJ government bond purchases.[29]

[29] The increase in loans inside Japan by the overseas sector in Chart 27, however, mainly reflects the increase in repurchase agreements and securities lending transactions as well as the increase in loans to Japanese branches of foreign-owned banks, and may therefore not be very effective in stimulating the real economy in Japan.

Chart 27: Investment Flows of the Overseas Sector



Source: Bank of Japan, "Flow of Funds Accounts Statistics."

BOX Rebalancing across Maturities

While this paper focuses on the rebalancing across different asset categories, i.e., from government bonds to other assets, in practice rebalancing may also take place across different maturities within the same asset category. In fact, in both Japan and the United States the maturity of newly issued corporate bonds tends to increase when the term spread decreases (Box Chart).[30] In Japan, this pattern can be clearly observed in the period since the introduction of QQE, and the same is true for the United States during periods of increased asset purchases by the Fed through the series of LSAP programs it has conducted. It has been also pointed out that the share of fixed-rate mortgages tends to increase relative to that of adjustable-rate mortgages when the term spread decreases.[31] From the perspective of asset holders or savers, this implies that the maturity of their assets becomes longer; that is, they shift from assets with short maturity to those with long maturity; from the perspective of debtors, this indicates that they borrow for longer terms. In general, when borrowing is more long-term, financing is more stable in the sense that a rise in market interest rates will be reflected more slowly in actual interest payments.[32] For this reason, it may be useful to pay

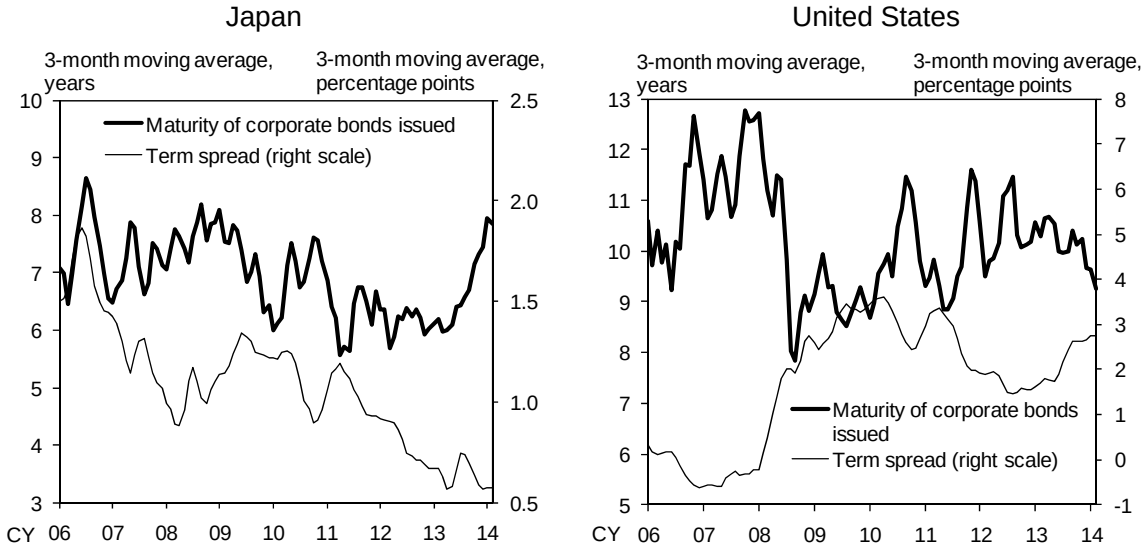
[30] See, e.g., Barclay and Smith (1995) and Guedes and Opler (1996).

[31] See Koijen et al. (2009) and Moench et al. (2010).

[32] See Stein (2012) and Turner (2013) on this point.

attention also to the rebalancing across different maturities when assessing the effects of government bond purchases by central banks.

Box Chart: Term Spread and Maturity of Corporate Bonds Issued



Notes: "Maturity of corporate bonds issued" is the simple average of the maturities of newly issued bonds within each month.
"Maturity of corporate bonds issued" for Japan is calculated from I-N Information Systems "Funding Eye," while for the United States this is calculated from "Dealogic."
"Term spread" is calculated as the difference between 10-year government bond yields for each country and the call rate (uncollateralized) for Japan and the FF rate for the United States.

4 Conclusion

Since the BOJ introduced QQE in April 2013, it has been increasing purchases of government bonds with a longer remaining maturity. In response, mainly domestic banks and the overseas sector have been reducing government bond holdings and increasing loans as well as investment in equities, mutual funds, and corporate bonds in Japan. As a result, looking at portfolio rebalancing at the macro level, entities other than the BOJ, as a group, have been reducing government bond holdings and increasing loans as well as investment in equities, mutual funds, and corporate bonds.

The analysis in this paper suggests that the nature of portfolio rebalancing differs greatly across types of entities, and it also differs depending on the remaining maturity of government bonds purchased by the BOJ. Specifically, when the BOJ purchases mainly short-term government bonds, domestic banks tend to reduce their holdings of government bonds, but do not tend to increase loans. In contrast, when then BOJ purchases government bonds with a

long remaining maturity, domestic banks tend to increase loans. Underlying this difference appears to be the following mechanism. When domestic banks reduce their holdings of long-term government bonds, the interest rate risk they hold decreases by a larger amount than when they reduce their holdings of short-term government bonds. This means that they are more likely to be able to take on additional risk by increasing loans. The overseas sector also tends to reduce government bond holdings when the BOJ purchases government bonds as a result of the decline in interest rates on government bonds, and tends to increase investment in Japanese equities and corporate bonds during these periods. In contrast to these types of entities, insurance companies and corporate pension funds so far have not tended to reduce government bond holdings when the BOJ purchases government bonds.

There are several caveats that apply to the analysis in this paper. This paper attempted to capture portfolio rebalancing that originates from the BOJ's government bond purchases. Part of the results presented in this paper, however, may also capture portfolio rebalancing arising from other sources. For example, factors such as an increase in inflation expectations, an increase in expectations of a currency depreciation, and an expected increase in stock prices may also lead investors to rebalance their portfolios from government bonds to other assets. These changes in expectations may arise from the central bank's government bond purchases, but may also arise from other factors such as an increase in the central bank's target level of inflation.

Our analysis, which is based mainly on time series data, is susceptible to identification problems. In particular, since the sample period after the introduction of QQE is not very long, it is difficult to tell clearly whether the rebalancing behavior of a type of entity is caused by the BOJ's monetary policy or by other factors. In future research, it would be desirable to employ cross-sectional information in addition to time-series information to deal with this identification problem.

Finally, we have seen that, so far, it is mainly domestic banks and the overseas sector that have tended to reduce government bond holdings in response to the BOJ's purchases of government bonds. If other types of entities start reducing their holdings of government bonds, the nature of portfolio rebalancing may differ from what we have seen in the past.

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Appendix 1: Data Used in the Regression Analysis for Bank Lending

The sources and the definition of the data used in the regression analysis presented in Chart 19 are as follows.

Variable	Coverage	Source and Definition
Loans made by domestic branches of major banks	10 major banks	The source is Bank of Japan, "Principal Figures of Financial Institutions."
Major banks' interest rate risk related to government bond holdings	10 major banks	Calculated as: average duration remaining maturity × amount outstanding of government bonds × 0.01. The sources are the annual reports of each bank. Semi-annual data are linearly interpolated to obtain monthly data.
BOJ's interest rate risk related to government bond holdings [Used in Appendix 2]	Bank of Japan	Calculated as: average duration × amount outstanding of government bonds × 0.01. The variable covers both treasury bills and fixed interest-bearing bonds. The remaining maturity of treasury bills is assumed to be 0.2 years. The source for the amount outstanding of fixed interest-bearing bonds is Bank of Japan, "Japanese Government Bonds held by the Bank of Japan," while the source for T-bills is Bank of Japan, "Monetary Base and the Bank of Japan's Transactions." The source for the duration data is Reuter's duration for JGBs across maturities.
Interest rate risk for the entire stock of government bonds in the economy as a whole [Used in Appendix 2]	—	Calculated as: average duration remaining maturity × amount outstanding of government bonds × 0.01. The variable covers both treasury bills and fixed interest-bearing bonds. The remaining maturity of treasury bills is assumed to be 0.2 years. The amount outstanding for fixed interest-bearing bonds is constructed from auction data, while the amount outstanding for treasury bills is from Bank of Japan, "National Government Debt."
Interest rate spread	5 city banks	Calculated as the difference between the lending rate on loans (outstanding loans, total) and the average rate on ordinary deposits. Loan rates are from Bank of Japan, "Average Contract Interest Rates on Loans and Discounts," while deposit rates

		are from Bank of Japan, "Average Interest Rates Posted at Financial Institutions by Type of Deposit."
Diffusion index for loan demand of large nonfinancial firms	Domestic banks	The source is Bank of Japan, "Senior Loan Officer Opinion Survey on Bank Lending Practices at Large Japanese Banks." The D.I. is calculated as: (percentage of respondents selecting "substantially stronger" + percentage of respondents selecting "moderately stronger" × 0.5) - (percentage of respondents selecting "substantially weaker" + percentage of respondents selecting "moderately weaker" × 0.5). Quarterly data are linearly interpolated to obtain monthly data.
Nonperforming loan ratio	5 city banks, 3 trust banks	The data are obtained from Financial Services Agency. Semi-annual data are linearly interpolated to obtain monthly data.

5 city banks: Bank of Tokyo-Mitsubishi UFJ, Mizuho Bank, Sumitomo Mitsui Banking Corporation, Resona Bank, and Saitama Resona Bank

3 trust banks: Mitsubishi UFJ Trust and Banking Corporation, Mizuho Trust and Banking Company, and Sumitomo Mitsui Trust Bank

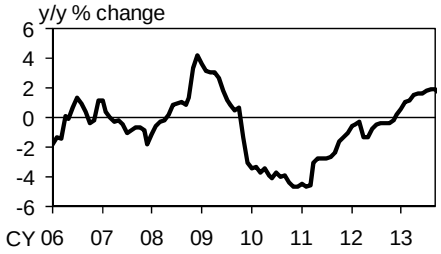
10 major banks: 5 city banks, 3 trust banks, Shinsei Bank, and Aozora Bank

Taking a brief look at the behavior of each variable over the sample period, major banks' interest rate risk related to government bond holdings decreased significantly since early 2013 when QQE was introduced (Appendix Chart 1). The amount of interest rate risk for the BOJ related to government bond holdings increased during the same period, since the BOJ substantially increased purchases of government bonds with long remaining maturity.[33] The interest rate spread has been on a declining trend in recent years. The nonperforming loan ratio fell by a large amount in the first half of the 2000s (not shown in the Chart) and has been more or less flat since the mid-2000s.

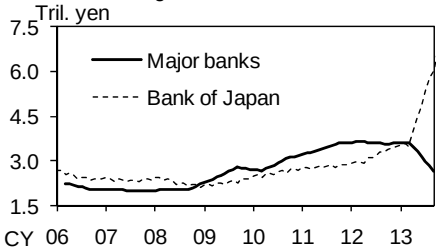
[33] Appendix Chart 1(c) shows the amount of interest rate risk related to government bond holdings for the economy as a whole. This has been steadily increasing as the amount outstanding of government bonds has increased and the maturity of newly issued government bonds has become longer.

Appendix Chart 1: Variables Used in the Estimation for Bank Lending

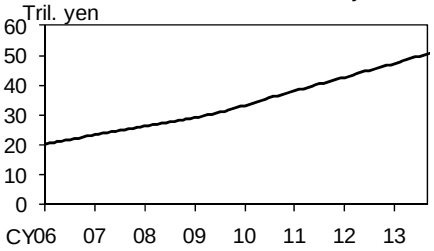
(a) Loans Made by Domesic Branches of Major Banks



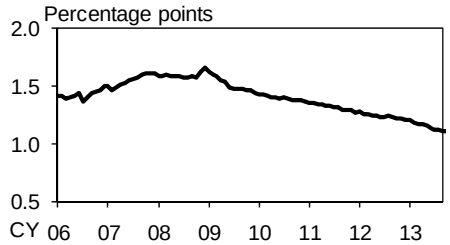
(b) Interest Rate Risk Related to Government Bond Holdings



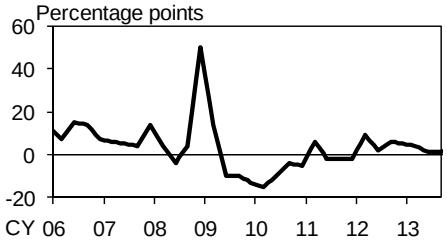
(c) Interest Rate Risk for the Entire Stock of Government Bonds in the Economy as a Whole



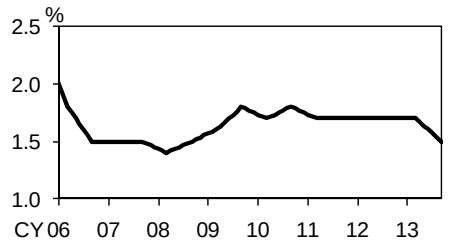
(d) Interest Rate Spread



(e) Diffusion Index for Loan Demand of Large Nonfinancial Firms



(f) Nonperforming Loan Ratio



Appendix 2: Robustness Check for the Regression Analysis on Bank Lending

The results in Chart 19 in Section 3 suggested that a reduction in major banks' interest rate risk related to government bond holdings has a negative and statistically significant impact on bank lending. However, the specification used in that analysis may suffer from endogeneity. Specifically, the specification used for the analysis in Chart 19 assumes that major banks' interest rate risk has a causal impact on bank lending. Causality, however, may run in the other direction; that is, major banks' lending decisions may affect their decisions regarding government bond holdings. If this is the case, one of the explanatory variables -- the interest rate risk for major banks -- and the error term in the regression equation are negatively correlated and the estimated parameters may be biased as a result.

In this appendix, we employ a different estimation that explicitly takes the potential endogeneity into account and show that the results presented in Section 3 are robust. Specifically, we conduct the following two-step instrumental variable estimation. In the first step, we regress major banks' interest rate risk related to government holdings on the BOJ's interest rate risk related to government bond holdings, the interest rate risk for the entire stock of government bonds in the economy, and the three explanatory variables in the original specification (the interest rate spread, the diffusion index for loan demand of large nonfinancial firms, and the nonperforming loan ratio).[34] Among these variables, we expect both the BOJ's interest rate risk and the total interest rate risk for the economy as a whole to be correlated with major banks' interest rate risk;[35] at the same time, we expect that neither of these two variables directly influence bank lending, i.e., neither of these two variables affects bank lending independently of major banks' interest rate risk. Thus, these two variables likely are good instruments for major banks' interest rate risk.

Appendix Chart 2 reports the estimation results for the first step. They suggest that major banks' amount of interest rate risk is negatively correlated with the BOJ's interest rate risk. They further suggest that major banks' interest rate risk is positively correlated with the

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[34] See Appendix 1 for the calculation of the BOJ's interest rate risk related to government bond holdings and for the calculation of the interest rate risk for the entire stock of government bonds in the economy.

[35] The correlation is expected to arise for the following reasons. First, when major banks reduce government bond holdings during a time of government bond purchases by the BOJ, major banks' interest rate risk will be negatively correlated with the BOJ's interest rate risk. Second, when additional government bonds are issued, interest rate risk in the economy as a whole increases; moreover, major banks are likely to purchase part of these additional government bonds, raising their interest rate risk, so that interest rate risk for the economy as a whole and major banks' interest rate risk are likely to be positively correlated.

interest rate risk of entire stock of government bonds in the economy as a whole.

In the second step, we estimate the same specification as in Chart 19, but replace major bank's interest rate risk with the fitted values obtained from the first step. The results are shown in Appendix Chart 3 and indicate that the fitted values from the first step are negatively correlated with bank lending. This suggests that our empirical results in Section 3 -- namely, that major banks' interest rate risk has a negative and statistically significant impact on bank lending -- is robust to explicitly taking the potential endogeneity into account.

Appendix Chart 2: Estimation Results of the First Step

Dependent variable: Major banks' interest rate risk related to government bond holdings (tril. yen)

Constant	Bank of Japan's interest rate risk related to government bond holdings (tril. yen)	Amount of interest rate risk related to government bonds in the whole economy (tril. yen)	Interest rate spread (% points)	D.I. for loan demand of large nonfinancial firms (% points)	Nonperforming loan ratio (%)
4.08***	-0.50***	0.06***	-2.18***	0.003***	0.63***
(0.27)	(0.02)	(0.00)	(0.09)	(0.000)	(0.06)

Adjusted R^2: 0.979.
Sample period: March 2006 - September 2013.
Notes: Figures in parentheses are Newey-West standard errors.
***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Appendix Chart 3: Estimation Results of the Second Step

Dependent variable: Loans made by domestic branches of major banks
(y/y difference of monthly amount)

Constant	Fitted value in the first step (y/y difference of monthly change)	Interest rate spread (y/y difference)	D.I. for loan demand of large nonfinancial firms (y/y difference)	Nonperforming loan ratio (y/y difference)
0.09***	-2.96***	0.36	0.03***	-1.62***
(0.01)	(0.61)	(0.32)	(0.00)	(0.18)

Adjusted R^2 : 0.282.
Sample period: April 2007 - September 2013.
Notes: Figures in parentheses are Newey-West standard errors.
***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.