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Deflation, bank credit growth, and non-performing loans: Evidence from Japan (Article)

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Abstract

In this paper, I examine the link between bank credit growth and non-performing loans in an economy with deflationary pressures. Using panel OLS regressions and two-step GMM regressions, I find evidence for the time-varying relationship between bank credit growth and non-performing loans in a sample of 82 publicly listed commercial banks in Japan during the period 1993-2013. I show that bank credit growth positively correlates with non-performing loans prior to the onset of the global financial crisis of 2007 but negatively correlates with non-performing loans afterwards. I find evidence to support the notion that large banks drive the observed effects of credit growth on non-performing loans. In addition, credit growth and non-performing loans have no effect on profitability. Overall, the findings suggest that while the increase in the supply of bank loans increases the level of non-performing loans, it does not lead to higher profitability. © 2016 Elsevier Inc.

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ABSTRACT

In this paper, I examine the link between bank credit growth and non-performing loans in an economy with deflationary pressures. Using panel OLS regressions and two-step GMM regressions, I find evidence for the time-varying relationship between bank credit growth and non-performing loans in a sample of 82 publicly listed commercial banks in Japan during the period 1993–2013. I show that bank credit growth positively correlates with non-performing loans prior to the onset of the global financial crisis of 2007 but negatively correlates with non-performing loans afterwards. I find evidence to support the notion that large banks drive the observed effects of credit growth on non-performing loans. In addition, credit growth and non-performing loans have no effect on profitability. Overall, the findings suggest that while the increase in the supply of bank loans increases the level of non-performing loans, it does not lead to higher profitability.

1. Introduction

The broad goal of this paper is to empirically test (1) whether the relationship between credit growth and non-performing loans is positive under low inflation conditions and, more importantly, (2) whether this relationship is time varying. Given that banks in Japan experienced economic and financial shocks in the late 1990s as well as during the 2007–2009 financial crisis and had substantial variation in credit growth over the past two decades, Japan is a natural setting where the time-varying relation between credit growth and non-performing loans under deflationary pressures can be examined.

Generally speaking, the literature on non-performing loans has focused mainly on the U.S. banks. However, my data in this paper are based on banks in Japan. One distinguishing feature of the Japanese banks relative to those in the U.S. is that Japan has experienced a long period of deflation, whereas the U.S. has not (at least until the global financial crisis of 2007 when the U.S. faced with a long period of very low levels of inflation). In addition, the Bank of Japan has implemented an expansionary monetary policy for a long period of time to stimulate economic growth. Thus, bankers in Japan encounter different challenges to those faced by bankers in the U.S., Europe, or in emerging markets countries. As it has been well documented that lending standards tend to be softer during periods of low interest rates (see e.g., Maddaloni & Peydró, 2011), very low inflation rates, together with easing monetary policies, in Japan should strengthen the positive relation between credit growth and non-performing loans.

To my knowledge, there has been no systemic analysis of the time-varying relationship between credit growth and non-performing loans in Japan,[1] especially the impact of the global financial crisis on this relationship. The understanding of the sensitivity of non-performing loans to credit growth in large and advanced economies under deflationary pressures such as Japan is important because shocks to financial markets in these countries have substantial ramifications for both the domestic economy itself and the economy of other countries. For instance, without interventions from the central bank, substantial jumps in non-performing loans in the Japanese system naturally lead banks to reduce the supply of loans to firms. The reduction in the supply of loans in the Japanese banking system may have the contractionary impact on not only firms in Japan but also firms in other countries that rely directly or indirectly on loans from banks in Japan.

A long period of very low inflation (or deflation), together with low interest rates and large non-performing loans in the banking system, would typically lead to low credit growth rates and low economic

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[1] It must be noted that banks in Japan are included in the study of Foos et al. (2010). However, their sample period is limited to the pre-global financial crisis. In a closely related study, Barseghyan (2010) examines the effects of a delay of government bailouts on non-performing loans and economic growth in Japan.

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growth rates, which have in fact happened in Japan.[2] The average loan growth rate for a sample of banks in 16 advanced countries during 1997–2007, as reported by Foos, Norden, and Weber (2010) is about 11.3%, while, as can be seen later in this paper, the average credit growth rate in Japan during the period 1993–2013 is −0.65%. With the limited demand for loans due to, e.g., limited investment opportunities, and large amounts of deposits, banks may lower lending standards in order to improve their profitability. If so, credit growth should positively correlate with non-performing loans. However, if banks are concerned with greater non-performing loans in the future as a result of lowering the lending standards, credit growth should negatively correlate with non-performing loans.

I use data from the banking sector in Japan over the period 1990–2013 to test the main hypothesis that the association between credit growth and non-performing loans varies across time. The starting point of the sample period in this study also corresponds to the implementation of the Financial System Reform Act in Japan in 1993, which allowed banks to get involved indirectly in security businesses through a subsidiary. I employ panel ordinary least square (OLS) regressions and dynamic GMM regressions to obtain the estimation results. My evidence regarding the time-varying association between credit growth and non-performing loans fills a gap in the literature for the role of bank loans. I find that credit growth seems to positively correlate with non-performing loans for commercial banks in Japan prior to the onset of the global financial crisis of 2007 and negatively correlate with non-performing loans after the onset of the global financial crisis of 2007. The fact that credit growth has a negative effect on non-performing loans after the onset of the financial crisis could be viewed as an indicator that weakened market discipline, if any, does not result in a higher level of non-performing loans.

An important question is why the relation between credit growth and non-performing loans becomes negative after the global financial crisis. One may argue that the practice of zombie lending in Japan has become less prevalent in recent years; that is, banks no longer keep lending to insolvent borrowers and recognize losses on bad loans in a timely manner.[3] However, such a change in banks' practices would lead to sudden jumps in non-performing loans. Another plausible explanation is that banks significantly tighten up their lending standards, leading to having better quality loans on their balance sheet over time. As a result, the positive effect of credit growth on non-performing loans becomes insignificant after the global financial crisis. In addition, I find that the effects of credit growth on non-performing loans are primarily evident in the large bank sample for the pre-GFC period and the post-GFC period, and that there is no observed relation between credit growth and non-performing in the small bank sample for both periods. These findings indicate that large banks in Japan contribute to the significant relation between credit growth and non-performing loans.

As I find no significant effect of credit growth and non-performing loans on bank profitability, my findings strongly suggest that while the increase in credit growth leads to higher levels of non-performing loans, it has neither direct effects on bank profitability nor indirect effects on bank profitability through non-performing loans. I view these findings as an indication that in the case of Japan or other countries under deflationary pressures (e.g., the United States), an attempt to increase the supply of bank loans to stimulate economic growth may not necessarily pose excessive risk to the financial system. However, these results do not imply that lending standards of banks should be softened in order to increase the supply of loans or to bring about a significant investment stimulus. Rather, the insignificant relation between credit growth and non-performing loans in Japan after the global financial crisis suggests that it is possible to increase the supply of bank loans without increasing non-performing loans.

I organize the reminder of the paper as follows. In Section 2, I provide a brief overview of related studies. In Section 3, I describe my data and variables. In Section 4, I present my empirical framework. In Section 5, I report and discuss empirical results. Finally, I conclude the paper in Section 6.

2. Brief literature review

Bank loans have long been a major source of external financing to firms in both developing and developed countries. The role of the banking sector in stimulating economic activities has been even more prominent in bank-based economies (see e.g., Kaufmann & Valderrama, 2008). However, it has long been documented that the availability of bank loans (hereafter "bank credit") is cyclical (see e.g., Becker & Ivashina, 2014; Bouvatier & Lepetit, 2008; Coffinet, Coudert, Pop, & Pouvelle, 2012; Repullo & Suarez, 2013; Uchida & Nakagawa, 2007). During periods of excess bank credit when banks are more willing to make loans to firms with riskier projects or to firms with lower credit worthiness, firms are more likely to borrow from banks at a relatively lower cost of debt (e.g., a lower interest rate) and potentially invest in projects that are relatively riskier. As a result, banks tend to have a larger share of risky loans and hence are exposed to economic shocks. As recessions emerge and credit markets become tight, the amount of non-performing loans on banks' balance sheet increases and sometimes causes a banking/financial crisis. While the relationship between bank credit growth (hereafter "credit growth") and non-performing loans is expected to be positive, it can be time varying under some conditions since Ellul and Yerramilli (2013) show that variation in the risk management function at banks can explain variation in tail risk, non-performing loans and operating performance.

Prior studies show that macroeconomic environments affect the behavior of banks. For example, Maddaloni and Peydró (2011) show that low short-term interest rates (i.e. during periods of expansionary monetary policy) lower lending standards for loans, and that low long-term interest rates do not lower the standards. In addition, Hsiao, Chang, Cianci, and Huang (2010) note that an increase in non-performing loans will lead to an increase in expenses associated with managing these loans, while Foos et al. (2010) document that loan growth results in a hike in loan loss provisions using a sample of banks in 16 advanced countries over the period 1997–2007. In a recent study, Mayordomo, Rodriguez-Moreno, and Peña (2014) show that non-performing loans and the leverage ratio have the largest economic impact on systemic risk of banks in the US during the period 2002–2011.

Some scholars (e.g. Barseghyan, 2010; Cukierman, 2013) argue that delayed bailouts of the banking and/or financial sector during a financial crisis typically lead to long economic downturns. That is, the presence of large non-performing loans on banks' balance sheets might cause a long-term decline in the real economy. As noted by Barros, Managi, and Matousek (2009), asset price bubbles in the late 1980s and the subsequent equity market crash and shocks to the banking sector in Japan have had profound effects on the real economy of Japan. In addition, Feldkircher (2014) shows that credit growth prior to a crisis on average results in an increase in the cumulative loss in real output.

Most recently, Ağca, De Nicolò, and Detragiache (2013) and Lee and Hsieh (2014) argue that financial reforms following the financial crisis result in tighter lending standards for banks. Improved risk management and stringent lending standards should reduce the amount of non-performing loans. In addition, Espenlaub, Khurshed, and Sitthipongpanich (2012) document that in the case of Thailand, after the financial crisis of 1997–1998, evidence of connections between banks and firms and the impact of this connection on corporate investment (e.g., the investment-cash flow sensitivity) become less evident. However, Beltratti and Stulz (2012) show that variation in bank performance during the global financial crisis of 2007–2008 is not correlated with differences in banking regulations across countries.

[2] During the 1990s and 2000s, the Bank of Japan implemented the zero-interest rate policy as well as the so-called quantitative easing to get Japan out of the deflation trap. For a detailed discussion of the Bank of Japan's unconventional monetary policy, please see Ueda (2012).

[3] For a detailed discussion of zombie lending and how to prevent it, please see Bruche and Llobet (2014).

Aghion, Angeletos, Banerjee, and Manova (2010) argue that tighter credit constraints faced by firms can result in both higher volatility of returns and lower mean productivity growth. As noted by Acharya and Naqvi (2012), loan officers of a bank are typically compensated based on the volume of loans, which naturally lead to greater risk taking of the loan officers. More importantly, Acharya and Naqvi (2012) look at the influence of the banking sector on the formation of asset price bubbles during periods of abundant liquidity. If banks mimic their peers' behaviors, we would observe a similar pattern of bank loans and/or funding strategies. Uchida and Nakagawa (2007) examine whether there are herd behaviors in the banking system and show that for a sample of outstanding loans of Japanese banks during the period 1975–2000, there is evidence for a cyclical pattern of irrational herd behaviors in bank lending. However, Demirgüç-Kunt and Huizinga (2010) show that there is substantial cross-bank variation in business models of banks in terms of (short-term) funding strategies and (non-interest) income strategies prior to the 2007–2009 financial crisis, and that the share of non-interest income to total income is positively associated with the return on assets. In a related study, Chang, Guerra, Lima, and Tabak (2008) document that the concentration in the banking sector, measured as the Herfindahl–Hirschman dual, is negatively associated with non-performing loans in Brazil over the period 2000–2005.

Several factors such as ownership concentration, the P/E ratio, size, and the inefficiency index have been found to affect banks' non-performing loans. For example, Shehzad, de Haan, and Scholtens (2010) document that conditional on supervisory control and shareholders protection rights, concentrated ownership is negatively associated with the non-performing loans ratio in a sample of commercial banks during the period 2005–2007. Chen and Kao (2011) find that the P/E ratio, size, and turnover of collateralized stocks negatively affect non-performing loans for a sample of banks in Taiwan during the period 1998–2008. Louzis, Vouldis, and Metaxas (2012) find that GDP, unemployment, interest rates, public debt, and bank inefficiency is associated with non-performing loans in a sample of banks in Greece.

Given that prior studies such as Cubillas, Fonseca, and González (2012) show that following a banking crisis, market discipline tends to be weakened by intervention policies during the crisis, it is reasonable to expect the financial crisis of 2007 to weaken market discipline in Japan. Consequently, Japanese banks would be less monitored and have opportunities to lower their lending standards to offset the decreasing demand for loans by firms for new corporate investments.

3. Data and variables

In this section, I describe my data in more detail. To examine whether the effect of credit growth on non-performing loans is time varying, I first construct the sample by obtaining a list of all publicly listed commercial banks in Japan during the sample period 1990–2013 from Datastream. To estimate the asymmetric effect of credit growth on non-performing loans prior to and post financial crisis of 2007, I exclude banks that were not listed by the end of 2010.

The initial sample consists of 89 publicly listed banks in Japan.[4] I retrieve annual bank-level financial data over the period 1990–2013 from Datastream and Worldscope. I remove 7 banks from the sample due to missing data on key variable; therefore, the final sample comprises 82 banks in Japan. Due to limited data in Datastream, values for non-performing loans and reserves for loan loss are not available prior to 1993 and 1991, respectively. Therefore, when the dependent variable is involved with non-performing loans, the sample period is from 1993 to 2013. Similarly, when the dependent variable is involved with loan loss reserves, the sample period is from 1991 to 2013.

[4] The initial list includes all banks that are listed in the Tokyo Stock Exchange, the Fukuoka Stock Exchange, and the Japan OTC Exchange.

Consistent with the literature (e.g., Iyer et al., 2014), I measure the non-performing loans ratio (NPLTA) as non-performing loans over total assets. Alternatively, I measure the non-performing loans ratio (NPLTL) as the non-performing loans over total loans, which has been used by several scholars such as Chang et al. (2008), Banker, Chang, and Lee (2010) and Festić, Kavkler, and Repina (2011). To additionally test the robustness of my results, I use the loan loss reserve ratio (LLRTA), which is computed as the ratio of reserves for loan loss to total assets (in %), to measure problem loans.[5]

Similar in sprit to Hammami and Lindahl (2014), I define bank credit (BANKCREDIT) as total loans (TLOAN) and capital lease obligations (LEASE) minus reserves for loan loss (LLR). Accordingly, bank credit growth (BCG) is measured as the first difference in the natural logarithm of the ratio of BANKCREDIT to total assets (in %).

To control for other bank-specific factors that might determine levels of non-performing loans, I include a large set of bank-level control variables. The choice of control variables is a result of a tradeoff between an attempt to address the endogeneity problem (arising from the omitted variables) and an attempt to have a parsimonious model.

As the risk profile of banks might be different due to size, I use bank size (LNTA), which is measured as the natural logarithm of total assets in millions Japanese Yen, to control for the size effect (e.g., various behaviors that vary across bank size).[6] According to the too-big-too-fail effect hypothesis, the probability of bank failures is smaller for large banks due to bailout expectations. That is, central banks or monetary authorities typically provide liquidity to large banks in times of illiquidity shocks or financial crises (Claeys & Schoors, 2007).

Prior studies such as those of Lepetit, Nys, Rous, and Tarazi (2008), Lozano-Vivas and Pasiouras (2010), and Pennathur, Subrahmanyam, and Vishwasrao (2012) typically use the leverage ratio and/or the ratio of non-interest income to total income to measure a bank's risk. A high level of the leverage ratio suggests that a bank is susceptible to exogenous shocks and bank runs. In addition, the bank's revenue diversification has been found to be positively associated with risk premium (see e.g., DeLong, 2001; Laeven & Levine, 2007). In a recent study, DeYoung and Torna (2013) show that the revenue volatility and the probability of bank failure increase with the degree of the bank's revenue diversification. To control for the profitability of banks, I use return on assets (ROA), which is measured as the ratio of EBIT to total assets (in %). This measure of bank performance has been used by a number of scholars such as Athanasoglou, Brissimis, and Delis (2008) and Cohen, Cornett, Marcus, and Tehranian (2014). To control for several aspects of bank risk, I include several variables that proxy for bank risk as control variables. The capitalization ratio (CETA) is measured as the ratio of common equity to total assets (in %). The revenue diversification ratio (BRD) is computed as the ratio of non-interest income to net revenue (in %). The liquidity ratio (LIQ) is measured as the ratio of cash and equivalent to total deposits (in %). The deposit ratio (DEPTA) is computed as the ratio of total deposit to total assets (in %). Operating risk (SDROA) is measured as the 3-year moving standard deviation of ROA.

4. Empirical framework

This article queries whether or not banks' credit growth increases non-performing loans and whether this effect changes over time. To test the main prediction that credit growth positively affects non-performing loans and that this relationship is time-varying, I primarily use two estimation techniques: (1) ordinary least square (OLS)

[5] LLRTA has been used by several scholars such as Bikker and Metzemakers (2005). In addition, Bouvatier and Lepetit (2012) also note that problem loans drive loan loss provisions.

[6] All year-end values for total assets in local currency are converted into USD using corresponding year-end exchange rates. There is evidence that central banks usually extended credit considerably to large banks (Claeys & Schoors, 2007).

regressions, and (2) dynamic GMM regressions. I discuss each of the techniques in more detail in subsections below.

4.1. Panel OLS regressions: the effect of credit growth on non-performing loans

First, to assess the impact of credit growth on non-performing loans, I estimate a series of panel OLS regressions of non-performing loans on credit growth and a set of control variables. As appropriate, I include bank fixed-effects to control for omitted time-invariant bank characteristics, period fixed-effects to control for any unobserved time-variant country effect that affects all banks in the sample, or both.[7]

I attempt to deal with the potential endogeneity problem by lagging all right-hand side variables by one period, which should address reverse-causality concerns (e.g., causal effects running from non-performing loans to independent variables). My approach is consistent with prior studies such as that of Chang et al. (2008). Accordingly, I regress a measure of contemporaneous non-performing loans on lagged credit growth and lagged control variables as follows:

$$NPLTA_{i,t} = \alpha + \beta_1 BCG_{i,t-1} \gamma \mathbf{BCON}_{i,t-1} + \eta_i + \upsilon_t + \varepsilon_{i,t}, \quad (1)$$

where $NPLTA_{i,t}$ is the non-performing loan ratio for bank i at time t; $BCG_{i,t-1}$ denotes the indicator of credit growth for bank i at time t-1; $\mathbf{BCON}_{i,t-1}$ is a vector of bank-level control variables for bank i at time t-1; η_i is a bank-fixed effect; ν_t is a period-fixed effect, and $\varepsilon_{i,t}$ is the zero-mean disturbance term. Standard errors that are adjusted for heteroskedasticity and serial correlation are clustered at the bank level. I expect a positive association between credit growth (BCG) and the non-performing loan ratio (NPLTA).

To examine whether the global financial crisis of 2007–2009 exerts any effect on the relationship between credit growth and non-performing loans, I estimate the following regressions:

$$NPLTA_{i,t} = \alpha + \beta_1 BCG_{i,t-1} + \beta_2 GFC_{i,t-1} + \gamma \mathbf{BCON}_{i,t-1} + \eta_i + \varepsilon_{i,t}, \quad (2)$$

$$NPLTA_{i,t} = \alpha + \beta_1 BCG_{i,t-1} + \beta_2 GFC_{i,t-1} + \beta_3 BCG_{i,t-1} GFC_{i,t-1} + \gamma \mathbf{BCON}_{i,t-1} + \eta_i + \varepsilon_{i,t}, \quad (3)$$

$$NPLTA_{i,t} = \alpha + \beta_1 BCG_{i,t-1} + \beta_2 BCG_{i,t-1} GFC_{i,t-1} + \gamma \mathbf{BCON}_{i,t-1} + \eta_i + \upsilon_t + \varepsilon_{i,t}, \quad (4)$$

where $GFC_{i,t}$ is a dummy variable of the global financial crisis of 2007, which takes a value of one during 2007–2013, and zero otherwise.

The coefficient β_2 in Equation (2) would indicate the direct effect of the global financial crisis of 2007–2009 on the non-performing loans in Japan. If the level of the non-performing loans increases after the onset of the global financial crisis, the coefficient β_2 in Equation (2) should be positive and statistically significant. The significant coefficient β_3 in Equation (3) would indicate the moderating effect of the global financial crisis on non-performing loans. As the global financial crisis should theoretically weaken the positive effect of credit growth on the non-performing loans due to, for example, the stringent lending standards following the onset of financial crisis, I expect this interaction effect to be a buffering one. That is, the coefficient β_3 in Equation (3) and the coefficient β_2 in Equation (4) should be negative.

4.2. Dynamic panel GMM regressions

Credit growth might be an endogenous choice made by banks. Banks' decision to increase or decrease the supply of bank loans could depend on many factors, including the expected loan loss. This means that the estimated coefficient on BCG from Equations (1) through (4) using OLS might not be an unbiased estimate of the effect of credit growth on non-performing loans. I address the endogeneity concerns and the possibility of the presence of simultaneity bias by using the dynamic two-step panel generalized method of moments (GMM) technique to obtain the estimation results. Specifically, I estimate a series of the following baseline dynamic two-step panel GMM models:

$$NPLTA_{i,t} = \alpha + \beta_1 NPLTA_{i,t-1} + \beta_2 NPLTA_{i,t-2} + \beta_3 BCG_{i,t-1} + \gamma \mathbf{BCON}_{i,t-1} + \varepsilon_{i,t}, \quad (5)$$

$$NPLTA_{i,t} = \alpha + \beta_1 NPLTA_{i,t-1} + \beta_2 NPLTA_{i,t-2} + \beta_3 BCG_{i,t-1} + \beta_4 BCG_{i,t-1} GFC_{i,t-1} + \gamma \mathbf{BCON}_{i,t-1} + \varepsilon_{i,t}, \quad (6)$$

where all variables are specified as earlier. In line with prior studies such as those of Arellano and Bond (1991); Athanasoglou et al. (2008); O'Connor and Rafferty (2012), and Ellul and Yerramilli (2013), I use one- and two-period lags of the dependent variable as the right-hand side variables to account for persistence in non-performing loans. Following the literature, I use the one-period lagged values of the same explanatory variables as instruments. To remove the unobserved cross-section effects, I first differentiate the regression equations. I also include period-fixed effects in all GMM regressions to control for unobserved time variant effects. It should be noted that estimating Equations (5) and (6) using the panel OLS regression with fixed effects would

Table 1
Summary statistics of key variables.
Panel A of this table displays summary statistics for variables in the full sample period (i.e., during 1993–2013). Panel B presents summary statistics for variables during 1993–2006, whereas Panel C reports summary statistics for variables during 2007–2013. The non-performing loan ratio (NPLTA) is computed as the non-performing loans over total assets (in %). Bank credit growth (BCG) is measured as the first difference in the natural logarithm of the ratio of bank credit (BANKCREDIT) to total assets (in %). Size (LNTA) is computed as the natural logarithm of total assets in millions Japanese Yen. The capitalization ratio (CETA) is measured as the ratio of common equity to total assets (in %). The liquidity ratio (LIQ) is measured as the ratio of cash and equivalent to total deposits (in %). The revenue diversification ratio (BRD) is computed as the ratio of non-interest income to net revenue (in %). The return on assets ratio (ROA) is measured as the ratio of EBIT to total assets (in %). Operating risk (SDROA) is measured as the 3-year moving standard deviation of ROA.

	Mean	Median	Min	Max	S.D.	N
Panel A: full sample						
NPLTA	2.73	2.33	0.13	9.21	1.87	1,350
BCG	−0.65	−0.52	−10.41	9.32	3.54	1,350
LNTA	14.84	14.74	12.64	18.81	0.93	1,350
CETA	4.63	4.56	0.54	8.23	1.34	1,350
ROA	0.26	0.32	−1.69	1.97	0.47	1,350
LIQ	32.42	30.55	15.27	143.75	12.33	1,350
DEPTA	90.16	91.66	46.11	96.00	6.85	1,350
BRD	21.88	21.24	1.85	57.64	11.09	1,350
SDROA	0.26	0.12	0.00	1.14	0.29	1,350
Panel B: 1993–2006						
NPLTA	2.99	2.72	0.13	9.21	2.21	862
BCG	−0.88	−0.68	−10.41	9.32	3.48	862
LNTA	14.69	14.65	12.64	18.77	0.79	862
CETA	4.50	4.42	0.54	8.23	1.20	862
ROA	0.21	0.30	−1.69	1.97	0.51	862
LIQ	29.93	28.23	15.27	143.51	10.56	862
DEPTA	90.86	91.75	46.11	96.00	5.45	862
BRD	18.37	17.16	1.85	57.64	10.47	862
SDROA	0.28	0.12	0.00	1.14	0.31	862
Panel C: 2007–2013						
NPLTA	2.28	2.13	0.13	6.13	0.85	488
BCG	−0.25	−0.25	−10.41	9.32	3.62	488
LNTA	15.11	14.94	13.30	18.81	1.07	488
CETA	4.85	4.81	0.54	8.23	1.53	488
ROA	0.34	0.37	−1.68	1.97	0.38	488
LIQ	36.81	34.53	15.27	143.75	13.91	488
DEPTA	88.91	91.39	46.31	95.96	8.67	488
BRD	28.08	27.79	4.53	57.64	9.31	488
SDROA	0.24	0.13	0.00	1.14	0.25	488

[7] The bank fixed-effects are included to control for any unobserved time-invariant bank effects, whereas the period fixed-effects are included to control for any unobserved time-variant effects. I rely on Hausman tests to indicate whether fixed-effects estimates are preferred to random-effects estimates.

Table 2
Correlation coefficients.
This table reports correlation coefficient for the sample of 1,350 bank-year observations. The non-performing loans ratio (NPLTA) is computed as non-performing loans over total assets (in %). Bank credit growth (BCG) is measured as the first difference in the natural logarithm of the ratio of bank credit (BANKCREDIT) to total assets (in %). Bank size (LNTA) is computed as the natural logarithm of total assets in millions Japanese Yen. The capitalization ratio (CETA) is measured as the ratio of common equity to total assets (in %). The liquidity ratio (LIQ) is measured as the ratio of cash and equivalent to total deposits (in %). The revenue diversification ratio (BRD) is computed as the ratio of non-interest income to net revenue (in %). The return on assets ratio (ROA) is measured as the ratio of EBIT to total assets (in %). Operating risk (SDROA) is measured as the 3-year moving standard deviation of ROA. Symbols ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	NPLTA	BCG	LNTA	CETA	ROA	LIQ	DEPTA	BRD	SDROA
1. NPLTA	1.000								
2. BCG	−0.121***	1.000							
3. LNTA	−0.191***	−0.013	1.000						
4. CETA	−0.145***	−0.002	0.107***	1.000					
5. ROA	−0.426***	0.065**	0.242***	0.326***	1.000				
6. LIQ	−0.177***	−0.196***	0.514***	0.305***	0.322***	1.000			
7. DEPTA	0.190***	0.022	−0.584***	−0.176***	−0.284***	−0.721***	1.000		
8. BRD	0.174***	−0.053*	0.395***	0.229***	0.178***	0.459***	−0.432***	1.000	
9. SDROA	0.535***	−0.096***	−0.037	−0.252***	−0.448***	−0.075***	−0.017	0.100***	1.000

yield inconsistent results because of the presence of the lagged dependent variable as the right-hand side variable.

5. Results

5.1. Univariate analysis

The bank data set used in this study primarily consists of yearly observations of 82 publicly listed commercial banks in Japan during the period 1993–2013 when non-performing loans are used as the dependent variable. I winsorize all variables at the 1% and 99% quantiles to minimize the effects of outliers. In the robustness section, when I use loan loss reserves as the dependent variable, the sample consists of yearly observations during the period 1991–2013.

Panel A of Table 1 provides summary statistics for key variables. Japanese banks in my sample have a high mean NPLTA (2.73%) relative to those in the US as reported by Mayordomo et al. (2014).[8] In addition, the banks also have a low mean ROA (0.26%). In Panels B and C of Table 1, I present financial ratios prior to and after the onset of the global financial crisis of 2007. The mean NPLTA prior to the crisis (see Panel B) is 2.99%, whereas the corresponding NPLTA after the onset of the global financial crisis is 2.28% (see Panel C), which indicate that, on average and assuming stable NPLTA within both periods, the banks in Japan in my sample experience a decrease in NPLTA after the onset of the global financial crisis. However, the mean credit growth after the onset of the global financial crisis is less negative than that of the pre-global financial crisis period. That is, the mean credit growth (BCG), which decreases from −0.88% during the pre-global financial crisis period to −0.25% during the post-global financial crisis (i.e., [−0.25 − (−0.88)]/−0.88 = 0.72 or 72%), changes more than the change in the mean NPLTA ratio (i.e., (2.28–2.99)/2.99 = 0.23 or 23%). It appears that the NPLTA ratio decreases after the onset of the global financial crisis partly due to improvements in lending standards for banks in Japan, and perhaps due to the decreased demand for loans as a result of falls in investment. In addition, the mean ROA after the crisis is slightly higher than the corresponding ROA before the crisis (i.e. 0.34% vs. 0.21%). Overall, I find weak or no evidence of greater non-performing loans after the onset of the global financial crisis using a sample of 82 banks in Japan between 1993 and 2013.

Table 2 reports correlation coefficients. Generally, I observe low to moderate level of correlations between explanatory variables. Interestingly, the sign of the correlation between non-performing loans (NPLTA) and credit growth (BCG) is negative and statistically significant. Non-performing loans appear to be negatively correlated with bank size (LNTA), the capitalization ratio (CETA), profitability (ROA), and the liquidity ratio (LIQ). However, non-performing loans are positively correlated with the deposit-to-asset ratio (DEPTA), the non-interest income ratio (BRD) and operating risk (SDROA). The positive and significant correlation between credit growth (BCG) and profitability (ROA) is consistent with Becker and Ivashina (2014) who show that the supply of bank loans is driven in part by bank profitability.

5.2. Multivariate analysis

5.2.1. Results of panel OLS regressions: the impact of credit growth on non-performing loans

In Model 1 of Table 3, I first estimate the baseline OLS regression including only control variables without fixed effects over the sample period 1993–2013. The dependent variable is NPLTA, which is the ratio of non-performing loans to total assets. As right-hand variables are one-period lagged, I lose one year of observations when estimating OLS regressions.

The results show that without fixed effects, LNTA, ROA and LIQ are negatively associated with NPLTA, while BRD and RISK are positively associated with NPLTA. CETA and DEPTA are not related to NPLTA. In Model 2, I estimate the baseline regression including both firm- and period-fixed effects.[9] With firm- and period-fixed effects, only ROA and RISK remain associated with NPLTA, while firm size, the liquidity ratio, the capitalization ratio, and the deposit/asset ratio have lost their significance.

To test the main prediction that credit growth increases non-performing loans, I add bank credit growth (BCG), which is the main variable of interest, in Model 3. As the coefficient on BCG is positive and statistically significant, the result indicates that credit growth is positively associated with non-performing loans for the full sample period. In addition, in Model 3, ROA and RISK are still associated with NPLTA.

One of the key questions I want to answer in this paper is whether the link between credit growth and non-performing loans is positive and stable across time, especially after the global financial crisis of 2007. To test whether the global financial crisis of 2007 alters the effect of credit growth on non-performing loans, I interact BCG with GFC, which is a binary variable taking a value of one during 2007–13, and zero otherwise.[10] Given that the coefficient on the interaction term between GFC and BCG in Model 4 is negative and statistically significant, the global financial crisis of 2007 appears to weaken the positive effect of credit growth on non-performing loans. Moreover, the magnitude of the coefficient on the interaction term is almost similar to that of

[8] Mayordomo et al. (2014) report that the mean ratio of non-performing loans to total assets for a sample of 95 U.S. banks during 2002–2011 is 1.5%.

[9] Hausman tests suggest that fixed-effect models are preferred to random-effect models.

[10] Alternatively, I use a GFC1 variable, which is a binary indicator taking a value of one during 2007–2009, and zero otherwise. The pattern of results remains largely unchanged.

Table 3
OLS regressions of the ratio of non-performing loans to total assets (NPLTA).
This table presents the results of panel OLS regressions of non-performing loans, measured as the ratio of non-performing loans over total assets (in %), for a sample of 82 banks during the period 1993–2013. Bank credit growth (BCG) is measured as the first difference in the natural logarithm of the ratio of bank credit (BANKCREDIT) to total assets (in %). Bank size (LNTA) is computed as the natural logarithm of total assets in millions Japanese Yen. The capitalization ratio (CETA) is measured as the ratio of common equity to total assets (in %). The liquidity ratio (LIQ) is measured as the ratio of cash and equivalent to total deposits (in %). The revenue diversification ratio (BRD) is computed as the ratio of non-interest income to net revenue (in %). The return on assets ratio (ROA) is measured as the ratio of EBIT to total assets (in %). Operating risk (SDROA) is measured as the 3-year moving standard deviation of ROA. Standard errors, which are reported in parentheses, are robust to heteroskedasticity and serial correlation and are clustered at the bank level. Symbols ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample period	Full sample period	Full sample period	Full sample period	1993–2006	2007–2013
Constant	4.730**	9.344	11.969**	12.243**	15.370*	−1.361
	(2.077)	(5.963)	(5.892)	(5.894)	(9.164)	(8.465)
$LNTA_{t-1}$	−0.305***	−0.299	−0.486	−0.488	−0.903	−0.222
	(0.084)	(0.364)	(0.363)	(0.363)	(0.625)	(0.513)
$CETA_{t-1}$	0.063	−0.017	−0.015	−0.015	−0.246**	0.121
	(0.053)	(0.068)	(0.068)	(0.068)	(0.108)	(0.088)
ROA_{t-1}	−1.060***	−0.483***	−0.483***	−0.483***	−0.334***	−0.431***
	(0.112)	(0.084)	(0.084)	(0.084)	(0.101)	(0.112)
LIQ_{t-1}	−0.020***	−0.001	0.006	0.005	0.010	0.006
	(0.007)	(0.009)	(0.010)	(0.010)	(0.016)	(0.013)
$DEPTA_{t-1}$	0.018	−0.027	−0.028	−0.030	0.014	0.073***
	(0.013)	(0.023)	(0.023)	(0.023)	(0.036)	(0.025)
BRD_{t-1}	0.046***	0.012*	0.011	0.011	0.013	−0.006
	(0.006)	(0.007)	(0.007)	(0.007)	(0.009)	(0.009)
$SDROA_{t-1}$	2.268***	1.047***	1.045***	1.049***	1.047***	0.095
	(0.242)	(0.166)	(0.165)	(0.165)	(0.196)	(0.188)
BCG_{t-1}			0.023***	0.033***	0.036***	−0.018*
			(0.008)	(0.010)	(0.011)	(0.009)
$BCG_{t-1} \times GFC_{t-1}$				−0.033**		
				(0.015)		
Bank-fixed effects	No	Yes	Yes	Yes	Yes	Yes
Period-fixed effects	No	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.419	0.782	0.784	0.785	0.829	0.701
F-statistics	138.629***	45.656***	45.543***	45.265***	43.124***	13.839***
Banks included	82	82	82	82	78	75
Bank-year observations	1,335	1,335	1,326	1,326	844	482

the coefficient on BCG, suggesting that the net effect of credit growth on non-performing loans after the global financial crisis is almost zero. Since time-variant common shocks (e.g., the government bailout of the financial sector, the Bank of Japan's quantitative easing, etc.) to all banks in the sample are controlled for by period-fixed effects, the finding of the moderating effect of the global financial crisis supports the notion that the relationship between credit growth and non-performing loans is time varying.

To further test whether the relationship between credit growth and non-performing loans is time varying, I divide the sample period into two periods using the onset of the global financial crisis (GFC) of 2007 as a breaking point. The pre-global financial crisis includes observations prior to 2007, whereas the post-global financial crisis includes observations from 2007 to 2013. In the subperiod analysis, I find that BCG has a positive effect on NPLTA in the pre-GFC period (i.e., during 1993–2006), as the coefficient on BCG in Model 5 is positive and statistically significant. However, given that the coefficient on BCG in Model 6 is negative and statistically significant only at the 10% level, credit growth is weakly associated with NPLTA after the onset of the GFC (i.e., during 2007–2013). Overall, these results provide additional evidence for the time-varying impact of credit growth on non-performing loans in Japan.

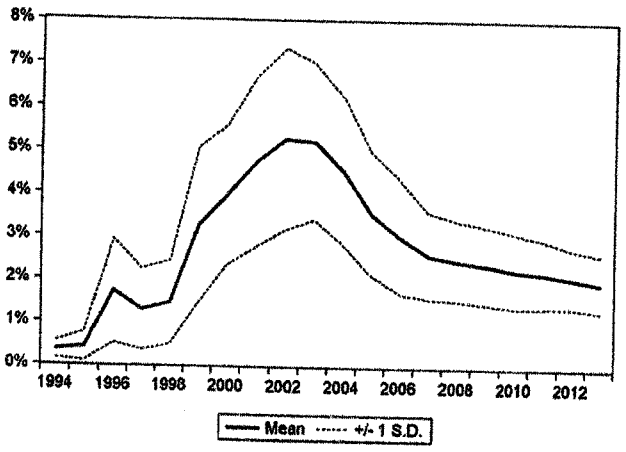

Fig. 1. The ratio of non-performing loans to total assets of Japanese banks in the sample. This figure illustrates a time-series pattern of the mean values of the ratio of non-performing loans to total assets (NPLTA) of Japanese banks in the sample during the sample period.

One plausible explanation for the insignificant effect of credit growth on non-performing loans in the post-global financial crisis is that a tightening of credit standards (e.g., banks' lending standards) in the aftermath of the financial crisis might lead to better quality of loans and hence decouples the link between credit growth and non-performing loans. Another potential explanation is that banks were no longer willing to rollover loans to insolvent borrowers and had large writedowns of loans over a period of time. After recognizing losses and writing down substantial amounts of bad loans, banks have higher quality loans on their balance sheet, causing the positive relationship between credit growth and non-performing loans to be disentangled. To visually see whether this line of reasoning is plausible, I plot the mean values of the ratio of non-performing loans over total assets (NPLTA) during the sample period in Fig. 1. As can be seen, there is a hike in the mean values of NPLTA at the end of the 1990s and the early 2000s, which appears to be a response to the Bank of Japan's initiatives to address bad loans in the banking system.[11] One may argue that these changes may insulate Japanese banks from adverse consequences

[11] A similar pattern is also observed when the mean values of the ratio of non-performing loans to total loans (NPLTL) are plotted.

Table 4
OLS regressions of the ratio of non-performing loans to total loans (NPLTL).
This table presents the results of panel OLS regressions of non-performing loans, measured as the ratio of non-performing loans over total loans (in %), for a sample of 82 banks during the period 1993–2013. Bank credit growth (BCG) is measured as the first difference in the natural logarithm of the ratio of bank credit (BANKCREDIT) to total assets (in %). Bank size (LNTA) is computed as the natural logarithm of total assets in millions Japanese Yen. The capitalization ratio (CETA) is measured as the ratio of common equity to total assets (in %). The liquidity ratio (LIQ) is measured as the ratio of cash and equivalent to total deposits (in %). The revenue diversification ratio (BRD) is computed as the ratio of non-interest income to net revenue (in %). The return on assets ratio (ROA) is measured as the ratio of EBIT to total assets (in %). Operating risk (SDROA) is measured as the 3-year moving standard deviation of ROA. Standard errors, which are reported in parentheses, are robust to heteroskedasticity and serial correlation and are clustered at the bank level. Symbols ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample period	Full sample period	Full sample period	Full sample period	1993–2006	2007–2013
Constant	1.622	11.973	16.056**	16.483**	21.567*	−8.024
	(2.890)	(8.120)	(7.981)	(7.980)	(12.300)	(12.913)
$LNTA_{t-1}$	−0.349***	−0.586	−0.857*	−0.861*	−1.314	−0.231
	(0.117)	(0.496)	(0.492)	(0.491)	(0.838)	(0.779)
$CETA_{t-1}$	0.139*	0.029	0.033	0.033	−0.281*	0.215
	(0.074)	(0.093)	(0.093)	(0.092)	(0.146)	(0.134)
ROA_{t-1}	−1.579***	−0.754***	−0.742***	−0.741***	−0.497***	−0.701***
	(0.155)	(0.115)	(0.114)	(0.114)	(0.135)	(0.173)
LIQ_{t-1}	0.007	0.019	0.026**	0.025*	0.043*	0.033*
	(0.010)	(0.012)	(0.013)	(0.013)	(0.022)	(0.019)
$DEPTA_{t-1}$	0.054***	−0.007	−0.010	−0.013	0.016	0.149***
	(0.019)	(0.031)	(0.031)	(0.031)	(0.048)	(0.038)
BRD_{t-1}	0.067***	0.020**	0.019*	0.018*	0.021	−0.012
	(0.008)	(0.010)	(0.010)	(0.010)	(0.013)	(0.014)
$SDROA_{t-1}$	3.135***	1.383***	1.373***	1.379***	1.331***	0.150
	(0.339)	(0.228)	(0.227)	(0.227)	(0.267)	(0.300)
BCG_{t-1}			0.021*	0.036***	0.045***	−0.033**
			(0.011)	(0.014)	(0.015)	(0.015)
$BCG_{t-1} \times GFC_{t-1}$				−0.052**		
				(0.021)		
Bank-fixed effects	No	Yes	Yes	Yes	Yes	Yes
Period-fixed effects	No	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.412	0.784	0.787	0.788	0.839	0.654
F-statistic	134.596***	46.283***	46.398***	46.167***	46.227***	11.348***
Banks included	82	82	82	82	78	75
Bank-year observations	1,335	1,335	1,326	1,326	844	482

of the global financial crisis, as there is no hike in the mean values of NPLTA after the onset of the global financial crisis of 2007. An alternative explanation for low non-performing loans in the post-global financial crisis is that banks might again continue lending to insolvent borrowers and thus do not recognize losses, thereby leading to low levels of non-performing loans. Unfortunately, I do not have data to indicate whether many banks in Japan engage in zombie lending in the aftermath of the global financial crisis.

As a robustness check, I replace NPLTA with NPLTL,[12] which is computed as the ratio of non-performing loans over total loans. Table 4 reports the results of OLS regressions using NPLTL as the dependent variable. I find that a similar pattern of results can be observed in Table 4. More specifically, credit growth (BCG) has a positive effect on non-performing loans, measured as NPLTL, for the full sample period. The global financial crisis moderates the positive impact of credit growth on NPLTL, as the coefficient on the interaction term in Model 4 is negative and statistically significant. During the pre-global financial crisis period, the effect of credit growth on NPLTL is positive (see Model 5); however, the impact of credit growth on NPLTL becomes negative after the onset of the global financial crisis (see Model 6).

Overall, the results in Table 4 suggest that the effect of credit growth on non-performing loans is positive prior to the onset of the global financial crisis of 2007 and is negative after the onset of the global financial crisis. Hence, the impact of credit growth on non-performing loans in Japan is time varying.

[12] NPLTL has been used by several scholars such as Chang et al. (2008); Banker et al. (2010) and Festić et al. (2011).

5.2.2. Results of dynamic GMM regressions: the impact of credit growth on non-performing loans

To further address the possibility of the presence of simultaneity bias, I use the dynamic two-step panel generalized method of moments (GMM) technique. More specifically, I estimate a series of Equation (4) using NPLTA and NPLTL as the dependent variable. One- and two-period lags of the dependent variable are included as the explanatory variables to control for persistence in non-performing loans. Therefore, I lose two years of observations when estimating the GMM regressions.

Table 5 presents the dynamic two-step panel GMM results using NPLTA as the dependent variable. I use the Sargan test (for over-identifying restrictions) to check whether the validity of my instrument set can be rejected. The results of the tests suggest that the null hypothesis that the over-identifying restrictions are valid cannot be rejected at the 5% level for all models in Tables 5 and 6, implying that the instruments used in this study are appropriate. Results for the Arellano-Bond tests for first-order autocorrelation (AR(1)) and second-order autocorrelation (AR(2)) in the residuals indicate that the first-order statistics are statistically significant, but the second-order statistics are not statistically significant. The absence of second-order autocorrelation in all GMM models suggests the consistency of the estimators.

Before discussing the results of each model, I note that estimated coefficients across specification in Table 5 are fairly stable, indicating that the estimation results are largely consistent. Model 1 of Table 5 is the baseline GMM regression. The coefficient on the first lag of the dependent variable is positive and statistically significant, but the coefficient on the second lag of the dependent variable is not statistically significant. The magnitude of the coefficients on the first lag of the dependent

Table 5
GMM regressions of the ratio of non-performing loans to total assets (NPLTA).
This table presents the results of dynamic panel GMM regressions of non-performing loans, measured as the ratio of non-performing loans over total assets (in %), for a sample of 80 banks during the period 1993–2013. Bank credit growth (BCG) is measured as the first difference in the natural logarithm of the ratio of bank credit (BANKCREDIT) to total assets (in %). Bank size (LNTA) is computed as the natural logarithm of total assets in millions Japanese Yen. The capitalization ratio (CETA) is measured as the ratio of common equity to total assets (in %). The liquidity ratio (LIQ) is measured as the ratio of cash and equivalent to total deposits (in %). The revenue diversification ratio (BRD) is computed as the ratio of non-interest income to net revenue (in %). The return on assets ratio (ROA) is measured as the ratio of EBIT to total assets (in %). Operating risk (SDROA) is measured as the 3-year moving standard deviation of ROA. Standard errors, which are reported in parentheses, are robust to heteroskedasticity and serial correlation and are clustered at the bank level. Symbols ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
	Full sample period	Full sample period	Full sample period	1993–2006	2007–2013
$NPLTA_{t-1}$	0.681***	0.688***	0.690***	0.462***	0.726***
	(0.029)	(0.031)	(0.030)	(0.026)	(0.012)
$NPLTA_{t-2}$	0.007	0.001	0.005	−0.062***	−0.020
	(0.013)	(0.013)	(0.014)	(0.018)	(0.017)
$LNTA_{t-1}$	0.056	−0.030	0.089	−3.102***	0.975***
	(0.121)	(0.178)	(0.209)	(0.416)	(0.282)
$CETA_{t-1}$	0.272***	0.281***	0.297***	0.531***	0.164***
	(0.040)	(0.040)	(0.041)	(0.064)	(0.037)
ROA_{t-1}	−0.137**	−0.146**	−0.156**	−0.108	0.100***
	(0.063)	(0.064)	(0.064)	(0.077)	(0.037)
LIQ_{t-1}	−0.002	0.008	0.002	0.102***	0.007
	(0.005)	(0.005)	(0.006)	(0.011)	(0.009)
$DEPTA_{t-1}$	−0.040***	−0.025*	−0.030**	0.067***	0.034***
	(0.014)	(0.014)	(0.013)	(0.024)	(0.009)
BRD_{t-1}	0.000	−0.001	−0.002	−0.018***	−0.017***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)
$SDROA_{t-1}$	0.432***	0.402***	0.417***	0.544***	−0.210**
	(0.065)	(0.070)	(0.068)	(0.081)	(0.084)
BCG_{t-1}		0.022***	0.034***	0.041***	−0.002
		(0.006)	(0.006)	(0.006)	(0.004)
$BCG_{t-1} \times GFC_{t-1}$			−0.048***		
			(0.014)		
Bank-fixed effects	Yes	Yes	Yes	Yes	Yes
Period-fixed effects	Yes	Yes	Yes	Yes	Yes
Sargan statistic	58.023	53.989	50.970	55.297	54.684
Sargan *p*-value	0.295	0.398	0.475	0.425	0.525
Banks included	80	80	80	75	73
Bank-year observations	1,113	1,103	1,103	640	463

variable in Models 1–3 is close to 1 (e.g., 0.68 in Model 1 of Table 5) implies that that the speed of the adjustment to equilibrium is low.[13]

To test the main effect of credit growth on non-performing loans, I add the bank credit growth variation (BCG) in Model 2. The coefficient on BCG is positive and statistically significant, indicating that credit growth has a positive effect on non-performing loans, after controlling for the persistence in non-performing loans. This result is consistent with the literature that suggests an increase in non-performing loans following higher levels of bank lending (see e.g., Foos et al., 2010).

To test the moderating effect of the global financial crisis, I add the interaction term between BCG and the global financial crisis variable (GFC) in Model 3. As the coefficient on the interaction term is negative and statistically significant and the coefficient on BCG remains positive and statistically significant, these results indicate that the global financial crisis weakens the positive impact of credit growth on non-performing loans.

[13] A value of the coefficient on the one-period lagged dependent variable close to 0 implies that the speed of the adjustment is very high.

To assess the time-varying effect of credit growth on non-performing loans before and after the onset of the global financial crisis, I estimate the dynamic GMM regression for two subperiods (i.e., during the period 1993–2006 and during the period 2007–2013). The coefficient on BCG in Model 4 is positive and statistically significant, indicating that the effect of credit growth on non-performing loans is positive prior to the onset of the global financial crisis of 2007. The coefficient on BCG in Model 5 is negative but statistically insignificant, suggesting that credit growth has no effect on non-performing loans after the onset of the global financial crisis. These results are consistent with the panel OLS regression results shown in Section 5.2.1.

Table 6 presents the GMM results using NPLTL as the dependent variable. I find that the results in Table 6 are generally similar to those reported in Table 5. That is, the impact of credit growth on NPLTL is positive in the full sample (see Models 2 and 3). The global financial crisis weakens the positive influence of credit growth on NPLTL (see Model 3). The effect of credit growth on NPLTL is positive in the pre-global financial crisis period (see Model 4) but is not significant after the onset of the global financial crisis (see Model 5). In sum, the main results that the impact of credit growth on non-performing loans in Japan is time varying are robust to a series of robustness checks.

Table 6
GMM regressions of the ratio of non-performing loans to total loans (NPLTL).
This table presents the results of dynamic panel GMM regressions of non-performing loans, measured as the ratio of non-performing loans over total loans (in %), for a sample of 80 banks during the period 1993–2013. Bank credit growth (BCG) is measured as the first difference in the natural logarithm of the ratio of bank credit (BANKCREDIT) to total assets (in %). Bank size (LNTA) is computed as the natural logarithm of total assets in millions Japanese Yen. The capitalization ratio (CETA) is measured as the ratio of common equity to total assets (in %). The liquidity ratio (LIQ) is measured as the ratio of cash and equivalent to total deposits (in %). The revenue diversification ratio (BRD) is computed as the ratio of non-interest income to net revenue (in %). The return on assets ratio (ROA) is measured as the ratio of EBIT to total assets (in %). Operating risk (SDROA) is measured as the 3-year moving standard deviation of ROA. Standard errors, which are reported in parentheses, are robust to heteroskedasticity and serial correlation and are clustered at the bank level. Symbols ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
	Full sample period	Full sample period	Full sample period	1993–2006	2007–2013
$NPLTL_{t-1}$	0.690***	0.709***	0.699***	0.456***	0.764***
	(0.028)	(0.029)	(0.030)	(0.036)	(0.018)
$NPLTL_{t-2}$	−0.001	−0.009	−0.003	−0.090***	−0.033*
	(0.015)	(0.015)	(0.016)	(0.018)	(0.018)
$LNTA_{t-1}$	−0.013	0.066	0.331	−4.324***	2.261***
	(0.206)	(0.333)	(0.413)	(0.783)	(0.382)
$CETA_{t-1}$	0.372***	0.368***	0.411***	0.588***	0.207***
	(0.049)	(0.049)	(0.058)	(0.111)	(0.047)
ROA_{t-1}	−0.147*	−0.158*	−0.201**	−0.077	0.052
	(0.082)	(0.087)	(0.090)	(0.096)	(0.061)
LIQ_{t-1}	−0.012	−0.002	−0.010	0.134***	0.009
	(0.009)	(0.010)	(0.010)	(0.023)	(0.015)
$DEPTA_{t-1}$	−0.048*	−0.029	−0.025	0.056	0.034**
	(0.025)	(0.025)	(0.023)	(0.053)	(0.014)
BRD_{t-1}	−0.004	−0.004	−0.004	−0.014**	−0.022***
	(0.004)	(0.004)	(0.004)	(0.006)	(0.006)
$SDROA_{t-1}$	0.566***	0.524***	0.544***	0.624***	−0.315***
	(0.108)	(0.107)	(0.105)	(0.124)	(0.096)
BCG_{t-1}		0.020**	0.037***	0.053***	0.001
		(0.009)	(0.009)	(0.012)	(0.006)
$BCG_{t-1} \times GFC_{t-1}$			−0.072***		
			(0.024)		
Bank-fixed effects	Yes	Yes	Yes	Yes	Yes
Period-fixed effects	Yes	Yes	Yes	Yes	Yes
Sargan statistic	56.317	53.798	51.514	54.056	60.826
Sargan *p*-value	0.352	0.405	0.454	0.472	0.306
Banks included	80	80	80	75	73
Bank-year observations	1,113	1,103	1,103	640	463

5.3. Additional robustness checks for the effect of credit growth on non-performing loans

In this subsection, I discuss a number of additional robustness checks that have been performed in this study. First, I use the loan loss reserve ratio (LLRTA), which is computed as the ratio of reserves for loan loss to total assets (in %), as an alternative measure of non-performing loans. Table 7 reports the results of OLS regressions using LLRTA as the dependent variable. A similar pattern of results is still observed. That is, the effect of credit growth on the loan loss reserve ratio is positive and is weakened by the global financial crisis (see Model 4). In addition, the effect of credit growth on the loan loss reserve ratio is positive during the pre-global financial crisis (see Model 5) but is statistically insignificant after the onset of the global financial crisis (see Model 6).

Second, I regress NPLTA on up to three-period lags of credit growth (BCG) to examine the long-term effect of credit growth on non-performing loans since loans are less likely to default within one year. That is, I test whether credit growth in year t-1, t-2, and t-3 affect non-performing loans in year t. In untabulated results, I find that the coefficient on BCG_{t-1} is positive and statistically significant as before, but the coefficients on BCG_{t-2} and BCG_{t-3} are statistically insignificant, indicating that credit growth does not have the long-term effect on non-performing loans for commercial banks in Japan during the sample period.

Third, since the level of risk-taking tends to be higher for larger banks than for smaller banks because the larger banks ex ante expect to be bailed out during a financial crisis, it is possible that larger banks drive the observed relation between credit growth and non-performing loans. As mentioned by Uchida and Nakagawa (2007), there are two types of commercial banks in Japan: city banks and regional banks. City banks are larger and operate nationally and internationally, while regional banks are smaller and operation mainly in a smaller city. To test the size effect on the relation between credit growth and non-performing loans, I divide the sample into two subsamples based on bank size using the cross-sectional median value of total assets. The large bank sample includes observations whose value of total assets is larger than the cross-sectional median value of total assets, while the small bank sample consists of observations whose value of total asset is equal to or smaller than the cross-sectional median value of total assets. The mean value of total assets for the large bank sample is about six times larger than the mean value of total assets for the small bank sample. The difference in the mean of total assets for the two groups is statistically significant at the 1% level. I estimate the main OLS specification (i.e., Equation (1)) separately for the pre- and post-GFC periods for both groups of banks. To save space, I do not tabulate the results. I find that during the pre-GFC period, the positive coefficient on BCG is observed for both large and small bank samples but is only statistically significant at the 10% level for the large bank sample. For the post-GFC period, the coefficient on BCG is negative for both samples and is statistically significant at the 10% and 5% levels, respectively, for the small bank sample and the large bank sample. These results suggest that large banks (e.g., city banks) appear to drive the observed effects of credit growth on non-performing loans in both pre- and post-GFC periods. Precisely, the relation between credit growth and non-performing loans is not evident for the group of small banks (e.g., regional banks) in both periods but is evident for the sample of large banks (e.g., city banks). This pattern of findings remains unchanged when NPLTL is used as the dependent variable.

5.4. The effect of non-performing loans on profitability

An important question arising from the findings shown thus far is whether variation in non-performing loans would improve or lower bank profitability. If an increase in the supply of bank loans is ex ante

Table 7
OLS regressions of the loan loss reserve ratio (LLRTA).
This table presents the results of panel OLS regressions of the loan loss reserve ratio (LLRTA), which is computed as the ratio of reserves for loan loss to total assets (in %), for a sample of 82 banks during the period 1991–2013. Bank credit growth (BCG) is measured as the first difference in the natural logarithm of the ratio of bank credit (BANKCREDIT) to total assets (in %). Bank size (LNTA) is computed as the natural logarithm of total assets in millions Japanese Yen. The capitalization ratio (CETA) is measured as the ratio of common equity to total assets (in %). The liquidity ratio (LIQ) is measured as the ratio of cash and equivalent to total deposits (in %). The revenue diversification ratio (BRD) is computed as the ratio of non-interest income to net revenue (in %). The return on assets ratio (ROA) is measured as the ratio of EBIT to total assets (in %). Operating risk (SDROA) is measured as the 3-year moving standard deviation of ROA. Standard errors, which are reported in parentheses, are robust to heteroskedasticity and serial correlation and are clustered at the bank level. Symbols ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample period	Full sample period	Full sample period	Full sample period	1991–2006	2007–2013
Constant	4.043***	5.374*	4.413*	4.486*	7.144*	−0.587
	(0.926)	(2.749)	(2.669)	(2.666)	(4.196)	(3.515)
$LNTA_{t-1}$	−0.112***	−0.173	−0.126	−0.125	−0.293	−0.068
	(0.038)	(0.168)	(0.164)	(0.164)	(0.278)	(0.212)
$CETA_{t-1}$	0.034	0.005	0.011	0.011	0.029	0.017
	(0.023)	(0.031)	(0.031)	(0.031)	(0.052)	(0.035)
ROA_{t-1}	−0.420***	−0.273***	−0.284***	−0.284***	−0.303***	−0.192***
	(0.047)	(0.043)	(0.043)	(0.043)	(0.054)	(0.048)
LIQ_{t-1}	−0.004	0.001	0.000	0.000	−0.003	0.003
	(0.003)	(0.004)	(0.004)	(0.004)	(0.007)	(0.005)
$DEPTA_{t-1}$	−0.017***	−0.021**	−0.019*	−0.019**	−0.021	0.026**
	(0.006)	(0.010)	(0.010)	(0.010)	(0.015)	(0.010)
BRD_{t-1}	0.009***	0.008**	0.010***	0.009***	0.013***	0.004
	(0.002)	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)
$SDROA_{t-1}$	0.746***	0.427***	0.419***	0.421***	0.440***	0.163**
	(0.093)	(0.078)	(0.077)	(0.077)	(0.097)	(0.079)
BCG_{t-1}			0.007*	0.011**	0.012**	−0.003
			(0.004)	(0.005)	(0.005)	(0.004)
$BCG_{t-1} \times GFC_{t-1}$				−0.017***		
				(0.006)		
Bank-fixed effects	No	Yes	Yes	Yes	Yes	Yes
Period-fixed effects	No	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.298	0.627	0.623	0.624	0.640	0.729
F-statistic	86.313***	22.921***	22.157***	22.054***	17.567***	15.702***
Banks included	82	82	82	82	78	75
Bank-year observations	1,410	1,410	1,398	1,398	916	482

expected to improve bank profitability in the short run and an increase in non-performing loans as a result of the increase in the supply of bank loans negatively affects bank profitability later, banks may attempt to improve short-term profits by increasing the supply of loans. If the level of non-performing loans, which reflect banks' credit risk, does not negatively affect profitability in the short run, then banks would be able to increase the supply of loans without fear of lowering profitability.

Prior studies provide mixed evidence for the link between credit risk and bank profitability. For example, Athanasoglou et al. (2008) show that credit risk (measured as, e.g., the ratio of loan loss provision to total loans) is negatively correlated with bank profitability for a sample of banks in Greece, while Apergis (2014) also show that this relationship is negative for a sample of banks in the United States. However, Dietrich and Wanzenried (2011) find that the relationship is not significant for a sample of banks in Switzerland.

To answer the question of whether non-performing loans are associated with bank profitability, I estimate the impact of non-performing loans on bank profitability, measured as ROA, by using three different approaches. First, I estimate two panel OLS regressions as follows.

$$ROA_{i,t} = \alpha + \beta_1 NPLTA_{i,t-1} + \gamma \mathbf{BCON}_{i,t-1} + \eta_i + \upsilon_t + \varepsilon_{i,t}, \quad (7)$$

$$ROA_{i,t} = \alpha + \beta_1 NPLTA_{i,t-1} + \beta_2 BCG_{i,t-1} + \gamma \mathbf{BCON}_{i,t-1} + \eta_i + \upsilon_t + \varepsilon_{i,t}, \quad (8)$$

where all variables are defined as before. I lag all right-hand side variables by one period.[14] Equation (7) examines whether non-performing loans affect bank profitability, while Equation (8) tests whether the relationship between non-performing loans and bank profitability remains evident after controlling for bank credit growth.

Since I earlier show that credit growth has a positive effect on non-performing loans, the estimation results of Equations (7) and (8) might be inconsistent. Therefore, I alternatively employ the two-stage least square (2SLS) approach by using the predicted value of NPLTA obtained from the first stage regression (i.e., from Model 3 of Table 3) as an instrumental variable in the second stage regressions as follow.

$$ROA_{i,t} = \alpha + \beta_1 PRE\_NPLTA_{i,t-1} + \gamma \mathbf{BCON}_{i,t-1} + \eta_i + \upsilon_t + \varepsilon_{i,t}, \quad (9)$$

$$ROA_{i,t} = \alpha + \beta_1 PRE\_NPLTA_{i,t-1} + \beta_2 BCG_{i,t-1} + \gamma \mathbf{BCON}_{i,t-1} + \eta_i + \upsilon_t + \varepsilon_{i,t}, \quad (10)$$

where PRE_NPLTA is the predicted value of NPLTA obtained from the first stage OLS regression.

Table 8 presents the estimation results of the effect of non-performing loans on bank profitability for the full sample. Models 1 and 2 of Table 7 report the results of panel OLS regressions. The estimated coefficients on NPLTA in both Models 1 and 2 are statistically significant only at the 10% level. Models 3 and 4 show the estimation results of the 2SLS regressions. The insignificant coefficients on NPLTA in Models 3 and 4 further confirm that the insignificant effect of non-performing loans on bank profitability, after controlling for bank-specific characteristics such as operating risk. The magnitude of the coefficients is fairly stable across specifications, indicating that the results from panel OLS and 2SLS regressions are largely consistent. Results in Models 1 through 4 suggest that liquidity risk and operating risk appear to play a major role in explaining variation in bank profitability. Consistent with theories, liquidity risk and operating risk are positively associated with ROA, indicating that banks might try to increase profits by taking on higher levels of risk.

Overall, the findings in Table 8 suggest that the level of non-performing loans has no effect bank profitability. When the finding that bank profitability has a negative effect on non-performing loans (see Table 3) is taken into account, it is reasonable to conclude the results documented in this paper indicate that the relationship between non-performing loans and bank profitability is not bi-directional and runs from bank profitability to non-performing loans. To summarize, I find that banks with higher credit growth rates have higher levels of non-performing loans but the positive effect of credit growth on non-performing loans does not have a significant effect on profitability. More importantly, bank credit growth has no effect on profitability after controlling for non-performing loans and other bank-specific factors.

[14] Some studies such as Apergis (2014) do not lag the right-hand side variables and thus examine the contemporaneous relationships.

Table 8
The effect of non-performing loans on bank profitability.
This table presents the results of panel OLS regression and 2SLS regressions of profitability (ROA), measured as the ratio of EBIT to total assets (in %), on non-performing loans (NPLTA), measured as the ratio of non-performing loans over total assets (in %). PRE_NPLTA is the predicted value of NPLTA obtained from the first stage regression of Model 3 of Table 3.Bank credit growth (BCG) is measured as the first difference in the natural logarithm of the ratio of bank credit (BANKCREDIT) to total assets (in %). Bank size (LNTA) is computed as the natural logarithm of total assets in millions Japanese Yen. The capitalization ratio (CETA) is measured as the ratio of common equity to total assets (in %). The liquidity ratio (LIQ) is measured as the ratio of cash and equivalent to total deposits (in %). The revenue diversification ratio (BRD) is computed as the ratio of non-interest income to net revenue (in %). The return on assets ratio (ROA) is measured as the ratio of EBIT to total assets (in %). Operating risk (SDROA) is measured as the 3-year moving standard deviation of ROA. Standard errors, which are reported in parentheses, are robust to heteroskedasticity and serial correlation and are clustered at the bank level. Symbols ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	(1) OLS	(2) OLS	(3) 2SLS	(4) 2SLS
Constant	−2.959	−3.039	−3.589*	−3.682*
	(1.983)	(1.969)	(2.148)	(2.134)
$LNTA_{t-1}$	0.128	0.138	0.158	0.171
	(0.121)	(0.120)	(0.130)	(0.129)
$CETA_{t-1}$	−0.035	−0.034	−0.028	−0.027
	(0.022)	(0.022)	(0.023)	(0.023)
LIQ_{t-1}	0.009***	0.008***	0.009***	0.007**
	(0.003)	(0.003)	(0.003)	(0.003)
$DEPTA_{t-1}$	0.015*	0.014*	0.016**	0.016*
	(0.008)	(0.008)	(0.008)	(0.008)
BRD_{t-1}	−0.005*	−0.005*	−0.005*	−0.005*
	(0.003)	(0.003)	(0.003)	(0.003)
$SDROA_{t-1}$	0.142**	0.141**	0.147***	0.144*
	(0.057)	(0.057)	(0.064)	(0.064)
$NPLTA_{t-1}$	−0.027*	−0.027*		
	(0.015)	(0.015)		
PRE_NPLTA_{t-1}			−0.029	−0.029
			(0.039)	(0.039)
BCG_{t-1}		−0.005		−0.006
		(0.004)		(0.004)
Bank-fixed effects	Yes	Yes	Yes	Yes
Period-fixed effects	Yes	Yes	Yes	Yes
Adj. R^2	0.381	0.383	0.366	0.369
F-statistic	8.407***	8.368***	7.845***	7.856***
Banks included	82	82	80	80
Bank-year observations	1,279	1,271	1,234	1,231

6. Conclusion

Japan provides a natural experiment to test empirically whether the effect of credit growth on non-performing loans varies over time when a country is under deflationary pressures and follows an expansionary monetary policy to stimulate economic growth and escape deflation. As scholars such as Maddaloni and Peydró (2011) show that bank lending standards are softer during periods of low interest rates, it is reasonable to expect that banks' credit growth should negatively correlate with the quality of loans, which is inversely correlated with non-performing loans. Therefore, I examine the relation between credit growth and non-performing loans of publicly listed commercial banks in Japan during the period 1990–2013.

I find that for commercial banks in Japan during the sample period, credit growth positively correlates with non-performing loans prior to

the onset of the global financial crisis of 2007 and negatively correlates with non-performing loans after the onset of the global financial crisis of 2007. My evidence regarding the time-varying link between credit growth and non-performing loans in Japan fills a gap in the extant literature for the role of bank loans in an economy with deflation. My analysis sheds light on the time-varying nature of the impact of credit growth on non-performing loans. In particular, the results suggest that the global financial crisis of 2007 alters the link between credit growth and non-performing loans. One implication of these results is that the global financial crisis of 2007 appears to somehow alter the mechanisms/channels through which bank lending affects non-performing loans for banks in Japan.

In conclusion, this study confirms the notion that the relationship between banks' credit growth and non-performing loans varies over time, and that bank credit growth and non-performing loans are not associated with bank profitability. Given the urgency of countries that are under deflationary pressure to stimulate economic growth but are concerned with potentially greater risk in the banking system due to increases in the supply of loans (e.g., Japan and some European countries), I underscore empirically the fact that an increase in bank credit growth does not always lead to higher levels of non-performing loans.

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